BeWater

Making society an active participant in water adaptation to global change

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D4.2 Four draft adaptation plans, one for eachCSRB

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Reference

BeWater (2015). Four draft adaptation plans, one for each CSRB. Deliverable D4.2, BeWater, FP7 project no. 612385 -SIS.2013.1.2-1 European Commission, 380 pp.

Executive summary

While many initiatives have begun to integrate climate change in water management at multiple scales, few attempts have been made to address this issue in *river basin management*. The BeWater project aims to respond to this gap by developing River Basin Adaptation Plans (RBAPs) in each of its four Mediterranean case study areas. A further objective is to move away from the traditionally expert-dominated approaches to adaptation planning and instead facilitate a bottom-up co-design process with local stakeholders and actors. This deliverable thus presents a first draft of the four case studys' RBAPs, the outcome of the ongoing collaboration between societal and scientific community representatives in each basin.

The present deliverable follows a modified version of the outine presented in Deliverable 2.3 and partially integrates the results to date of Work Packages 3 and 4 in the BeWater project. The incomplete chapters of the current RBAP drafts will be finished by March 2016, at which time the draft plans will be discussed and validated by stakeholders in an interactive workshop in each basin and subsequently adapted to take feedback into account before being finalized.

The deliverable is structured according to the four case study river basins focused on within the BeWater project, namely: 1) Tordera river basin, Spain; 2) Vipava river basin, Slovenia; 3) Pedieos river basin, Cyprus; 4) Rmel river basin, Tunisia. Each RBAP presented includes an *introduction* to the river basin, information on the *current and future state of the basin*, and the developed *water management options*.

Contents

1. Introduction

Climate change is increasingly being recognized as a crucial consideration in many policy areas, not least of which is water management. While many initiatives have begun to integrate climate change in water management at multiple scales, few attempts have been made to address the issue in *river basin management*.

The BeWater project aims to respond to this gap by developing River Basin Adaptation Plans (RBAPs) in each of its four Mediterranean case study areas. A further objective is to move away from the traditionally expert-dominated approaches to adaptation planning and instead facilitate a bottom-up co-design process with local stakeholders and actors. This deliverable thus presents a first draft of the four case studys' RBAPs, the outcome of the ongoing collaboration between societal and scientific community represenatives in each basin.

As a first step towards drafting the plans presented here, a review of existing RBAP examples and experiences (deliverable D4.1) was conducted to (1) learn from initiatives integrating climate adaptation into water management planning processes at river basin or sub-catchment level, (2) identify and illustrate key areas of interest for the preparation of BeWater plans and (3) lay the foundation for a collective discussion within the consortium on the appropriate content of RBAPs and suitable methods to be used in developing them.

Building on this review, a protocol (deliverable D2.3) was subsequently written to guide the development process of the RBAPs. The protocol aims to homogenise the considerations, information and activities included in the plans across the case studies and accordingly consists of two main parts:

- Part A: a step-by-step guidance on how to prepare the RBAPs.
- Part B: a (draft) outline and brief content descriptions of the final BeWater RBAPs.

The present deliverable follows a modified version of the outine presented in D2.3 and partially integrates the results of step 2.1 ('*Characterising policy and stakeholder basis of WMOs'*), Work Package 3 and Task 4.1 in the BeWater project. The remaining steps as outlined in the protocol will be completed by March 2016, at which time the draft RBAPs will be discussed and validated by stakeholders in an interactive workshop in each basin and subsequently adapted to take feedback into account before being finalized. Remaining steps are the assessment of the co-benefits and conflicts between water management options and the bundling of the water management options. Chapter 4 of each plan will be restructured according to bundles for the different challenges and filled with information on the water management options from the existing and remaining assessments.

The deliverable is structured according to the four case study river basins focused on within the BeWater project, namely: 1) Tordera river basin, Spain; 2) Vipava river basin, Slovenia; 3) Pedieos river basin, Cyprus; 4) Rmel river basin, Tunisia. Each RBAP presented includes an *introduction* to the river basin, information on the *current and future state of the basin*, and the developed *water management options*.

2. Tordera, Spain

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Foreword

From 2013-2017, the BeWater project involved four Mediterranean river basin case studies, each developing a specific river basin adaptation plan. The European Commission's 7th Framework Programme funded the project, which involved 12 consortium members. Close cooperation between the four river basins, including Tordera River Basin as well as Pedieos, Rmel and Vipava River Basins, and the remaining project partners guided the process of writing the respective river basin adaptation plans.

Over the course of the three and a half-year project, the following river basin adaptation plan for the Tordera River Basin has been developed. This basin was selected due to the need for increased awareness of challenges facing its citizens and the environment due to global changes and to the availability of information from in depth previous studies that assessed global change impacts in the basin. The plan that has been developed is thus the result of intense team effort, targeted information gathering, wide stakeholder involvement, critical analysis, and thoughtful planning.

The main emphasis of this river basin adaptation plan is water management, used as a leitmotif to integrate sectoral perspectives and other policy frameworks, like agriculture, forest or urban planning. The goal of the adaptation plan is to act as a catalyst for the development of further river basin adaptation plans in the Mediterranean region, as well as across Europe more broadly.

2.1 Introduction

2.1.1 Context

2.1.1.1 Description of the Tordera Basin

Tordera River Basin is located in the northern part of Catalonia (NE Spain) and presents overall Mediterranean climate conditions but with a high climatic diversity, ranging from the temperate areas at the headwaters mountaintops to typical Mediterranean conditions in its delta area (Fig 1.1).

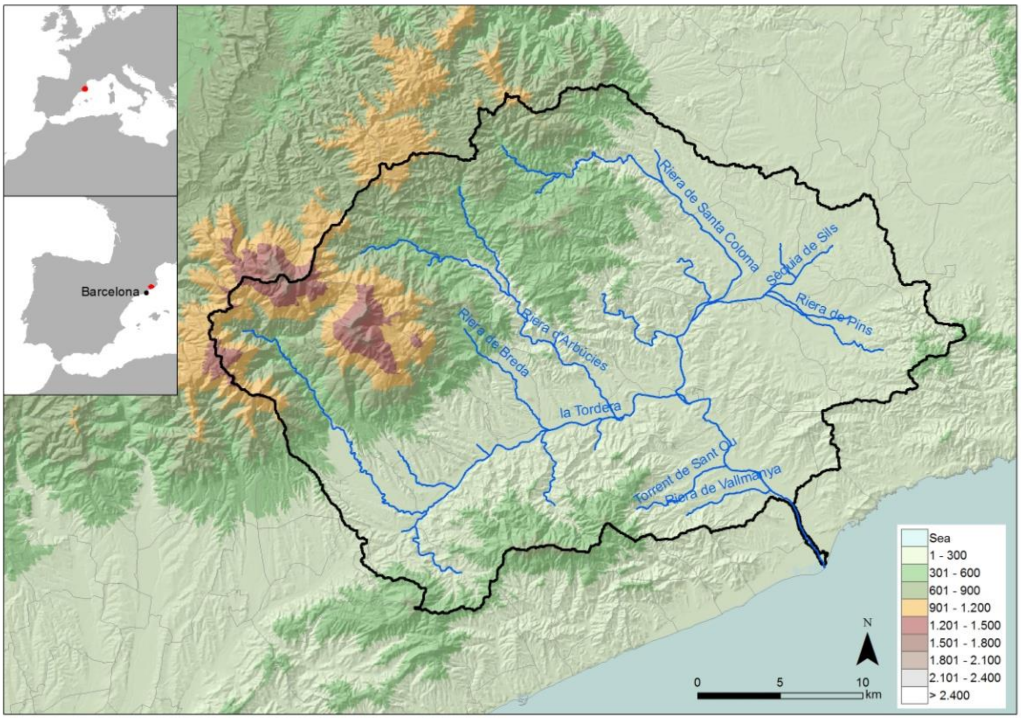


Figure 1.1: Geo-localization of the River Tordera Basin. Source: own elaboration

The Tordera River flows for 55 km along the Catalan Pre-Coastal Range through 3 counties; Vallès Oriental, Selva and Maresme, and covers an area of 894 km^2 between the provinces of Barcelona and Girona, 81% of which is covered by forests. Different forms of environmental protection safeguard its richness in biodiversity: some areas are included in the Catalonian network of Natural Protection Sites, a number of them have been declared Habitats of Communitarian Interest and there are two natural parks: Montnegre Corredor and Montseny, the latter designated in 1978 by UNESCO as a biosphere reserve.

This natural landscape, as well as the basin's proximity to Barcelona and the Mediterranean Sea makes Tordera Basin a very intensive touristic area. The Basin has approximately 111,800 inhabitants[1], with unbalanced population distribution, exacerbated by major fluctuations in the touristic season, when population of most coastal towns doubles or triples.
The Tordera River is part of the Catalan Internal River Basin District[2], it has an average flow of 5 m^3/s with a torrential regime. Main course of the Tordera river recieves two tributary streams: Arbùcies and Santa Coloma, located north and north-east from the main course. The river is characterized by intense flooding episodes called *Torderades*, and river dynamics design a bending trace, generating fertile riparian areas often used for agriculture and short rotation timber production. Historically, most agriculture land was located in the alluvial plain of the river mouth area and riparian areas along the whole river. Starting from the '70s other activities were developed in the riverbed, such as gardening centres or industrial areas, as well as inter-regional

[1] Source: ACCUA 2011, own figures based on data from ACA and IDESCAT
[2] http://aca-web.gencat.cat/aca/appmanager/aca/aca;jsessionid=vFvKJhVMSG6hCQRGp5m08KgpyCnXbpVCYWJkgyyFBLvH1y57m1W7!-283999339!1745676463?_nfpb=true&_pageLabel=P46600176421381934582085

transport infrastructure (highways, railways, gas, oil and water pipelines) and entailed the building of hillocks and canalization of the main stream in different locations.

Land use developed during the last century has lead to high fragmentation of the basin's territory (Fig. 1.2). and changed stream and sediment dynamics. Consequences entail, for example, that connectivity between the river and shallow aquifers is lost in certain sites. Indeed, a highly permeable geological mosaic characterizes the hydrogeology of the basin where surface and groundwater are very much interconnected.

Tordera river water use exceeds availability; therefore management has been mostly supply oriented: a desalination plant and connection to inter-basin water transfer systems integrate local resources (ATLL[3]). Indeed, given there are not many water regulation infrastructures in the Tordera main course, groundwater flows are currently by far more important than surface water for supplying all users.

In the central (river water) and lower part of the river (groundwater) agriculture demand is a direct competitor with urban demand, especially in the summer. Tordera aquifers also provide water to intensive horticulture in areas outside the Tordera basin boundaries in the coastal area of Maresme County. Therefore, this area is included in the analysis, although formally not considered as the Tordera river basin district.

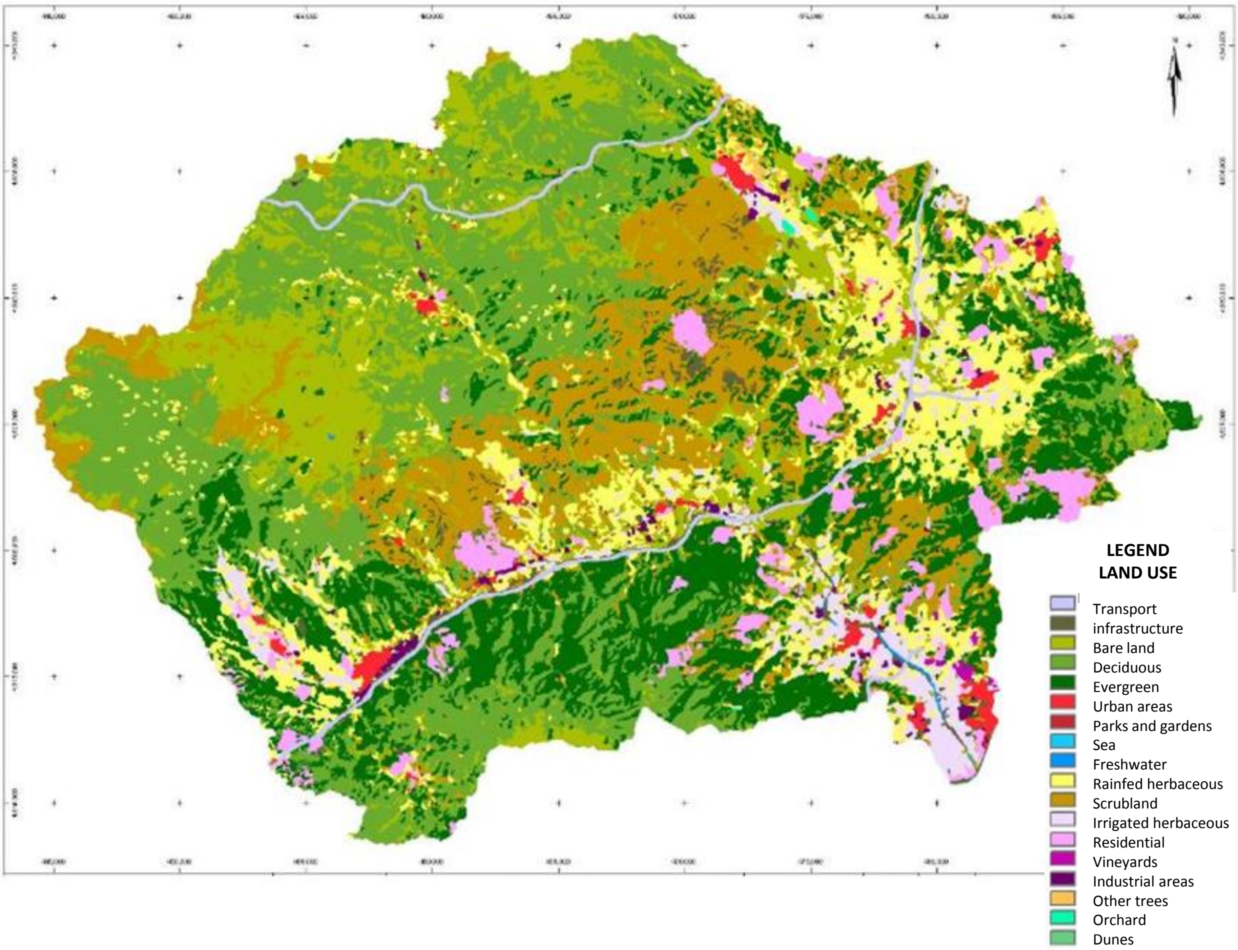


Figure 1.2: Land use in the Tordera Basin. (Source ACA, 2011[4])

[3] Tordera basin is served by the regional water transfer system called "Aigües Ter-llobregat" http://www.atll.cat
[4] http://aca-web.gencat.cat/aca/documents/ca/publicacions/espais_fluvials/publicacions/estudis_pef/f_tordera/pef_tordera.htm

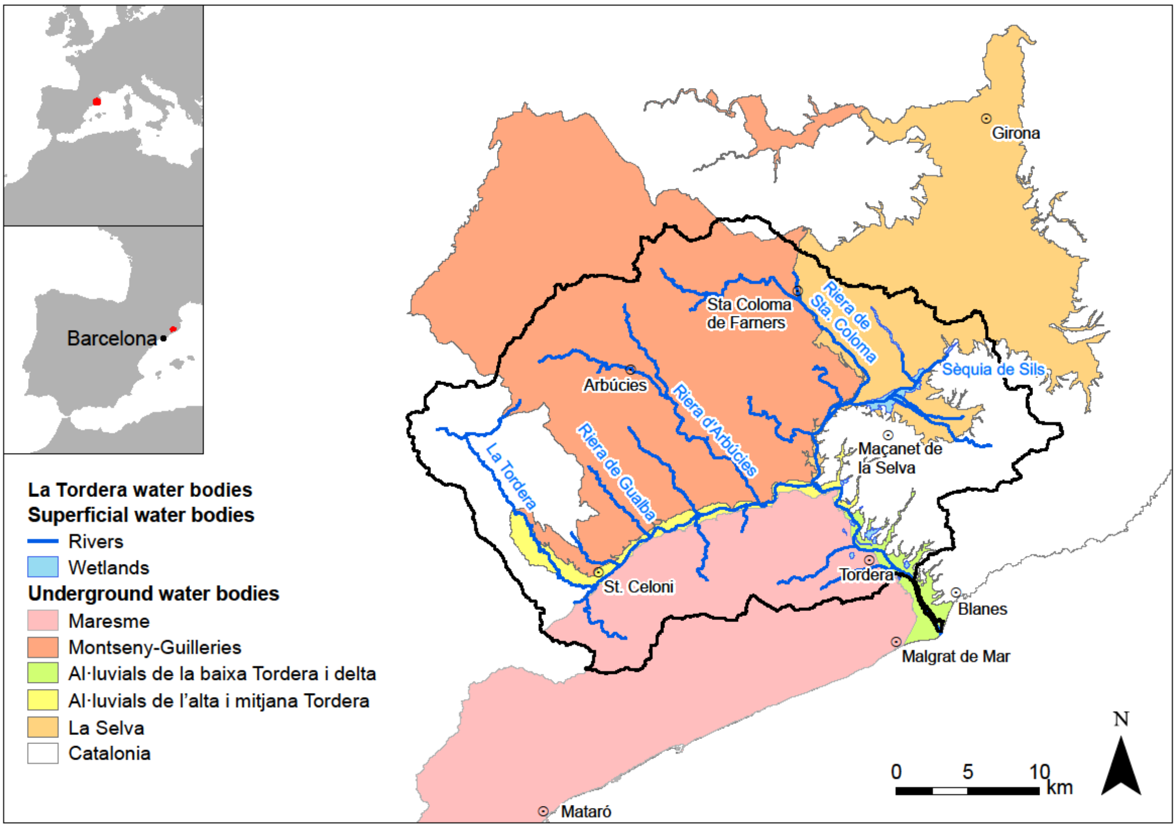


Figure 1.3: River LaTordera water bodies: superficial and groundwater. (Source ACA, 2010)[5]

2.1.2 Reasons for developing the RBAP

Tordera river basin is a small watershed, but very rich both in natural heritage and economic development. Impacts of global change may have a particular relevance in this territory, affecting both local population as well as regional population, due to the crucial role of this basin in the connection between North and South Catalonia.

The development of a River Basin Adaptation Plan (RBAP) complements existing regulation in terms of urban, agriculture, water and forest management planning. These exisiting plans and regulations take into consideration global change only partially and are developed under fragmented policy lines by Catalonian government.
The BeWater RBAP aims to give an integrated and consistent view of the challenges at stake, promoting an intersectoral, inter-departmental and multidisciplinary framework to develop concrete proposals enhancing adaptive management to address these challenges Indeed, actions to face global change necessarily need to be developed acknowledging the complexity and variety of society's vulnerability to all different kind of impacts, therefore a bottom up approach allowing people to be at the centre of both problem shooting and problem solving is crucial.
Therefore, developoing a RBAP for the River Tordera consititutes a very important step forward in facing global change impacts and learning to manage water in a changing environment.

2.1.3 Overview of contents

Section 2.1 provides a brief overview of the main actor groups and their roles and competing interests in the river basin. Furthermore a brief reference to how these actors may be affected by impacts of global changes is provided.

In addition, legislation and policies affecting management planning of the river basin are listed and described, as well as the mandates of relevant public authorities.

[5] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204954461208200540455

Section 2.2 presents very briefly the methodology and procedures used to design, contextualize, evaluate and select WMOs. Moreover, this section specifically outlines which stakeholders and experts were involved in each of the the steps of the RBAP planning process, reporting also the type of involvement : consultation, co-creation, support or *una tantum* expert advise.

Section 2.3 reports the list of events held, information products prepared and disseminated, as well as target groups and stakeholders involved.

Section 3 introduces the current state and expected future state of the land, water, biodiversity and people for the whole basin. In particular, section 3.1 reports a short diagnosis of the basin and the impacts of global change, section 3.2 describes the main challenges identified and the interlinkages between them, while section 3.3 describes uncertainties and knowledge gaps detected.

Section 4 presents information on the WMOs selected by stakeholders during the project.

2.2 The development of the river basin adaptation plan

2.2.1 Tordera society: role of local actors and relevant policy framework

2.2.1.1 Role of local actors and vulnerability to global change

Tordera basin society is very diverse, and the different socio-environemental realities that co-exist in the basin can be described referring to the upper, central and lower river sections.

In the river's headwaters there is low population density and economic activities focus mainly on forest management and exploitation, tourism and bottled water industry.

Authorities competent for the Biosphere Reserve of the **Montseny natural park** are responsible for applying the conservation strategies needed to protect the biodiversity of the area, as well as ensuring a harmonized co-exisitence with local population and the economic activities developed in the area. Over the last decades, the role of the park authorities changed from a "command and control approach" into a "mediation" approach, positioned in between municipal development and environmental protection policies. Facing global change is a priority of the management strategy developed by the park authorities, given the multiple impacts forests may endure. The biggest concern is controlling wildfire risk, which may increase in the future due to the impact of temperature rise, but also due to incidents caused by resident and visiting population (like barbeques or cigarette butts). Wildfire risk control is mainly tackled by clearing undergrowth and other biomass which constitutes potential fuel for these fires, as well as awareness rising.

Water bottling industries are located in the upper boundery of the basin, extracting mineral water from profund aquifers. Impacts of this form of water extraction are not fully perceived by local population and administration, given the high inertia of the connectivity with shallow aquifers. These industries have special protection plans in place, regulating the activities that can be developed in the water catchment area, including payment for ecosystem service schemes. Global change will impact this industry by changes in the precipitation patterns affecting groundwater recharge rates. Moreover, aquifers will gradually gain a predominant strategic role for water supply when other sources become scarce, increasing socio-political pressure on the justification of this business.

The touristic sector is very important in this area and different facilities are in place both inside and outside the bioreserve boundaries. Hotels and restaurants are relevant for local economy, as well as the production, hunting and collection of gastronomic products retrieved from the forest. Global change may strongly affect the involved stakeholders, highly depending on the health of water and forest ecosystems and landscape. On the other hand, tourism also causes impacts on these factors, which are mainly tackled by concentrating facilities and access roads to the most attractive sites, preventing the disturbance of habitats in other areas.

In the headwaters of the **Arbùcies** and the Santa **Coloma** streams, different **industrial hubs** are located, as well as intensive silviculture (black poplar) and **gardening centres**. These actors play an important role in the basin, as both benefits in terms of jobs and impacts in terms of pollution of water and soil are considerable at local level.

The **central river section of the Tordera** is characterised by a higher density of population, presence of industrial hubs, agriculture, and strategic infrastructure. Therefore, the main group of actors identified by the project are municipalities, industrial sector, gardening centres, as well as the different governmental and private actors related to service exploitation and management of the infrastructures.

The main concerns of **municipalities** in the central section are to provide adequate water supply and sanitation service and urban planning related tasks, including flood protection. This area is affected by competetition for water provision between **irrigation** and urban supply, the two systems being strongly interrelated and both presenting demand peaks in summertime. Therefore,

new water supply and sanitation master plans are under development, but in some cases these are conflictive, in terms of assignment of responsibilities and funding of needed investments. **Agriculture** in the central river section is not very developed, but stakeholders have an active role in the political realm, as they behold ancient entitlements that awaken the interest of many potential water uses.

Global change impacts may affect municipalities of this area, increasing challenges related to adequate drinking water quality standards, water availability for supply to different uses, and decrease of the river ecological statequality . Uncontrolled urban expansion may escalate these challenges.

The **Arbùcies** and the **Santa Coloma** streams discharge into the Tordera River main stream, thefore flooding risk is high in these areas. In the future it is possible that this risk that municipalities face will increase, given the changes in rainfall patterns and invasion of the river space by different infrastructures.

Actors related to the **industrial sector** are aware of the water management challenges imposed by global change, and some are willing to adopt technological solutions to reduce their impact on the environment as long as it would not affect economic profitability and job creation. In some cases, the vulnerability of these industries to the impacts of global change is higher than others, like in the case of a nanotechnology industry that is very dependent on high quality standards of water supply.

Gardening centres, just like the industrial sector, are a relevant economic activity in the area. Global change may strongly affect this group of actors as most plantations are located in flooding zones.

In the same line, **actors related to service exploitation and management of the infrastructures** may be strongly affected by floods. Differently than for other actors identified, there is little interaction between local society and decision making proceses concerning the management of these infrastructures as these engage regional and international actors. An example of thee role of these actors is particularly evidenced when it comes to inter-basin water transfer supply, where municipalities have a weak position when negotiating conditions and prices.

The **lower section** of the basin is characterized by the Montnegre Corredor Natural Park, intensive horticulture, strongly developed coastal tourist facilties and urban areas.

Montnegre Corredor Park authorities have an active role in the area and are very much engaged in promoting economic activities related to the park, like livestock farming and other industries related to biomass management, as well as cork production and tourism.

Farmers doing horticulture in this area are not constituted in irrigation associations, but there are different producer cooperatives for product commercialization. These have a strong position on the Catalonian market and production levels are high, entailing high level of water consumption. Global change may affect this stakeholder group both in terms of water availability and quality, as overexploitation entails groundwater salinization. Coastal erosion and sea level rise may also affect agriculture plots, and competition for landuse with touristic facility development is high. Indeed, stakeholders related to **seasonal tourism** represent an important economic sector (camping and hotel facilities) and play an important role with respect to coastal management and hydromorphological pressures on the river space. This sector may be strongly affected by global change, similar to the agricultural sector, amplified by landscape quality and comfortable metereological conditions for tourists.

Environmental NGOs provide insights on the whole basin, with a cross-sectoral and integrated view. NGOs have an active role in monitoring the basin's ecological conditions and have a lot of valuable information on species and land uses of the area, providing deep insight of the factors that would need to be tackled to increase the basin's resilience to global change. The role of this actor group is to promote good practices and rise awareness about the importance of preserving ecosystem functionality, although campaigns sometimes may be conflictive, given the trade-off between interests with economic sectors and the administration.

2.2.1.2 Role of public authorities and relevant policies

Governmental insititutions, like the Catalan Water Agency, Catalan Office for Climate Change, Agriculture Department, Energy Insitute, Territorial Sustainability Department and county councils and municipalities have an overarching and crucial role in the basin.

The Catalan Water Agency (ACA)[6] is one of the most relevant actors for this poject, given the central focus on water management. During the project duration, the agency released a draft RBMP with a 2016-2021 horizon, in accordance with the WFD calendar. The proposals elaborated by BeWater have been included in the participation and consultation processes to this RBMP, allowing to be taken into consideration before its definitive approval.
La Tordera is one of the 17 basins included in the Catalonian river basin district, therefore specific water management actions relevant for this basin are included in the overaching plan of measures, flood risk management plan, urban and industrial sanitation program, drought management plan (under construction) and monitoring and control program.

The Catalan Office for Climate Change (OCCC)[7] also has a crucial role, providing the necessary adaptation policy framework for the RBMP. During the project duration, the Office released a new climate change law proposal, submitted to citizen participation and currently presented to the Catalan Parliament. The extreme relevance of this strategic process to the BeWater objectives entailed active participation and knowledge sharing with the Office, who also interacts by being amember of the BeWater Advisory Board .

The Catalan Department for Agriculture, Livestock, Fishing and Food (DAAM)[8] is responsible for policies extremenly relevant to tackle global change in the Tordera basin, like Rural development Plans and all sort of comepertences on forest management, environmental protection fishing and productive land use, as well as innovation and educational programs. BeWater was in contact both with regional and local offices, as well as farmer associations closely related to the implementation of different adaptation measures.

The Catalan Energy Institute[9] promotes relevant mitigation policies and during the project development the Catalan Energy and Climate Change Plan (2012-2020) was vigent. This plan aims to coordinate energy related strategies at local and regional level, taking into account national and European policies, as well as integrating sectoral plans and policies, specially related to territory and environment.

The Department for territory and sustainability[10] is an overarching department including water, waste, urban, transport and environmental planning at different levels. Therefore this is a very important actor to mention in the policy framework although BeWater related with specific sub-departments.

Vallès Oriental, Selva and Maresme **County Councils** are responsible for administration of the territory included in the Tordera Basin. These entities are composed by political charges complementing central govenement with different adminsitrative funcions in relation to concrete territorial scopes.

Municipalities located inside the permiter of the biosphere reserve are actively engaged in the development of management strategies to protect and maintain this area. Specific working groups are in place, where local sectoral policies are negotiated and best practice guidance is provided. In other areas, like the headwaters of the Arbùcies and Riera de Santa Coloma streams, different environmental protection forms are in place to protect the habitats necessary to support the rich biodiversity of the basin, like Natura 2000, and areas of special interest for certain species. These

[6]http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P52400163221431526441490
[7] http://canviclimatic.gencat.cat/ca/
[8] www.gencat.cat/agricultura/
[9] http://icaen.gencat.cat/es/
[10] http://territori.gencat.cat/ca/01_departament/05_plans/

normatives are managed by the Vallès Oriental and La Selva county councils and the municipal government. Global change may affect municipalities in multiple ways and their biggest concern is that these actors perceive they have little means to face them all, claiming more funds and coordination with other institutions. Municipalities are at the end of the line of policy implementation and need to be able to effectively attend Tordera society when affected.

2.2.2 RBAP development and stakeholder engagement

During the whole implementation of the project methodology, different stakeholders were involved, each time with a specific role. The information obtained was taken up in the project with specific methodologies too, allowing a stuctured integration of all different perspectives into the stages of the RBAP development.

In the first stage of the process, stakeholders were engaged with the aim to elicit the current state of the basin's vulnerability to global change and future expectations. In a workshop celebrated in May 2014 in Sant Celoni, one of the most central towns of the basin, stakeholders developed the reference information the whole subsequent process was based on.

Indeed, starting from this very first stage of the project, stakeholder engagement aimed building up a broad range of different perspectives in order to build up a comprehensive picture of the Tordera society's opinions and concerns with respect to the impacts of global change on the basin's water bodies and possible ways forward.

Participants of this first BeWater workshop represented municipalities, farmer associations, forest landowner associations, environmental protection NGOs, different industrial sectors, as well as competent authorities responsible for water, natural park areas and climate change policies.

In this workshop, BeWater provided updated information on the results of scientific research on the impacts of global change in the basin, with a 2030 horizon. Strengthened by this complementary knowledge, stakeholders provided information on their perspective of the current status and pressures on water bodies, as well as the formulation of a common vision on the future status of the river basin. In the light of these considerations, some first ideas on ways forward and water management options that need to be implemented were gathered too.

The analysis of the workshop results allowed to identify information gaps, which have been tackled by specific interviews to relevant actors to complement outcomes with additional information. These specific interviews were made with experts of the economic development of the basin's territory, representatives of the local water bottling industry, competent authorities of agriculture development and farmer associations of the basin's counties, different environmental organizations, municipal and supra-municipal water supply operators, natural park authorities from Montseny Biosphere reserve and Montnegre-Corredor, touristic sector operators from the coastal area, as well as the director of an ethographic museum providing information on the basin's history and culture.

In addition, the activities organized as part of the awareness campaign and dissemination efforts allowed to involve the general public and were developed in such a way that comments, discussions and opinions of these actors could be included in the understanding of the basin's narrative and challenges.

This intense stakeholder consultancy process allowed the Tordera case study partner to elaborate a narrative of the basin and identify 4 main challenges, synthesizing the wide range of relevant aspects detected.

Furthermore, information related to the first ideas on how to tackle these challenges was analysed in depth, and desk work of the case study partner allowed to formulate a first draft of concrete water management options. These were again presented to relevant stakeholders, with the aim to pin down and characterize water management options, as well as identifying opportunities to integrate these new proposals into the local socio-economic and political context. This process

engaged mostly competent authorities on water, agriculture and climate change policies, as well as municipal boards.

Clustering and refining this information was developed by the Tordera case study partner, finally reaching the level of detail necessary to develop a sound narrative of the basin, both in the form of a text and visually represented through a fuzzy cognitive map.

The results of this process was presented to a broader range of stakholders in a workshop celebrated in December 2014 in Hostalric, involving stakholders who participated at the first workshop, as well as new actors, like researchers and public authorities covering relevant aspects which were not included in the first stage. Stakeholders developed two exercises: on the one hand they validaded and contributed linking proposed water management options to the challenges identified, and on the other, helped to improve the mapping exercise of main factors characterizing the basin's current status, pressures and drivers.

Subsequently, the Tordera case study partner formatted this information in a such a way it could be included in the methodology developed by the expert partner EFI to evaluate the water management options. This format allowed to consolidate the water management options' description and characterization, as well as to develop an impact analysis of the effectiveness of the options to face the challenges of the basin. Indeed, the 33 water management options resulting out of this process have been tested with a specific impact analysis which used the basin's fuzzy cognitive map.

The results of this desk work were presented to the stakeholders by organizing a second workshop in June 2015, in Santa Maria de Palautordera. This time, participants were required to select and characterise suggested criteria needed to evaluate the water management options by means of a multicriteria analysis. Therefore, basic assumptions used to evaluate the options' effectiveness to tackle the impact of global change in the basin were developed by the participants of the workshop. Moreover, the water management options were presented in detail and discussions allowed for better scoping of the actions proposed, gathering ideas on specific places where these options would best be implemented and data on similar experiences. Therefore, participants' consultancy enriched the information and reviewed outcomes for local implementability and accuracy. Moreover, the outcomes of the multicriteria analysis were discussed, allowing integrating participants' perspectives for the interpretation of the final prioritization of options.

The results of this process, once integrated, were presented to a group of new stakeholders in October 2015 in Riudarenes. Results of this event allowed to test if results elaborated by a certain group of stakeholders in the basin would also be considered representative for another, different group of actors. Indeed, participants invited were from the county called "La Selva", located near the Riera de Santa Coloma, an affluent of the main River Tordera and represented reasearchers, teachers, environmental NGOs, municipalities, forest rangers and landowners which had not participated in other BeWater events. Therefore, it is possible to affirm that the process outcomes reflect actors representing Tordera basin society's main perceptions.

2.2.3 List of engagement and dissemination activities

Dissemination and engagement activites complemented BeWaters' relation with Tordera society in different ways: workshops, events, talks, individual and group interviews, as well as guided visits. A summarized list of main activities is listed in table 1.

Workshops were developed in accordance to the project stages under the guidance of engaged expert partners.
For dissemination talks and events, adapted power point presentations have been developed each time, taking into consideration the interests of the target audience and setting constraints. During these occasions interactive sessions have been designed and implemented.

Moreover, the material developed for the awareness campaign was used to guide the talks in most cases. The exposition of 12 banners developed for Tordera included general information of the BeWater project, as well as 8 thematic banners: water consumption in cities, water and agriculture, water and forests, river flows and river space, water economy and water governance, introduced by a glossary of terms. Each thematic banner provides an introduction on the issue, how the issue relates to climate change, specific challenges for the Tordera basin and provoquing questions for each theme.

Focused interviews were supported by specific documents, in function of the information that needed to be worked out. In order to complement information sometimes the interviews also included a guided visit to installations or natural sites.

Table 2.1: List of engagement and dissemination activities

Dissemination/engagement activity	Content	Target group	Dates
Interviews	BeWater project. Impacts and challenges in Tordera RB	Key stakeholders from different sectors	March, April, May 2014
1st BeWater workshop	Challenges and WMO taking into account Global Change impacts	Multi-stakeholder	28 May 2014
Interviews	Challenges and governance	Key stakeholdrs and Policy representatives	June, July and September 2014
Stakeholder event	FC mapping of the Tordera challenges	Multi-stakeholder	12 Desember 2014
Stakeholder activity	Challenges and options for Tordera RB	Education and municipalities stakeholders	19 February 2015
Stakeholder activity	WMOs	Multi-stakeholders	12 June 2015
2nd BeWater workshop	Evaluation of WMO	Multi-stakeholder	17 June 2015
Stakeholder event	Water quality challenges in Tordera	Multi- stakeholder	8 July 2015
Interviews	WMOs	Water Authority (all departments involved)	July 2015
Interviews	WMOs	Key stakeholders and Policy representatives	May, June September 2015
Stakeholder activity	Challenges and options for Tordera RB	Municipalities' stakeholders	3 October 2015
Stakeholder event	WMOs	Multi-stakeholder	24 October 2015

2.3 The Tordera River Basin

2.3.1 Current and future state of the river basin

2.3.1.1 Current state of the river basin

Historical climatic tendencies in the Tordera basin, similar to the rest of Catalonian litoral region, revealed that during the period 1951-2000 temperatures rose around 1.25°C, with considerable increase in winter and summer seasonal maximum temperatures (Fig. 3.1)[11].

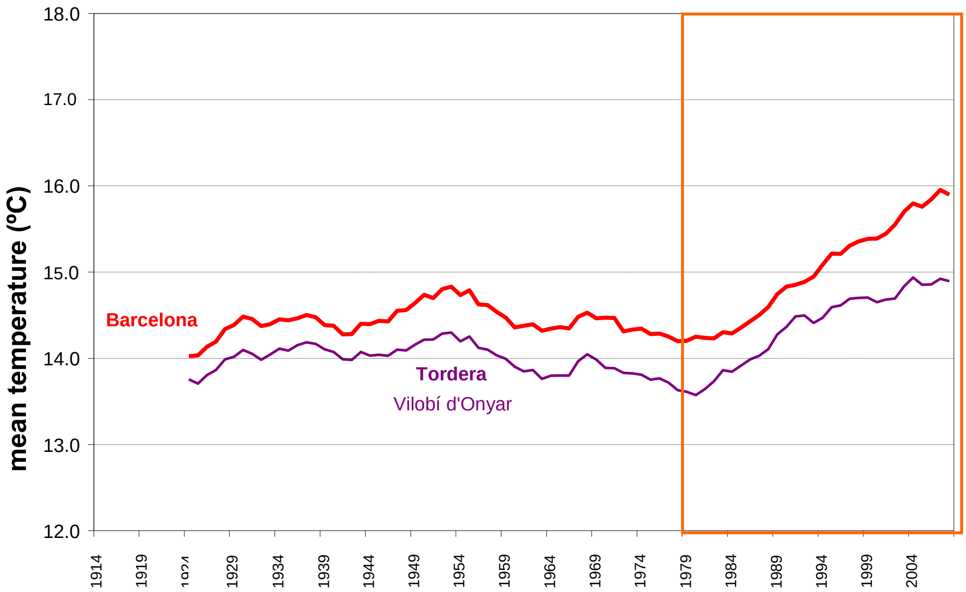


Figure 3.1: Historical mean temperature trends in the Tordera Basin. (ACCUA, 2010)

Annual precipitation trends did not reveal statistically significant changes in the period 1928 -2000 (Fig. 3.2), although significant decrease is registered in rainfall patterns: less precipitation during the months of July and March, while more precipitation in January. These figures are particularly preoccupying taking into consideration that the month of March is a crucial moment of water bodies recharge before spring and summer seasons (Fig. 3.3).

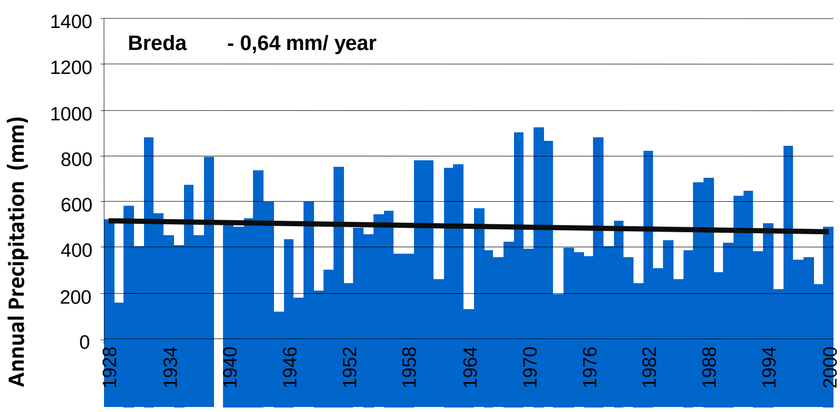


Figure 3.2: Annual precipitation in the Tordera Basin. (ACCUA, 2010)

[11] Source of all data used for this section, unless mentioned otherwise, is ACCUA project (http://www.creaf.uab.cat/accua/)

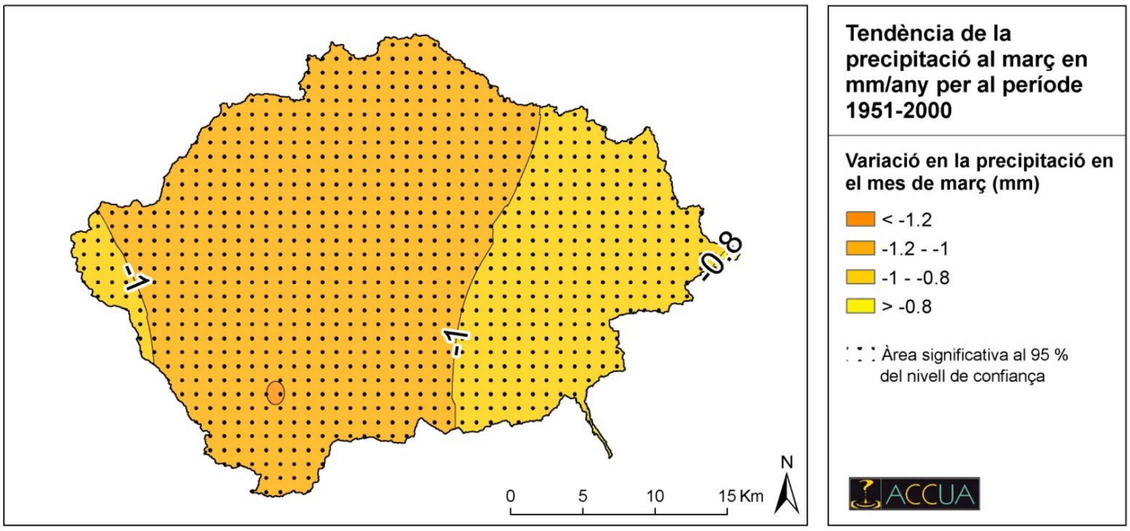
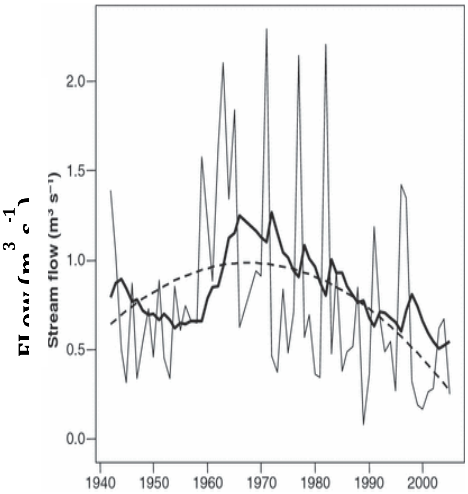
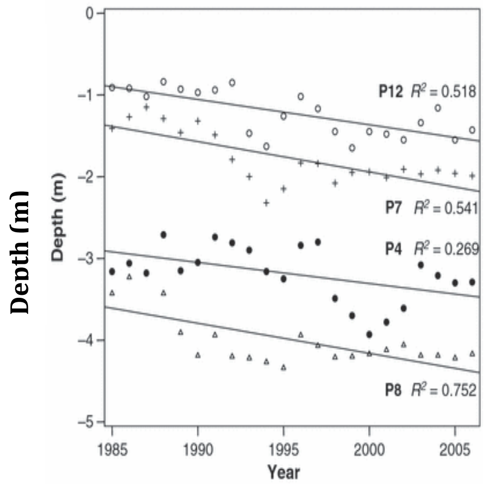


Figure 3.3: Precipitation during the month March in the Tordera Basin (1951-2000). (ACCUA, 2010)

These decreasing trends in precipitation are related to decrease of river flows and groundwater recharge rates, as shown in figure 3.4 a&b.





a. Gauging station in Sant Celoni

b. Level of different piezometers in the basin

Figure 3.4 a & b: Decrease of water quantity in the Tordera basin (Source: Benejam et al. 2009)

Land use has changed in the Tordera River Basin over the past decades, indicating a slight increase of forest land and a reduction of cropland due to the abandonment of some agriculture areas, especially pastures. Urban areas have doubled between 1993 and 2005, occupying around 9% of the basin, located specially in the delta region.

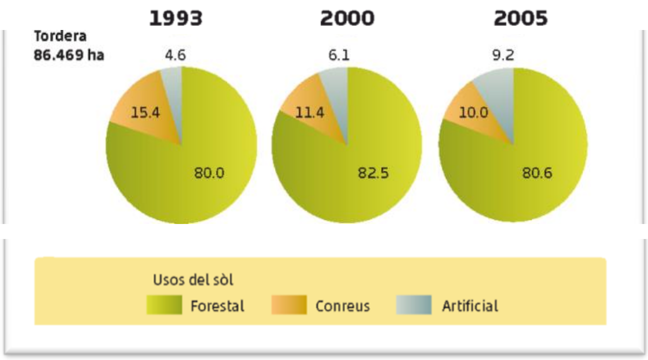


Figure 3.5: Land use changes in Tordera Basin (source ACCUA, 2010)

2.3.1.2 Future state of the river basin and impacts of climate change

Climate change impacts in the Tordera Basin were assessed during the ACCUA Project, and related studies[12 13]. These studies applied future projections covering the 2001–2100 period extracted from a dynamical downscaling procedure that used one of the many atmosphere–ocean coupled models, ECHAM5/MPI-OM[14 15], performed by the Meteorological Service of Catalonia[16 17]. For this exercise, scenarios A2 and B1 defined by the IPCC[18] were used. A2 and B1 scenarios predict temperature may rise by 0.5^{o}C and 0.7 ºC respectively between 2006-2030, reaching 3.6 ^{o}C and 2.4ºC by 2100 respectively. (Fig 3.6)

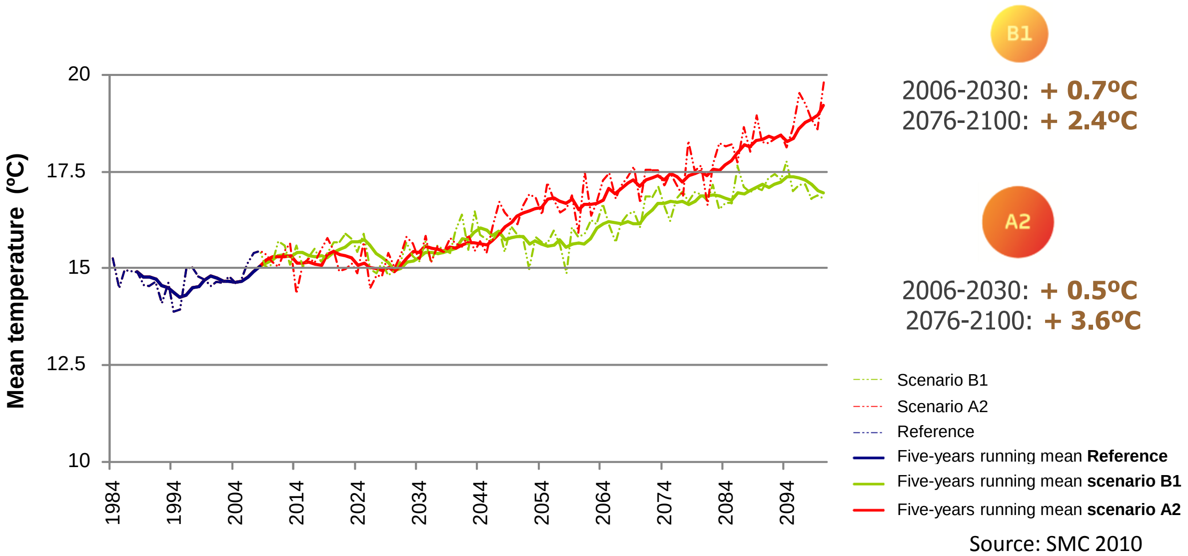


Figure 3.6: Future temperature trends (ACCUA, 2010)

These same projections indicate that precipitation may decrease by 6.5% and 5.4% in the period 2006-2030 depending on the scenario (Fig 3.7). Most important are the projected changes in the rainfall patterns throughout the year, which show that summer, the already driest season in this climate, would be the season most affected by climate change with the highest decreses in precipitation for both scenarious (Fig 3.8). These predicted changes in rainfall patterns may entail different effects, like intensification of summer droughts and a decrease of flood frequency. Nevertheless, due to urban expansion in the river space the risk of flood damage would not decrease proportionally.

The analysis of the precipitation projected data also shows more frequent occurrence of extreme wet and drought epiodes for the future (Fig 3.9)[19].

12 Lopez-Bustins J.A., Pascual D., Pla E., Retana J. (2013) Future variability of droughts in three Mediterranean catchments. Natural Hazards. 69: 1405-1421.Doi: 10.1007/s11069-013-0754-3

13 Diana Pascual, Eduard Pla, Joan A. Lopez-Bustins, Javier Retana & Jaume Terradas (2014): Impacts of climate change on water resources in the Mediterranean Basin: a case study in Catalonia, Spain, Hydrological Sciences Journal, DOI: 10.1080/02626667.2014.947290

14 Marsland SJ, Haak H, Jungclaus JH, Latif M, Ro¨ske F (2003) The Max-Planck-Institute global ocean/sea ice model with orthogonal curvilinear coordinates. Ocean Model 5:91–127

15 Roeckner E, Lautenschlager M, Schneider H (2006b) IPCC-AR4 MPI-ECHAM5 T63L31 MPI-OM GR1.5L40 SRESB1 run no. 1: atmosphere 6 HOUR values MPImet/MaD Germany, World Data Center for Climate, Hamburg, Germany. doi:10.1594/WDCC/EH5-T63L31OM-GR1.5L40B116H

16 Barrera-Escoda A, Cunillera J (2010) Study of the precipitation evolution in Catalonia using a mesoscale model (1971–2000). Adv Geosci 26:1–6

17 Barrera-Escoda A, Cunillera J (2011) Climate change projections for Catalonia (NE Iberian Peninsula). Part I: regional climate modeling. Tethys 8:75–87

18 IPCC (2007) Climate change 2007: synthesis report. Contribution of working groups I, II and III to the fourth assessment report of the intergovernmental panel on climate change, IPCC Secretariat, Geneva

19 Lopez-Bustins J.A., Pascual D., Pla E., Retana J. (2013) Future variability of droughts in three Mediterranean catchments. Natural Hazards. 69: 1405-1421.Doi: 10.1007/s11069-013-0754-3

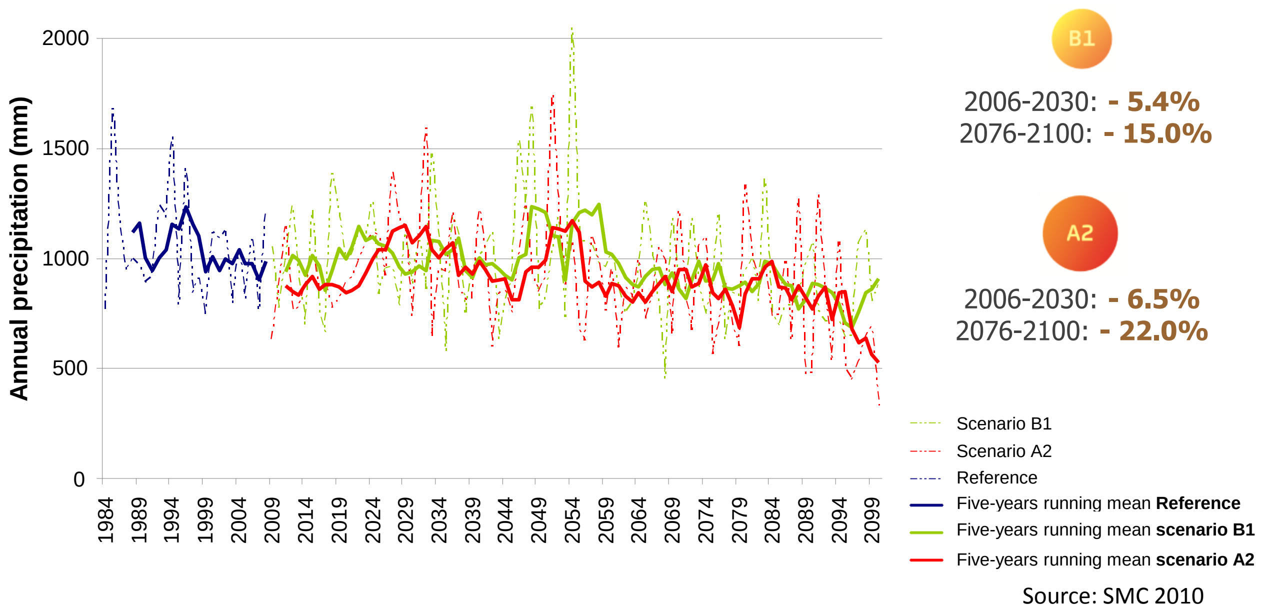


Figure 3.7 Future precipitation trends. (ACCUA, 2010)

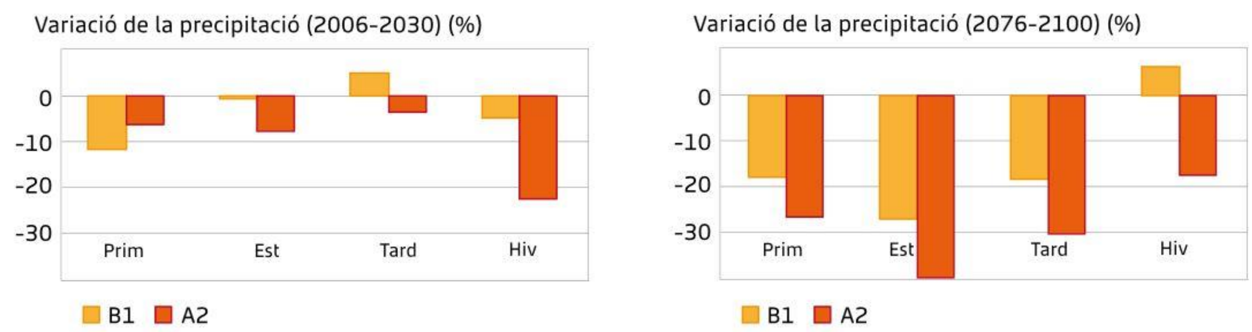


Figure 3.8 Variation in rainfall per season for B1 and A2 scenarios. Percentage change calculated respect to the reference period (1984-2008). (ACCUA, 2010)

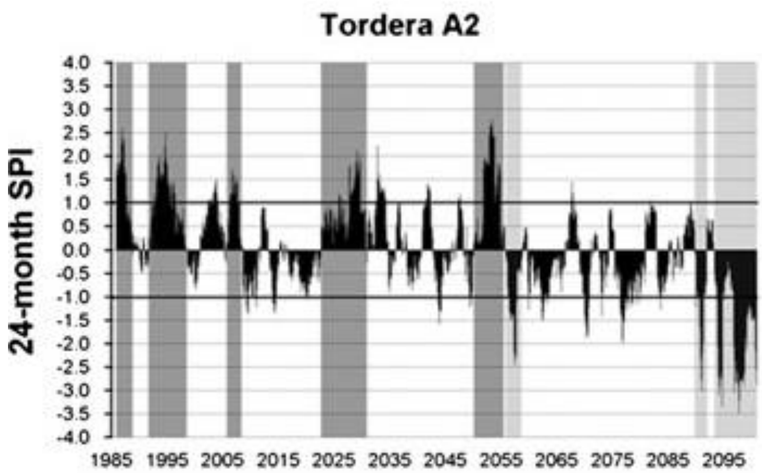


Figure 3.9 24-Month standardized precipitation index (SPI, index that estimates meteorological drought) at Tordera for the 1984–2100 period using data generated from the model simulations in the A2 scenario. Extremely wet/drought episodes with a value of the index higher/lower than 1.99/-1.99 are shaded in dark/light gray. Bold lines show thresholds of moderate wet episodes (above 0.99) and moderate droughts (below -0.99), respectively. (Source Lopez-Bustins J.A., 2013).

The uncertainty related to the use of just one specific atmosphere–ocean coupled model, in this case ECHAM5, and in general to modelling exercises need to be acknowledged when interpreting results. Two different contrasted IPCC scenarios (A2 and B1) were included as to widen the range of possibilities taken into account and thus tackling the complex issue of uncertainty in this type of studies to some extend. The impacts of changes in the basin's climate could be very relevant: both surface and groundwater availability would be affected by the projected reduction of natural flows. The 152.6 hm^3/year flow that River Tordera carries today may decrease almost 30% by 2025 compared to the reference period 1984 – 2008 and by the same period, groundwater recharge would decrease by almost 10%. In particular, climate change projections indicate a stream flow reduction at the river mouth by the end of the Century, more severe at A2 scenario (37%), compared to the in the B1 scenario (25%) (fig 3.10). Projections by 2030 indicate the highest reductions of stream flow are expected in the headwaters, affecting environmental flow regimes for the whole basin under current extraction rates (Fig. 3.11).

	Stream flow variation at headwater	Stream flow variation at river mouth	
B1	- 5 %	- 3 %	Year 2030
A2	- 11 %	- 14 %	
B1	-22 %	-25 %	Year 2100
A2	- 33 %	-37 %	

Figure 3.10: Stream flow variations under climate change scenarios A2 and B1 for the River Tordera. (Source ACCUA 2010)

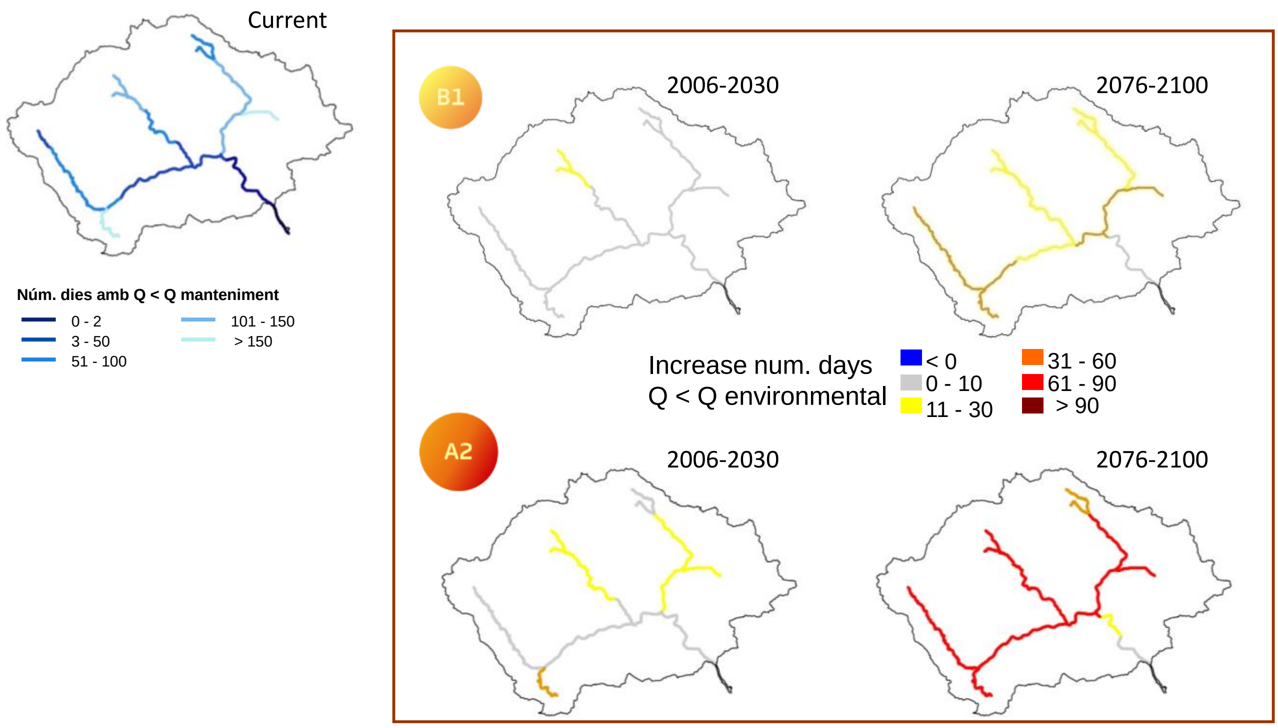


Figure 3.11: Number of days with flows below the environmental flow increases at the end of the century (Source ACCUA 2010)

These impacts on the basin's natural hydrologic cycle are foreseen to increase the disconnection between water bodies, strongly affecting both water quality and quantity, especially endangering wetlands and the delta area of the river. The latter will probably face many related consequences: dropping levels of groundwater would intensify seawater intrusion, and disruptions of sediment dynamics would worsen the erosion of beaches and dunes. Moreover, fish population and abundance is strongly dependent on the freshwater nutrients provided by the Tordera. Therefore impacts of global change considered for continental waters need to be integrated with those referring to marine environments, in line with the objectives of the Marine Strategy Framework Directive (2008/56/EC)[20].

Temperature rise and changes in rainfall patterns will cause an overall increase of the water demand for irrigation and reduce productivity of heat sensitive crops. Nevertheless, these climatic conditions may also influence the vegetative cycle of some species, positively changing the agronomic calendar of crop management and balancing the impact in terms of water demand.

Rising temperatures will also affect people living in the basin, with more tropical nights and heat waves acting on personal comfort. More diseases and extreme events will integrate the complex composition of risks people are likely to be exposed to. Moreover, the population in Tordera basin has shown a noteworthy increase in the last decades[21] and this trend could be plausibly maintained in the coming decades.

In the future, pressure of water demand on water bodies will increase, challenging local population to manage resources in such a way economic development and environmental protection are addressed in a balanced way.

In addition to the climatic changes, land use changes may have important impacts too: agriculture land abandonment entails the expansion of forested areas, increasing overall evapotranspiration of the vegetation in the basin. Moreover, as these forested areas are not properly managed, an excessive underbush growth and rising temperatures due to climate change will most probably entail higher wildfire risk. Projected climatic change may induce important variations in forest ecological functions, like the increase of tree mortality and modification of the suitability of species in the area. Projections indicate that by the end of the century forests may change from carbon sinks into carbon sources, highlighting the importance of forest management in the basin to face global change.

In the future the strategic role of groundwater will increase, given that these water bodies have a great inertia to climatic variations and can provide more reliable water provision. Neverthless, overexploitation, pollution and salt intrusion need to be tackled to achieve increased resilience to the foreseen reduction of groundwater recharge rates.

In the same line the importance of good hydrogeomorphological quality will increase, allowing to buffer floods, increase sediment mobility, and increasing both hydrological and ecological connectivity. Nevertheless, infrastructure present in the riverbed hinders the recovery of river space in some areas, especially in the central section of the river. Flooding damage to these infrastructures is also likely to increase, implying considerable risks for people (transport facilities) and for the environment (pollution due to oil and gas piplelines). Territorial development policies should take into account the impacts of industries on the basin's resilience, as well as the vulnerability of these industrial areas to climate change, like flooding and drought.

2.3.2 Main challenges and their interlinkages

This sub-section presents the main challenges facing the river basin, based on the stakeholder contributions and the narrative developed by BeWater.

Challenge A: Water quantity

The lack of an adequate environmental flow regime has been identified as the most important

[20] http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm
21 Idescat, Institut Estadístic de Catalunya, 2012 [online]. Available from: http://www.idescat.cat/en/ [Accessed March 2013].

factor for the bad ecological status of the water bodies in the basin. In the same line, stakeholders considered antropogenic pressure on the basin's water as the main challenge in the basin[22].

The current number of gauging stations is considered inadequate and insufficient data are available to adequately monitor actual river flows. In many municipalities people still have private wells dating from the 50's-70's, and it is considered that many of these are not correctly registered and monitored, obstructing an adequate control of extraction rates[23]. Stakeholders considered that the overall functioning of the control and monitoring plan to assure compliance with WFD water quality standards is insufficient all through the basin.

Tordera's groundwater bodies are officially declared as overexploited[24]. Shallow extractions for irrigated horticulture in the coastal area is causing salt intrusion, while bottling industries located in the upper part of the river extract important quantities of high quality water from deep wells. According to Montseny Natural park studies, the groundwater extraction rate in 2002-2003 increased by factor 20 with respect to 30 years ago, and with respect to measurements in 1988-1989, extraction rates tripled during the last 15 years. These alterations of water bodies negatively affect 34% of flora and fauna and 50% of habitats with interest for environmental protection objectives for the Montseny Biosphere Reserve Conservation Strategy[25]. This trend is true also for other parts of the basin, like the wetlands located in Sils for example, whose valuable ecosystems are almost entirely dependent on groundwater levels.

Unconventional water production (e.g. desalination and wastewater reuse) is currently one of the main proposals to face the lack of water availability for some uses. In accordance to some stakeholders these projects are crucial adaptive water management strategies to overcome trade-offs between bulk water cost, water demand and availability. Indeed, Tordera has a desalination plant operating since 2002 and expanded in 2007, as well as different reclaimed water use initiatives. Nonetheless, other stakeholders indicate these solutions also entail important impacts, like increased energy consumption, concentration of pollutants and, paradoxically, reduction of river flows. Indeed, surface water bodies strongly depend from wastewater flows in many cases and recycling would reduce water returned in-stream after use.[26].

The Tordera River is connected to the inter-basin water transfer system (ATLL), with the aim of achieving higher flexibility of available volumes for supply. The idea is to enhance the opportunities to complement local resources with those flowing in this regional distribution system, especially in times of drought[27]. Unfortunately, this strategy is building expectations among the citizens in the basin that water availability would in future not be a problem. Nevertheless, the ATLL system depends on the flows of other rivers (Rivers Ter and Llobregat) affected by growing demands, lack of implementation of environmental flow regimes and drought, similar to the situation in the Tordera basin. Bulk water cost, which municipalities have to pay to access this resource, are considerably higher than those of local resources, and their negotiation capacity with the big corporations managing the ATLL system is low. To summarise, the basin's self-sufficiency of water availability is considered an important challenge by stakeholders[28].

Challenge B: Health of forests and water ecosystems

Tordera's river basin society emphasized the need to integrate forest management practices as a strategic element of water management in the river basin. Unattended forests are currently undergoing excessive biomass growth and high tree mortality, making them more vulnerable to wildfires and affecting the quality of the forest ecosystems. As most forests are private, public policies for adaptation need to be orientated to stimulate good practices by landowners rather than

[22] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "desired state" BeWater Tordera Workshop Report chapter 6, section 6.4
[23] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "challenges and issues" BeWater Tordera Workshop Report chapter 5
[24] Overexploitation edict: DOGC N^{0}. 3819 - 11.02.2003
[25] Carmona and Puigsaver, 2009 (internal report) cited in "Pla de Conservació del Park Natural del Montseny" pag. 96; available at http://parcs.diba.cat/web/montseny/pladeconservacio
[26] Information obtained from direct interviews
[27] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "options" BeWater Tordera Workshop Report chapter 7, section 7.2
1.1 [28] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "challenges and issues" BeWater Tordera Workshop Report chapter 5

to intervene directly. Therefore the challenge of environmental protection, although being a public administration's responsibility, is strongly linked to forest exploitation and agriculture sectors[29].

Disappearance of traditional animal husbandry has an important impact on forest structure, resulting in fewer open spaces and meadows, as well as on more understory vegetation, which affects wildfire risk. Stakeholders from the agriculture sector say recovering extensive livestock farming is not possible without proper funding programs, as current activities cannot reach economic profitability. In their opinion, cattle management practiced in function of forest management is laborious and lowers the already fragile economic viability. Therefore, when this activity is promoted as a measure for forest management it would be entirely dependent on subsidies, giving birth to the expression *"civil servant sheep"*. Moreover, current subsidies to the agriculture and livestock sectors are said to lead to undesired effects[30].

Stakeholders envision the overall challenge for the basin is to overcome the currently unbalanced land use mosaic, combining arable land, forests, areas of natural interest and urban areas, such that it enhances the capacity of the territory to develop and maintain itself[31].

Forest management is fundamental also to avoid biodiversity being negatively affected by forest exploitation. Montseny Natural Park authorities indicate profitability of forest exploitation interventions led to the use of non-native or unsuitable (in terms of climate, pests and ecological functions) species (e.g. black poplar). Such species, introduced by humans or developed colonising degraded habitats, constitute a problem for the biodiversity of the park[32].

Moreover, incorrect river flow regime, pressure and impacts on riparian vegetation and infrastructures impeding connectivity between habitats, some invasive species (mostly fish and riparian vegetation) are getting a prominent role in local ecosystems. Colonization of invasive species in the basin's habitats affects local land and water related ecosystems in different ways: reducing native species populations, increasing specific pests, reducing water quality (i.e. in case of alga blooms) as well as affecting water quantity (i.e. eucalipus trees)

Hydro-morphology of the river is significantly modified by infrastructure crossing the region: in the riverbed we find gas and oil pipelines, high speed train track, highways, high tension electricity lines and water pipelines. Moreover, historical gravel extraction from the riverbed has caused it to deepen significantly, affecting flooding dynamics and connection with groundwater tables. Indeed, sediment mobilization - highly depending on river flow regimes and river morphology - is disrupted, causing increased erosion of the coastline too. Hydromorphological quality is strongly related to the quality of water and land related ecosystems, determing –inter alia-, water temperature, flow speed, turbidity, and health of riparian vegetation. Therefore recovering the river space functionality is a crucial challenge in the basin[33].

Challenge C: Water quality

Drinking water quality is very high on the agenda in the basin, due to a pollution episode by faecal bacteria that caused the intoxication of 650 people in Santa Maria de Palautordera in 2002[34]. The service provider reported that pollution was due to uncontrolled urban wastewater discharge by upstream municipalities, causing great mistrust of tap water quality by local population still persistent today.

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[29] Source direct interviews.
[30] Source direct interviews.
[31] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "desired state" BeWater Tordera Workshop Report chapter 6, section 6.4
[32] Source direct interviews. Problem described in "Pla de Conservació del Park Natural del Montseny"p 332; available at http://parcs.diba.cat/web/montseny/pladeconservacio
[33] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "challenges and issues" BeWater Tordera Workshop Report chapter 5
[34] Source direct interviews. Episode analyzed in the study " social complexity of the Tordera Basin " available at: http://www.baixmontseny.net/pdf/Complejidad%20social%20en%20la%20cuenca%20del%20rio%20Tordera.pdf

Installation of wastewater treatment plants is considered a challenge in the basin. Many small towns and dwellings, especially in the upper part of the river, are not provided with treatment facilities and discharge their wastewater directly into the river. Although specific depuration development plans are in place, both for industrial and urban users, the lack of a solid funding scheme and sound coordination between public administrations are major obstacles for increasing the quality of river waters.

Problems related to water quality also affect management of infrastructure and treatment facilities. This is illustrated by stakeholders reporting the case of drinking water supply to Tossa de Mar, Lloret de Mar and Blanes, when demand rose due the touristic development in the 50's and 60's. Consequently, Tossa de Mar and Lloret de Mar integrated their supply with wells in the Tordera aquifer, but these wells contained high levels of iron and manganese, making it necessary to provide adequate purifying treatment. To face the costs the Costa Brava Consortium (CCB) was formed, which currently provides bulk water to 27 municipalities of the area, under direct assignment of the Catalan Water Agency. Aquifer quality constrains drinkwater quality and quantity, therefore wells positioned close to the coast are obliged to have a lower extraction rate than those more inland in order to avoid increasing salinity rates. Municipalities are therefore engaged in difficult negociations on the bulk water price established by CCB and by the desalination plant (managed by ATLL in Blanes), as some need to integrate with the (expensive) desalinated water more than others[35].

Challenge D: Integrated Water Management

Stakeholders indicated that they do not have sufficient access to relevant information on the basin's water management. For example, information on the exact amount of water extracted by bottling industries is not available, neither for citizens, nor for the Water Agency[36], as this is regulated under mining legislation and protected by industrial information regulations. Citizens expressed their basin is providing 27% of total mineral water consumed in Spain and that "*more water flows on the highway than in the river*"[37]*.* This is only one example for the fact that access and transparency to relevant information is considered a major challenge for sound adaptive water management and citizen participation. Tordera society experiences insufficient democratic quality in water governance, demanding better practices and specific deliberative spaces allowing to face the basin's challenges.

Moreover, water use entitlements are considered to not be properly managed; current water quantities assigned are higher than the actual flows in the river, making water scarcity directly the result of management practices[38]. Entitlements are legislated by Spanish authorities and shared responsibilities with Catalan Water Agency, but the Catalan administration claims to have limited negotiation capacity to introduce modifications given current jurisprudence and that eventual agreements would need to be voluntary. On this issue, the main challenge reported is that in order to recover water entitlements needed for environmental flow regime implementation the Agency is obliged to compensate the users for lost benefits until the entitlement expiration date, entailing unaffordable and unjustified costs. This is particularly challenging with regards to long term service contracts emitted in favour of water supply and treatment enterprises[39].

Water economy is a major issue, as Catalonia is experiencing significant problems to properly fund supply infrastructure building, exploitation and maintenance. These challenges involve issues related to the distribution of resposabilities, inconsistencies regarding bulk water cost, water pricing design and management objectives of the water supply and treatment facilities. Indeed, companies exploiting water production and distribution systems need to prioritize economic management criteria to maintain business, while public administrations need to guarantee the quality of supply to all citizens, good status of water bodies and related ecosystems. Given that direct catchments from

[35] Source direct interviews. Problem described in press article: http://www.lavanguardia.com/local/girona/20140501/54406500489/maresme-blanes-rebelion-precio-agua-aca.html

[36] Direct interview with Catalan Water Agency, allthough bottling industry ays it does provide those data they are legally bounded to.

[37] Source direct interview

[38] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "options" BeWater Tordera Workshop Report chapter 7, section 7.1

[39] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "options" BeWater Tordera Workshop Report chapter 5

water bodies are cheaper than unconventional resources and that cost recovery is proportional to the volumes of water sold, these criteria are in open contradiction with the general interest: protection of water bodies and reduction of consumption levels[40].

Moreover, in the basin's area there are many tourist facilities, including hotels, scattered houses with swimming pools, camping and harbours, etc., as well as transport infrastructure and supply services. All this infrastructure is designed in accordance to attend demand peaks in the touristic season, but costs of operation and maintenance of these fall on the shoulders of the resident population. This situation is considered unfair by residents and leads to intense debates on water pricing in the basin, especially in the delta area[41].

In order to ensure adaptive management practices, public authorities need to face the major challenge to better coordinate at all levels. Stakeholders expressed that many policy objectives are not met due to contradictory sectoral policies and perverse subsidies[42]. For example, the Agriculture department is promoting expansion and consolidation of irrigated agriculture while Water Authorities need to reduce extractions from Tordera aquifers. Similarly, municipalities would welcome more coordination and better dialogue with the Water Agency, for example on the development of wastewater treatment plants[43]. In order to promote the implementation of important measures, municipalities consider they would need better coordination between themselves on issues related to spatial planning, etc.

2.3.3 Basin Dynamics: Fuzzy Cognitive Mapping

A Fuzzy Cognitive Map (FCM) is a graphical representation of a system -for example a river basin -where the components (factors) are represented as boxes and relationships as arrows. The arrows reflect the sign and strength of the relationships between the factors. The map is cognitive because it is a representation of a belief system, i.e. it represents the dynamics in a system based on the understanding of individuals. FCMs can be constructed with inputs from stakeholders from different backgrounds and are able to include local, expert knowledge. The FCM for Tordera was constructed by experts of the BeWater Project in close collaboration with participants of a stakeholder consultation on in December 2014.

FCMs can be converted into simple mathematical models to be used for discussion and exploration of complex issues. The BeWater project team therefore used the FCMs to assess the impact of the water management options (WMOs) on the river basin. By using FCMs the BeWater project team was able to produce a semi-quantitative estimate of the impact of WMOs on the basin's dynamics, allowing to get an integrated view on direct and indirect effects on the basin's main characterizing factors.

Final FCM for the Tordera basin identified climatic variables, like temperature and precipitation, as well as population, environmental legislation, and WFD[44] objective compliance as the drivers of the system.

Water availability for supplying water to municipalities, touristic facilities, industry - including bottling plants - and agriculture, as well as the implications of water consumption in terms of water quality or necessary infrastructure are summarised in the factor 'water uses'. Very strong relation links water uses to water quantity in water bodies (factor referring both to surface and ground water). The aim assigning such a strong weight is to reflect also the structural overexploitation in the Tordera basin. On the other hand, when water is available, more uses are enhanced, and later consolidated through the possibility to integrate local resources with external water, transferred from other basins or produced through desalination. This management model prevents actions

[40] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "options" BeWater Tordera Workshop Report chapter 7, section 7.2
[41] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "desired state" BeWater Tordera Workshop Report chapter 6, sections 6.3 and 6.4
[42] Source direct interviews.
[43] Source: stakeholder workshop Tordera River Basin, 28.05.2014, session on "challenges and issues" BeWater Tordera Workshop Report chapter 5
[44] Water Framework Directive (Dir 60/2000/CE)

orientated to increase overall water use efficiency to deliver significant results and induces high cost of bulk water, due to the needed infrastructure and energy consumption it entails.

Water quantity and quality are very strongly linked, as water flows in the river have a very strong diluting effect. Moreover, the natural capacity to neutralise pollutants is linked to the water flow regime, providing the adequate habitats both for in-stream, riparian and wetland ecosystems. For groundwater this relation is expressed by the impact indicator salt intrusion.

The factor health of forests reflects the rich biodiversity in the basin, as well as the importance to maintain its conditions as to avoid the occurrence of wildfires, especially with high temperatures in summer.

The factor health of water ecosystems intends to resume the environmental status of water related environments, including wetlands, riparian and in-stream ecosystems.

Agricultural land use is expressed separately for extensive and intensive farm exploitation models, due to their different impact on the environment and different water consumption patterns.

Hydro-geo-morphological related factors are summarized in one factor. On the one hand, it considers flood damage, indicating that when river space is occupied by dwellings or infrastructure, the impact of floods is higher, and on the other hand, it relates to health of forests and ecosystems, indicating the significant importance of this feature for proper river functionality. This factor includes considerations about sediment flows and all characteristics of connectivity: a) linear – migration of species along the stream – b) lateral – riparian habitats – and c) vertical – interrelation between in-stream, wetlands and groundwater bodies.

Dwellings and industries located in sensible areas, like the river space, coastal or environmental protected zones are included in the factor urban expansion. This factor also refers to the growing pressure of tourism and population on the territory, referring both to the impacts on hydro-geo-morphology and water availability.

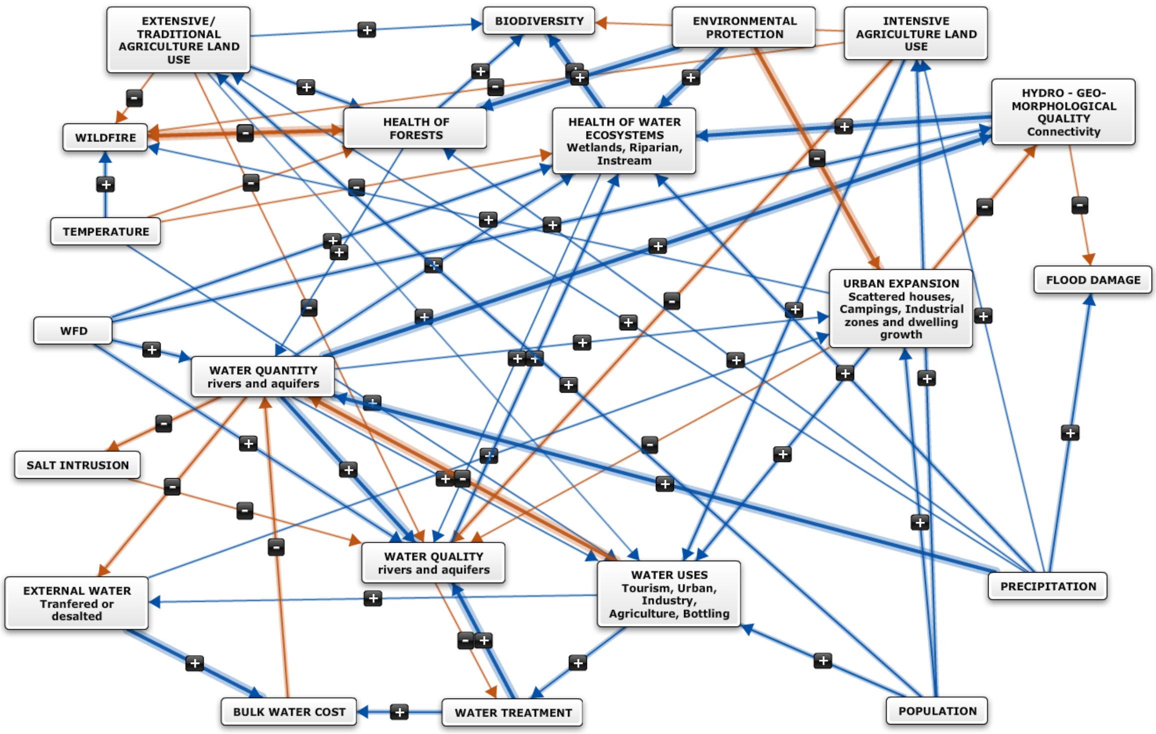

Figure 3.12: Cognitive map of the Tordera river basin (blue: +, red:-; strength: thin line: 1, medium width: 2, wide line: 3)

2.4 Water management options for the Tordera River Basin

To address the challenges identified by stakeholders they were invited to contribute to the formulation of potential water management options. Based on their answers, 33 water management options in total were identified, which are listed in Table 4.1 and described in detail in Annex 1. There are 7 options addressing Water quantity (challenge A), 10 options addressing Heath of Water and forest ecosystems (challenge B), 4 options addressing water quality (challenge C) and 9 options addressing Integrated water Management (Challenge D). Several options address more than one challenge: 2 options address both water quantity and quality challenges, and one option addressing both water quantity and integrated water management challenges.

Table 4.1: Overview of the identified water management options for the Tordera river basin

#	Name of WMO	Challenge
1	Develop and refurbish facilities to consolidate and extend livestock grazing in the forest.	B
2	Create specific branding for the commercialization of extensive livestock products.	B
3	Expand the Catalan School for Shepherds in the Tordera basin area.	B
4	Enhance rainfed crop production.	A
5	Revise the Extractions Master Plan.	A
6	Establish water use entitlement conditions.	A/D
7	Enhance knowledge transfer on irrigation with reclaimed water.	A
8	Integrate water saving solutions in construction protocols.	A
9	Enhance the use of renewable energy to power water management infrastructures in small towns and scattered houses.	D
10	Enhance water recycling in production processes.	A
11	Create Water User Associations (WUA).	D
12	Create a “Permanent Participation Centre”(PPC)	D
13	Develop a water traceability label for agriculture products.	A
14	Create Municipal Adaptation coordination board.	D
15	Enhance soft depuration plants in small municipalities and scattered houses.	B
16	Create an Integrated Plan for the Protection of the Tordera Delta.	B
17	Foster selective fishing.	B
18	Foster local use of adaptation to global change indicators.	D
19	Awareness rising.	D
20	Modernize irrigation techniques.	A
21	Integrate adaptation principles into water service provider contracts.	D
22	Increase environmental protected areas.	B
23	Water provision guarantee as a precondition for urban expansion.	D
24	Recovery of wetlands and their connectivity.	B
25	Elimination of toxic substances used in Municipal parks and gardening practices.	C
26	Create a catchment agreement to reduce diffuse pollution.	C
27	Centralize and facilitate access to relevant data on the basin water bodies’ status and uses.	C
28	Protect groundwater recharge areas.	A/C
29	Implement environmental flow regime.	A/C
30	Recover and protect river space.	B
31	Revision and actualization of water entitlements.	D
32	Develop River custody agreements.	B
33	Adaptive forest management agreements.	B

In order to face most urgent recovery of water body's status, most options focus on recovering water quantity and/or quality related aspects, while there are few tackling hydro geo-morphological quality (8 out of 33), but considered as crucial for the basin's resilience to global change by the participants of the project. Surface and groundwater bodies are equally addressed and the great majority of water management options proposed aim to be relevant for the basin as a whole, although different actions focus on specific areas. For example, a specific plan to apply integrated water management strategies for the delta area is proposed, but given that the lower river section bears the effects of upstream management, this process will affect the whole basin.

All water use sectors are addressed, with special emphasis on local population, tourism and agriculture water use. It is worth mentioning that the majority of proposed options aim to strengthen water management practices with an inter-sectoral and multiplying effect.

Notably, participants did not put special emphasis tackling extreme events, as flood damage has not been high in the latest years and awareness on this risk is currently quite low. Nevertheless, different measures aim to provide more resilience to drought, probably due to the basin's society experience of last long lasting drought episode in 2008.

Most options have a municipal and basin wide scope, although strong coordination will be needed with regional and national competent authorities.

Regarding the implementation process, for most of the options it is considered that they can be carried out on a short term (less than 5 years) with an expected lifetime up to 20 years and are expected to deliver medium to high effectiveness in a short time horizon.

The implementation costs of the water management options proposed is estimated to range mostly in two categories: between 10 000 euro/year up to 100 000 euro/year and between 100 000 euro/year and 1 M euro/year, with low to medium operational costs. This is also due to the fact most proposals envision management solutions and foster behavioural changes above infrastructural approaches to adaptation, focussing to increase the flexibility of water use patterns and sound planning to reduce vulnerability.

In coherence with the WFD principles, this set of options has a strong environmental conservation character, as well as enhancing demand management and actions to support integrated water management practices.

The potential to address global change mostly seeks flexibility, as to allow adjusting the focus coherently with the iterative nature of adaptation management. A priori, most options are considered feasible and acceptable for the local situation, even if minor obstacles for implementation need to be overcome. Those cases where serious obstacles are envisioned mostly refer to changes in legislation or institutional structures, as well as for low acceptability mostly refer to water management options that would affect private propriety or entail strong political debate.

Annex 1 Detailed presentation of water management options

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 612385

1. Water Management option: Develop and refurbish facilities to consolidate and extend livestock grazing in the forest

Overall description of the WMO

Short explanation	The lack of active forest management entails an increase of the density of plant cover and undergrowth, increasing in this way total forest biomass. Reducing uncontrolled biomass can help to reduce forest evapotranspiration and wildfire risk, as well as improving its health. Grazing activities are expected to contribute to a reduction of biomass in forests. In order to facilitate livestock management in the forest, this option includes the building of fences to host the cattle in the forest, beverage and foddering points for cattle, as well as specific agreements on pathways to be used by shepherds to move in the territory.
Addressed challenges	(B) Health of forests and water ecosystems. In particular: restore land use mosaic, reduce biomass.
Target locations and water uses	Location: River as a whole. In particular, natural park areas, like Montseny or Montnegre Corredor, as well as the area around Arbùcies and la Selva Region would be target locations. Water uses: Agriculture, Forestry. Reduction of biomass would have combined benefits on forests and water ecosystems.
Benefits	Enhance extensive agriculture, increase forest health, reduced wildfire risk, create employment, and consolidate engagement of local actors.
Potential negative impacts	When livestock production needs to satisfy forest management objectives, the farm's economic profitability is reduced. Therefore, integrating production practices enhancing forest management into herd management may reduce structural dependence of subventions.
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacle
Robustness	No. Measure is highly dependent on socio-economical, as well as environmental constraints.
Flexibility	Yes. Pasture areas can be re-designed in accordance to forest conditions, as well as the infrastructure proposed is removable and flexible to different use patterns.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 69,000 € Running/Operational costs: Low (below 10,000 €) – cost assessment (WP3): around 7,500 €/year The cost estimation is based on the following assumptions: • A study will be conducted to identify areas where interventions/grazing would be optimal to obtain the desired effects. This requires 6 person-months of a technician; • 300 ha of forest will be fenced to host cattle (about 200 km of fence); 80 beverage and foddering points will be established; • The initial agreement for will require an investment of 6 person-months of a technician;

	• The animation of the programme will require 3 person-month of a technician. Investment made by shepherds (cattle and time as well as maintaining the infrastructures) is not considered since returns on this activity are supposed to compensate for the costs. Therefore, only supporting costs (mandatory to make the sustainable grazing activity economically possible) are considered.
Synergies and conflicts with policy objectives	No conflicts. Synergies with - General Forestry Policy Plan (Pla General de Política Forestal 2014-2024[45]) - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[46]) - Livestock development Plan (Pla de recuperació del sector oví i cabrum[47]) - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[48]) - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[49])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.) Some doubts were raised during second workshop on an over-estimation of the effectiveness of the measure at basin scale.
Suggested stakeholder involvement	Main stakeholders are Natural park authorities or forestland owner associations who would need to impulse the initiative.
Preconditions for success	Identification of farmers and forest landowners willing to take up the proposal and establish an activity or modify their herd design. Improve local commercialization strategies to enhance added value.
Concrete examples where applied	• Montseny, Solana de Matagalls pasturage[50] • Montnegre Corredor, Vall de Fuirosos [51]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
General Forestry Policy Plan (Pla General de	Considers pasturage as a strategic activity to be promoted (section 3, action 3.4)	

[45]http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[46] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[47] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[48] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[49]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[50] http://www.naciodigital.cat/baixmontseny/noticia/3066/projecte/recupera/pastures/al/parc/natural/montseny
[51] http://www.naciodigital.cat/baixmontseny/noticia/557/vaques/albera/vall/fuirosos

Name of policies *(examples)*	**Opportunities**	**Barriers**
Política Forestal 2014-2024[52])		
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[53])	WMO contemplated in the Plan as restoration of existing but abandoned beverage points for livestock (measure c2.1.1 and c2.1.5), recovery of semi-natural pastures (measure C2.1.6. PC)	
Livestock development Plan (Pla de recuperació del sector oví i cabrum[54])	Fire-control tree-free areas used as pasture. Funding for new herds and infrastructure.	
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[55])	Measure 6 on agrarian diversification (06.04.01) Measure 7 on director plans on natural areas (07.01.01)	
Rural development plan Catalonia – concrete dispositions *(ORDRE ARP/222/2015[56])*	Enhancing agriculture activities in forested areas and related infrastructure.	Difficulties defining the pasturage area[57]
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[58])	Enhance sustainable livestock farming Improve forest management	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social	Difficulties to constitute a consortium, competition between projects

[52] http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[53] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[54] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[55] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[56] http://portaljuridic.gencat.cat/ca/pjur_ocults/pjur_resultats_fitxa/?action=fitxa&mode=single&documentId=698827&language=ca_ES
[57] http://www.heraldo.es/noticias/aragon/2015/03/31/la_nueva_pac_los_pastos_virtuales_aragon_348652_300.html
[58] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf

Name of policies *(examples)*	Opportunities	Barriers
	integration through an integrated and territorially based cooperation approach.	
Private investment (CSR, special programs by banks or Foundations…)	Local experiences developing similar actions to those proposed in the WMO were funded by private initiatives[59].	Consistency and timeline of programme often does not allow follow up and consolidation of the herds.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	**Role of stakeholder**	**Opportunities**	**Barriers**	**Possible involvement**
Barcelona Council (Diputació)	Political and funding backup	Supportive towards measure	Budget allocation	Already included in strategic policy lines, but limited funding
Girona Council (Diputació)	Political and funding backup	Supportive towards measure	Budget allocation	Already included in strategic policy lines, but limited funding
Montseny Park Authorities	Receive funds from Council and design project	Recovery of forest health and increased acceptance of Natural Park environmental protection constraints on local economy.	Interaction with local entities	Already included in strategic policy lines
Montnegre-Corredor Park authorities	Receive funds from Council and design project	Supportive towards measure	Almost all potential already exploited	Already included in strategic policy lines

[59] For example: http://lacaixaparcs.diba.cat/

Agriculture Department	Planning of livestock sector recovery	Supportive towards measure	Limited economic importance of the sector	Already included in strategic policy lines but limited availability to coordinate with other actors
Municipalities	Authorizations and visibility	Supportive towards measure	Coordination with competent authorities	Limited availability to get involved
Farm Associations	Implementation, co-design	Amplify sector diversification	Limited economic importance of the sector	Limited interest but would be if well funded
Forest landowners Associations	Implementation, co-design	Forest managed	Limited availability to get involved	Limited interest but would be if well-funded

2. **Water Management option: Create specific branding for the commercialization of extensive livestock products**

Overall description of the WMO

Short explanation	The lack of active forest management entails an increase of the density of plant cover and undergrowth, increasing in this way total biomass in the forest. Reducing uncontrolled biomass can help to reduce forest evapotranspiration and wildfire risk, as well as improving its health. In order to contribute consolidating forest management related livestock farms, this option proposes to create an association of producers and develop a brand for the commercialization of their products, with the aim to increase added value of products, improve visibility and share costs for product transformation.
Addressed challenges	(B) Health of forests and water ecosystems. In particular: sustain extensive livestock farming.
Target locations and water uses	Location: River as a whole. Water uses: Local population, Agriculture, Forestry. In particular, natural park and all other touristic areas in the basin would be target locations.
Benefits	Enhance creation of added value needed for the economic viability of livestock management in function of forest management objectives. Awareness raising and local development.
Potential negative impacts	When livestock production needs to satisfy forest management objectives, the farm's economic profitability is reduced. Therefore, branding products would help associations of extensive livestock producers to enhance added value.
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacle
Robustness	No. Measure is highly dependent on socio-economical constraints.
Flexibility	Yes. Branding can be re-designed in accordance to value chain and product visibility needs.
Costs	Implementation costs: Low (below 10,000 €) – cost assessment (WP3): around 5,000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 60,300 €/year. The cost estimation is based on the following assumptions: • A specific association would be constituted to manage and promote the brand. Current cost estimation could be increased by additional administrative costs, up to a maximum of 15 000 €. • Running costs include administrative costs, management and branding as well as communication tasks. Cost estimation of commercial actions could also be increased due to local market constrains, but was currently not possible to evaluate with more precision.
Synergies and conflicts with policy objectives	No conflicts. Synergies with

	- General Forestry Policy Plan (Pla General de Política Forestal 2014-2024[60]) - Montseny Biosphere Reserve Conservation Plan (Pla de Conservació del Parc Natural i Reserva de la Biosfera del Montseny[61]) - Livestock development Plan (Pla de recuperació del sector oví i cabrum[62]) associations of producers and diversification - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[63]) - "Innovation in the agro-food sector" program of Agriculture Department of Catalonia[64] - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[65])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Main stakeholders are agro-cooperatives, park authorities and county council who would need to impulse the initiative.
Preconditions for success	Identification of value chains rooted in consumption patterns of the local area.
Concrete examples where applied	• Guide to local food products, Ripollés[66] • Montnegre Corredor, Asaja KM0 online shop [67] • Promoting local products after wildfire[68] • Montseny park Rural commercialization project[69]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la	Seeks to Foster socio-economic activities in the biosphere reserve area.	

[60]http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[61] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[62] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[63] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[64] http://www.ruralcat.net/agroindustria/llibretinnovacio2014.pdf
[65]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[66] http://issuu.com/energialeader/docs/ftixes
[67] http://www.naciodigital.cat/baixmontseny/noticia/2319/comprar/pages/sense/sortir/casa
[68] http://www.diaridegirona.cat/tecnologia/2014/07/22/web-promocio-productes-locals-vol/679790.html
[69] http://www.rururbal.eu/barcelona/?p=317 and http://www.rururbal.eu/barcelona/?p=321

Name of policies *(examples)*	Opportunities	Barriers
Biosfera del Montseny[70])		
Livestock development Plan (Pla de recuperació del sector oví i cabrum[71])	Promotes actively the establishment and consolidation associations of producers and diversification of products.	
Proximity selling Decree of Catalan Government (Decret 24/2013, de 8 de gener - DOGC núm. 6290 - 10/01/2013)[72]	Different subsidies for enhancing profitability for local actors in agro-products value chain	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[73])	Different subsidies aiming to enhance more resilient and sustainable consumption patterns	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects
Private investment (CSR, special programs by banks or Foundations…)	Local experiences developing similar actions to those proposed in the WMO were funded by private initiatives[74].	Consistency and timeline of programme often does not allow follow up and consolidation of the herds.
Program Med (FEADER)[75]	Under this program initiatives like the Rururban project in Montseny have flourished	

[70] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[71] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[72] http://agricultura.gencat.cat/ca/ambits/alimentacio/venda-proximitat/dar_concepte/
[73] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[74] For example: http://lacaixaparcs.diba.cat/
[75] http://www.programmemed.eu/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	**Role of stakeholder**	**Opportunities**	**Barriers**	**Possible involvement**
Barcelona Council (Diputació)	Political and funding backup	Supportive towards measure	Coordination effort needed	Needs solid economic viability plan
Girona Council (Diputació)	Political and funding backup	Supportive towards measure	Coordination effort needed	Needs solid economic viability plan
Montseny Park Authorities	Establish production conditions for the label	Increased acceptance of Natural Park environmental protection constraints on local economy.	Negative experiences on previous similar initiatives	Needs solid economic viability plan
Montnegre-Corredor Park authorities	Establish production conditions for the label	Increased acceptance of Natural Park environmental protection constraints on local economy.	Coordination effort needed	Has already good experiences and would amplify existing commercialization channels
Agriculture Department	Enhance funding and visibility	Increase economic viability of the sector	Overlapping other labels, protocols and certifications	Will negotiate less restrictive production conditions for the label
County Council	Enhance funding and visibility	Increase economic viability of the sector	Coordination effort needed	Would support the measure
Municipalities	Authorizations and visibility	Enhanced value of local products	Coordination effort needed	Would support the measure
Agro-cooperatives	Advise and maybe promotion	Enhanced value of local products	Overlapping other labels, protocols and certifications	Would be available to consider the measure

3. **Water Management option: Expand the Catalan School for Shepherds in the Tordera basin area.**

Overall description of the WMO

Short explanation	The lack of active forest management entails an increase of the density of plant cover and undergrowth, increasing in this way total biomass in the forest. Reducing uncontrolled biomass can help to reduce forest evapotranspiration and wildfire risk, as well as improving its health. Currently there is an urgent need for generational turnover in the livestock farming sector, therefore this option aims to contribute consolidating the model developed by the Catalan School for Shepherds as to increase interest for the profession to ensure generational turnover. The option proposes to identify farms willing to collaborate with the school and potential new farms to be exploited; teach and encourage sustainable shepherds’ activities.
Addressed challenges	(B) Health of forests and water ecosystems. In particular: tackle generational turnover of extensive livestock farming.
Target locations and water uses	Location: River as a whole. Water uses: Local population, Agriculture, Forestry. In particular, natural park and other forested areas in the basin would be target locations.
Benefits	Enhance generational turnover in the livestock-farming sector, sustain herd management practices functional to adaptive forest management practices.
Potential negative impacts	Cultural barriers for new shepherds to be accepted in local community and lack of consolidation of new herds given economical and agronomical constraints.
Timeline of implementation	Short (under 5 years’ time)
Feasibility	No major obstacle
Robustness	No; measure is highly dependent on socio-economical constraints.
Flexibility	Yes; new herds can adapt to new conditions of the forest and of the market.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 50 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 12 500 €/year The cost estimation is based on the following assumptions: • One-year program by a manager specialized in the sector to create the conditions to extend the number of livestock farmers collaborating with the Catalan school of shepherds project in the Tordera basin area. • A specialized manager for 3 PM/year dedicates specific follow up to enhance and consolidate the program. Communication tasks are not included, given that the network of partners of the shepherds’ school would provide these.

Synergies and conflicts with policy objectives	No conflicts. Synergies with - General Forestry Policy Plan (Pla General de Política Forestal 2014-2024[76]) - Montseny Biosphere Reserve Conservation Plan (Pla de Conservació del Parc Natural i Reserva de la Biosfera del Montseny[77]) - Livestock development Plan (Pla de recuperació del sector oví i cabrum[78]) associations of producers and diversification - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[79])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Main stakeholders are Catalan shepherd school, park authorities and county council who would need to impulse the initiative.
Preconditions for success	Farms willing to collaborate.
Concrete examples where applied	• La Gaiata Association project “Ramats al bosc”[80] • Projecte Gripia[81] • Montseny park Rural commercialization project[82]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[83])	Seeks to Foster socio-economic activities in the biosphere reserve area.	

[76] http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[77] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[78] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[79] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[80] http://ramatsalbosc.org/index.html
[81] https://projectegripia.wordpress.com/
[82] http://www.rururbal.eu/barcelona/?p=317 and http://www.rururbal.eu/barcelona/?p=321
[83] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3

Name of policies *(examples)*	Opportunities	Barriers
Livestock development Plan (Pla de recuperació del sector oví i cabrum[84])	Promotes actively forest-grazing herds to be recovered, sustained and new farms to be developed.	
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[85])	Measure 6 addresses generational turnover (06.01.01)	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects
European Network for Rural Development[86]	Knowledge sharing and cooperation between EU countries to implement rural development calls	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Barcelona Council (Diputació)	Political and funding backup	Supportive towards measure		Would support the measure
Girona Council (Diputació)	Political and funding backup	Supportive towards measure		Would support the measure
Montseny Park Authorities	Authorization, design and promotion	Already trying to implement the measure	Lack of farms willing to collaborate, socio/cultural problems.	Already declared they would
Montnegre-Corredor Park authorities	Authorization, design and promotion	Expand to more farms	Limited number of existing farms to	Almost all potential already exploited

[84] http://agricultura.gencat.cat/ca/ambits/ramaderia/dar_pla_recuperacio_sector_ovi_cabrum/
[85] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[86] http://enrd.ec.europa.eu/es

			establish the program	
Agriculture Department	Enhance funding and visibility	Generational turnover for the sector	Limited economic importance of the sector	Would support the measure
County Council	Enhance funding and visibility	Enhance economic activity in the area	Limited economic importance of the sector	Would support the measure
Municipalities	Authorizations and visibility	Enhance economic activity in the area	Limited economic importance of the sector	Would support the measure
Catalan shepherd school	Design and promotion	Expansion of the project	Number of people involved	Needs solid economic viability plan

4. Water management option: Enhance rainfed crop production

Overall description of the WMO

Short explanation	The expansion and consolidation of irrigated agriculture is a strong pressure for the water bodies of the basin. Rainfed crops are not sufficiently promoted to become a viable alternative. In order to promote practices aiming at increased economic viability of rainfed crop production, this option proposes to create specific knowledge transfer programs in the framework of Farm Advisory Services, including assistance with crop selection and rotation, soil management (structure and fertility), green water management, exploitation design and commercialization of products.
Addressed challenges	(A) Increase water quantity. In particular, reduce agricultural water consumption.
Target locations and water uses	Location: River as a whole. Water uses: Agriculture, water management.
Benefits	Increase agro-biodiversity, diversify agriculture production and reduce pressures on water resources.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles: related to the integration of new policies into the existing FAS program.
Robustness	No; measure is highly dependent on socio-economical constraints.
Flexibility	Yes; rainfed crops can be adapted to new conditions, because not subject to high investment.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 38 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 30 000 €/year The cost estimation is based on the following assumptions: • Integration with specialized professional advise service by integrating existing Farmers Advisory Service, provided under the Common Agriculture Policy implementation standards, with a half time contract at manager level. • Combination of communication tools and actions for knowledge transfer to farmers on how to increase economic viability of rainfed crops in the basin. Cost estimation includes a publication to disseminate the knowledge acquired to other basins in Catalonia.

Synergies and conflicts with policy objectives	No conflicts. Synergies with - Montseny Biosphere Reserve Conservation Plan (Pla de Conservació del Parc Natural i Reserva de la Biosfera del Montseny[87]) - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[88]) - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[89])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	County Agriculture Department Vallès Oriental, Maresme and La Selva.
Preconditions for success	Collaboration with the existing FAS[90], like those existing for irrigation[91]
Concrete examples where applied	Berglund, M.; Dworak, T. (2010): Integrating water issues in Farm advisory services - A Handbook of ideas for administrations.[92]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[93])	C2.2.5. on recovering habitats (also rainfed agriculture related)	
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[94])	Measure 2 on Farm advisory services (02.01.01) Measure 6 on agrarian diversification (06.04.01)	

[87] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[88] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[89] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[90] http://www.ruralcat.net/web/guest
[91] http://www.ruralcat.net/web/guest/oficina-del-regant
[92] http://ec.europa.eu/environment/water/quantity/pdf/FAShandbk.pdf
[93] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[94] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/

Name of policies *(examples)*	Opportunities	Barriers
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[95])	Collaborate with farmers to adopt more resilient agriculture practices.	
European Network for Rural Development[96]	Knowledge sharing and cooperation between EU countries to implement rural development calls	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
County Agriculture Department Vallès Oriental	Develop FAS program	Increase economic opportunities and production diversification	Low budget solutions are not economically interesting for agro-industry	Limited acceptance, socio/political/cultural problems need to be addressed
County Agriculture Department Maresme	Develop FAS program	Increase economic opportunities and production diversification	Low budget solutions are not economically interesting for agro-industry	Limited acceptance, socio/political/cultural problems need to be addressed
County Agriculture Department La Selva	Develop FAS program	Increase economic opportunities and production diversification	Low budget solutions are not economically interesting for agro-industry	Limited acceptance, socio/political/cultural problems need to be addressed
Experts on rainfed agriculture	Integrate FAS program	Hot topic in agro science & engineering	Not many professionals available	Needs proper working conditions to be created
Farmer associations	Promote knowledge transfer	Increase economic opportunities and production diversification	Increased risk in production conditions	Limited acceptance, socio/political/cultural problems need to be addressed

[95] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[96] http://enrd.ec.europa.eu/es

5. Water management option: Revise the Extractions Master Plan.

Overall description of the WMO

Short explanation	The declaration of over-exploitation of the alluvial aquifer in the central and lower section of the River Tordera through the 2003 edict[97], decreed developing an "Extractions Master Plan" (EMP) for these water bodies POE, DOGC 11/2/2003). In the context of this master plan a specific IT management tool was developed that allows establishing an overall water account of the basin's uses in accordance to specific river sections, with the aim to regulate extraction rates. This option wants to promote: • Updating of the management tool: increase the quality and scope of data included, increase the level of detail and gather relevant information that can be made available for local entities. • Amplifying the territorial scope where the tool is used, like for example the Arbúcies and Santa Coloma streams, with the aim to extend the extraction master plan to the whole basin. • Delegation for the use and maintenance of the IT tool to local entities.
Addressed challenges	(A) Increase water quantity. In particular: promote stricter framework for groundwater extractions.
Target locations and water uses	Location: Current EMP concerns only the lower part of the River, but this option proposes to extend it to the River as a whole. The option targets specifically groundwater users and would integrate current water management;
Benefits	Increase health of water ecosystems, strongly related to biodiversity, hydro geomorphology, water quality and salt intrusion; it also benefits accounting for water uses and empowerment of local actors for water allocation conflict solving.
Potential negative impacts	Potentially, limitations on groundwater extractions may increase the pressure on other water bodies and water transfer demand.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Serious obstacles: vested water uses would be affected and strong political will would be required.
Robustness	No; measure is highly dependent on socio-economical constraints.
Flexibility	Yes; the EMP could be revoked and reviewed in any moment
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 84,000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 45,000 €/year The cost estimation is based on the assumption that the actual revision process of this master plan would be at the expense of Water Authority in its normal functions, while BeWater would complement and consolidate actions towards

[97] http://aca-web.gencat.cat/aca/documents/ca/legislacio/edicte/edicte_26092003.pdf

	increased water accounting, through: • Coordination for data gathering with local entities with the help of a specialized technician to set up a common platform. • In order to expand the area managed under the conditions of the master plan, juridical advice is needed to set up and develop the negotiations with municipalities from the Arbucies and la Selva region. • Enable the Water User Association - WMO 11 – to be in charge to use, maintain and update the water accounting tool provided by the Extraction Master Plan.
Synergies and conflicts with policy objectives	This option is in conflict with almost all sector plans, as water demand for economic activities would have fewer possibilities to expand to allow water tables to improve. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[98]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.) If adequately managed the extraction plan would increase water provision guarantee of current users.
Suggested stakeholder involvement	Catalan Water Agency and local entities.
Preconditions for success	The constitution of a WUA (WMO 11), awareness rising on the need to regulate extractions.
Concrete examples where applied	2003 Lower Tordera aquifer overexploitation edict[99]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[100]	A2006/A2007/A2008 (analysis of extractions, data gathering, connectivity) A3004 (extraction control) A6008 (extraction cartography) A6011 (definition of water bodies) B2010 (water saving local entities)/G0006 (revision of entitlements)	All sector policies increasing water demand

98 http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
99 http://aca-web.gencat.cat/aca/documents/ca/legislacio/edicte/edicte_26092003.pdf
100 http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322

Name of policies *(examples)*	**Opportunities**	**Barriers**
	B5008 (improve control) E1001 (innovation)	
Water Framework Directive (2000/60/CE)	Improve water accounting	Data available

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan Water Agency	Competent authority for the master plan design and revision	Adjust master plan and integrate new strategies	May be counterproductive to open this "Pandora box", consolidating overexploitation	Already declared they would promote the option
Exploitation board (juntes d'explotació)	Subjects of the plan: composed by local entities, like water supply service providers, municipalities, big water users, etc	Consolidate users' role in decision making, increased incidence on exploitation regime	Inertia of existing power relations	Willingness conditioned by favourable socio-political environment
Local entities currently not included in the plan	Involved though the expansion of scope envisioned by the measure	Consolidate users' role in decision making, increased incidence on exploitation regime	Lack of coordination and communication between relevant actors	Willingness conditioned by favourable socio-political environment

6. Water management option: Establish water entitlement conditions

Overall description of the WMO

Short explanation	Investments in water saving technologies don't deliver the expected results due to the rebound effect: saved water is re-invested in production until the entitled volumes are used up, therefore savings don't return to water bodies. When public administration awards subsidies to foster water saving practices and decrease the pressure on the environment, specific conditions can be introduced in the entitlement in order to guarantee effective savings. For example: adopting flow limiting devices, adopting complementary environmental protection measures, realizing technological improvements, installing piezometers, increasing the time lag of the entitlement validity in exchange of a reduction of volumes entitled, etc… An adequate normative structure exists, but there is the need to amplify, innovate and consolidate the available options that can be used when new conditions are negotiated. This option wants to promote a participatory process / open debate targeting municipalities, big water users and relevant actors with the aim to: • Disseminate information about the opportunities to modify/integrate entitlements (existing and new) contemplated in current legal framework; • Gather experiences from citizens, administration and academia on the effectiveness of the different conditionalities currently already adopted; • Design new specific proposals for the Tordera basin.
Addressed challenges	(A/D) Increase water quantity/ IWM. In particular: generate opportunities to reduce water extraction
Target locations and water uses	Location: River as a whole. The option targets all water uses with an entitlement and integrates current water management practices.
Benefits	Strong increase in health of water ecosystems, strongly related to biodiversity, hydro geomorphology, water quality and salt intrusion. Preserving local water bodies from over extraction would also reduce bulk water cost.
Potential negative impacts	Potentially, limitations on water extractions may increase the pressure on water transfer demand.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles: vested water uses would be affected, but no loss of water productivity.
Robustness	No; measure is highly dependent on socio-economical constraints.
Flexibility	Yes; the conditions can be re-negotiated and adapted.

Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 58 000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • Material and information production for the participatory process developed by ACA with professional facilitators. • Specialized professional advice (part time) to structure received information and design concrete proposals for the basin • Special communication program to disseminate the results and the lessons learned of the process itself to transfer knowledge to other Catalonian and Spanish basins.
Synergies and conflicts with policy objectives	This option is in conflict with almost all sector plans, as water demand for economic activities would have fewer possibilities to expand. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[101]
Acceptance	Low, revisions of water entitlement conditions are politically conflictive because of vested interests.
Suggested stakeholder involvement	Catalan Water Agency and local entities.
Preconditions for success	The willingness of the Catalan Water Agency to proceed.
Concrete examples where applied	A negotiation process to introduce conditions in existing water use entitlements was established during the first RBMP (2009-2015)[102]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[103]	G0006 (revision of entitlements)	All sector policies increasing water demand

[101] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[102] https://aca-web.gencat.cat/aca/documents/ca/planificacio/cabals/implicacions_implantacio_pscm_cic.pdf
[103] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322

Name of policies *(examples)*	**Opportunities**	**Barriers**
Water Framework Directive (2000/60/CE)	Enhance water saving	Compensation demands
Marie Sklodowska-Curie actions[104]	Research grants	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan Water Agency	Competent authority for entitlements	Increase available regulation tools, increase awareness and conditions for implementation	Contingent barriers for implementation of conditions	Already declared they would promote the option
Entitlement holders	Adopt conditionality	Adjust entitlement to real use	Loss of opportunity to speculate with entitlement rights	Needs favourable negotiation conditions

[104] http://ec.europa.eu/research/mariecurieactions/

7. Water management option: Enhance knowledge transfer on irrigation with reclaimed water.

Overall description of the WMO

Short explanation	Irrigation with reclaimed water is considered a big opportunity to avoid using water of higher quality for crops, but it is crucial to evaluate limitations and opportunities of these solutions in terms of public health concerns, agronomic, infrastructural, energy consumption and managerial parameters, as well as coordination between competent authorities and normative issues. This option aims to promote: • The elaboration of a study to evaluate the effectiveness of currently existing irrigation with reclaimed water aiming to achieve a reduction of pressure on water bodies in the basin, including an evaluation of the entailed energy consumption, in order to increase the information available on the limitations and opportunities of such projects for the Tordera Basin. • Realize a knowledge transfer program on the use of regenerated water for irrigation targeting public administration, academia and relevant actors.
Addressed challenges	(A) Increase water quantity. In particular: reduce the impact of agriculture water use.
Target locations and water uses	Location: River as a whole. The option targets irrigated agriculture and gardens (built-up land). Water uses: agriculture and water management.
Benefits	Better scoping of water reuse opportunities.
Potential negative impacts	Increase in water treatment (energy consumption), concentration of pollutants and reduction of wastewater feeding river flows.
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacle.
Robustness	No; measure is highly dependent on socio-economical constraints.
Flexibility	Yes; the knowledge can enhance better adaptation strategies.
Costs	Implementation costs: Medium (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 149 000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • Full PhD program student during three years in order to elaborate the information object of a knowledge transfer program

	• Development of a knowledge transfer program based on 10 field visits for around 20 people and a publication to report the experience and disseminate the lessons learned.
Synergies and conflicts with policy objectives	No conflicts Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[105] - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[106]) - Spanish decree on water reutilization (R.D. 1620/2007)[107]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Catalan Water Agency, DAAM, IRTA, ACSA and CCB.
Preconditions for success	Availability of CCB and/or other actors implementing reutilization systems to provide data for the study.
Concrete examples where applied	• CCB are very much involved in pilot cases in their service area[108], (partially in our basin). • Reutilization projects enhanced by ACA[109] • Reutilization projects enhanced by IRTA[110] • DEMOWARE project[111]

[105] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[106] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[107] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/reutilizacion-aguas-depuradas/
[108] http://www.ccbgi.org/reutilitzacio.php
[109] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1226654461208201584588
[110] https://www.gencat.cat/salut/acsa/html/ca/dir2982/triptic_reg.pdf
[111] http://demoware.eu/en

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[112]	B2014 (demand management, non conventional water and energy use) B3003 (prioritization in case of drought) B3004 (access to reclaimed water during drought) B4001 (subventions for reclaimed water use and substitution of sources) B4002/B4003/B4004 (reclaimed water entitlements) B4005 (reutilization infrastructure)	Economic, technical and normative feasibility
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[113])	Enhance water reutilization	Energy consumption
Spanish decree on water reutilization (R.D. 1620/2007)[114]	Establishes conditions for water reutilization	Many potential uses not allowed
Water Framework Directive (2000/60/CE)	Enhance water reutilization	Lack of guarantee of positive effects on the ecological status of the river
Council Directive 91/271/EEC concerning urban waste-water treatment [115]	Enhance water reutilization	Limited transposition at national scale.

[112] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[113] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[114] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/reutilizacion-aguas-depuradas/
[115] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0271

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan water agency	Promote the study	Enhance conditions for reclaimed water use	Legal and funding constraints	Would support the measure
Agriculture department (DAAM)	Promote the study	Consolidate irrigated plots	Legal and funding constraints	Would support the measure
Health department	Promote the study	Overcome health related insecurity	Health risks related to pilot plots	Would support the measure
Consorci Costa Brava (CCB)	Promote the study	Promote management and technological innovation	Pilot cases out of the area of their service	Would support the measure
Institut de Recerca i Technologies Agraries (IRTA)	Promote the study	Promote management and technological innovation	Important data on technical and economical performance may need long timespan	Would support the measure
Agència Catalana de Seguretat Ambiental de la Generalitat de Catalunya (ACSA)	Promote the study	Promote quality standards	Undesired effects performance may need long timespan.	Would support the measure
Target actors for knowledge transfer program	Provide data, take up the results obtained	Enhance conditions for reclaimed water use	Limited data availability and funding constraints	Would support the measure

8. Water management option: Integrate water saving solutions in construction protocols.

Overall description of the WMO

Short explanation	Urban water consumption has a significant impact on the basin. Water savings could be maximized in urban and touristic buildings, both if refurbished or new constructions, reducing current water consumption levels.
	
	This option wants to promote:
	
	• A basin specific study aiming at:
	    ○ Identifying opportunities for water reutilization in buildings,
	    ○ Identifying opportunities and barriers to optimize operation and maintenance conditions for installations,
	    ○ Minimize energy consumption for water reutilization installations.
	• Dissemination of good practices in the design of grey water management installations in buildings.
	• Revision of management patterns and local norms orientated to support this kind of initiatives.

Addressed challenges	(A) Increase water quantity. In particular: optimize water use in buildings.
Target locations and water uses	Location: River as a whole. The option targets specifically built-up land and all related water users.
Benefits	Better scoping water reuse opportunities.
Potential negative impacts	Costs may override benefits.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the coordination between urban planning and water supply provision, as well as communication between Municipalities and real estate construction promoters.
Robustness	Yes; once installed, cost of investment obliges to maintain the system as long as possible even if conditions change.
Flexibility	No, this is a grey measure, not easy to adapt to new conditions.
Costs	Implementation costs: Medium (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 365 000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): 1000 €/year. The cost estimation is based on the following assumptions: • Preparation of material for dissemination re-editing existing material from Diputació • Elaboration of a diagnostic study specific for the Tordera by engineer full time

	• Forster take-up by municipalities through the work of a full time coordinator, moving around the basin to establish pertinent agreements.
Synergies and conflicts with policy objectives	No conflicts Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[116] - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[117]) - Spanish decree on water reutilization (R.D. 1620/2007)[118]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Barcelona Council (Diputació) - network of towns and villages for sustainability – and Municipalities.
Preconditions for success	Availability of engaged actors to participate in the study.
Concrete examples where applied	Today 46 Municipalities in Catalunya have adopted this type of ordinance: • Prototype for municipal protocols for this approved by Catalan government[119] • Presentation by environmental department of Barcelona Council[120] • Report on water protection guidelines for Tordera by ACA[121] • Study dated 2010 on the state of art of the adoption of municipal ordinances for water saving [122] • Sant Cugat Municipality experience[123]

[116] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[117]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[118] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/reutilizacion-aguas-depuradas/
[119] http://www.diba.cat/xarxasost/cat/OrdenancaAigua.pdf
[120] https://upcommons.upc.edu/revistes/bitstream/2099/8163/1/20_Enric_Coll.pdf
[121] http://aca-web.gencat.cat/aca/documents/ca/informes_planejament_urbanistic/guia_tordera_besos.pdf
[122] http://www.diba.cat/documents/553295/963215/estudi_final_ordenances_virtual-pdf.pdf
[123] http://www.oficinasostenible.santcugat.cat/files/23-43555-document/2_150324_sistemes_ag_sc_moliver_3.pdf?go=3d7fa7fcaa728fb8fd74573c0171495cd5ccdde1fa055411b2e497bb17de6028c147669a02e8c1fa34c28eed39467a0c57b463de9bc6842e

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[124]	B2011 (water saving for local entities) B2012 (water loss reduction) B2014 (demand management, non conventional water and energy use) B2015 (demand management)	Economic, technical and normative feasibility
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[125])	Enhance water reutilization	Energy consumption and technical difficulties refurbishment of existing buildings
Spanish decree on water reutilization (R.D. 1620/2007)[126]	Establishes conditions for water domestic grey water reutilization.	Unstable composition of grey water produced
Water Framework Directive (2000/60/CE)	Enhance water reutilization and saving	Effects on the ecological status of the river
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects
Marie Sklodowska-Curie actions[127]	Reaseach grants	

[124] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[125] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[126] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/reutilizacion-aguas-depuradas/
[127] http://ec.europa.eu/research/mariecurieactions/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Barcelona Council (Diputació) - network of towns and villages for sustainability	Political and funding backup	Supportive towards measure	Limited results in some cases, difficult implementation	Already included in strategic policy lines, but limited funding
Municipalities	Provide data and adopt conclusions	Supportive towards measure	Limited data availability	Needs coordination effort
Construction companies	Provide data and adopt conclusions	Business opportunity	Costs generated by new protocol	Limited willingness to adopt the measure.

9. Water management option: Enhance renewable energy to power water management infrastructure in small urbanizations and scattered houses.

Overall description of the WMO

Short explanation	Disposing of the necessary energy supply for correct functioning of water management infrastructure, like water treatment plants, impulsion and/or extraction can be problematic in small urbanizations and scattered houses. In these cases, locally produced renewable energy supply could enhance better water management practices. This option aims to promote: • Pilot cases on the use of renewable energy in water treatment plants, water heating, impulsion and/or pumping in small towns and scattered houses. • Dissemination of the information obtained targeting public administration, academia, water supply providers and relevant actors.
Addressed challenges	(D) Integrated water management. In particular tackling the relation water-energy.
Target locations and water uses	Location: River as a whole. The option targets water management sector.
Benefits	Increase health of water ecosystems, biodiversity, water quality and water quality given the improved wastewater treatment; improved energy use.
Potential negative impacts	Renewable energy installation technical constraints and maintenance.
Timeline of implementation	Medium (5-20 yrs)
Feasibility	Minor obstacles, related to renewable energy installation technical constraints and maintenance.
Robustness	Yes; once installed, cost of investment obliges to maintain the system as long as possible even if conditions change.
Flexibility	No, this is a grey measure, not easy to adapt to new conditions.
Costs	Implementation costs: Medium (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 235 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 11 945 €/year. The cost estimation is based on the following assumptions: • Two pilot cases of renewable energy installation to power soft depuration plants proposed in measure 15, developed and designed by a researcher during 3 years. • Development of a knowledge transfer program and publication on lessons learned after the first 3 years of pilot running. • Maintenance of the pilot cases is accounted for in the description of option 15.
Synergies and conflicts	No conflicts

with policy objectives	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[128] - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[129]) - National Adaptation Strategy for Spain[130] - Catalan renewable energy strategy[131] - Energy and climate change Plan for Catalonia (Plan de la Energía y Cambio Climático de Cataluña 2012-2020) [132]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA, ICAEN and municipalities
Preconditions for success	Economic and technical feasibility
Concrete examples where applied	• Acuamed[133] • Case studies of energy and water management in the region (Tordera Aquifer)[134]: • Study on renewable energy for desalting plants[135] - • Study for renewable energy for purification processes[136] • Study for renewable energy for electrolysis process[137]

[128] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[129] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[130] http://www.magrama.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/plan-nacional-de-adaptacion-al-cambio-climatico/
[131] http://icaen.gencat.cat/web/.content/05_gestio_economica_i_administrativa/subvencions/documents/arxius/20131030_documentinformatiuajutsidae.pdf
[132] http://icaen.gencat.cat/es/pice_l_institut/PlansProgrames/pice_pecac/
[133] http://www.acuamed.es/actualidad/acuamed-contrata-con-acciona-green-suministro-electrico-instalaciones-procedente-energias-renovables
[134] http://www.ccbgi.org/docs/publicacions_revistes/Chelsea%20Burns%20water%20energy%20nexus%20report.pdf
[135] p115 https://upcommons.upc.edu/pfc/bitstream/2099.1/4752/2/PFC-Annexos.pdf
[136] http://upcommons.upc.edu/pfc/handle/2099.1/17397
[137] http://upcommons.upc.edu/pfc/handle/2099.1/9123

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[138]	B2014 (demand management, non conventional water and energy use)	Economic and technical feasibility
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[139])	Enhance renewable energy use	
Catalan renewable energy strategy[140]	Subventions for renewable energy installations	
National Adaptation Strategy for Spain[141]	Enhance renewable energy use	
Renewable energy directive[142]	Enhance renewable energy use	Limited transposition at national scale.
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and	Difficulties to constitute a consortium, competition between projects

[138] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[139]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[140] http://icaen.gencat.cat/web/.content/05_gestio_economica_i_administrativa/subvencions/documents/arxius/20131030_documentinformatiuajutsidae.pdf
[141] http://www.magrama.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/plan-nacional-de-adaptacion-al-cambio-climatico/
[142] https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan institute for energy (ICAEN)	Competent authority	Enhance renewable energy production	Funding availability	would promote the measure
Catalan water agency	Competent authority	Increase water management quality in small towns and scattered houses, de-centralize energy supply, gather data	Funding availability	Possible measures for take up exist in current RBMP
Actors related to pilot cases (to be defined, but would be municipalities and water supply service entities)	Competent authority and/or manager	Increase water management quality in small towns and scattered houses, de-centralize energy supply, produce information	Funding availability, other barriers depend on cases chosen	Willingness assessed case by case, but generally municipalities and water management entities would support the measure if funding is available.

10. Water management option: Enhance water recycling in production processes

Overall description of the WMO

Short explanation	There are different industries in the basin that have a water consumption pattern that could include closed water recycling systems, like for example wine production or chemical industry. This option aims to promote: • Concrete pilot cases for industries as a reference for best practices and innovation projects on closed water recycling systems. • Dissemination of the information obtained targeting public administration, academia and relevant actors.
Addressed challenges	(A) Increase water quantity. In particular: optimize current water use.
Target locations and water uses	Location: River as a whole. The option targets agriculture, industry and energy water use sectors, as pilots could be enhanced in different production sectors.
Benefits	Reduce pressure on water bodies and reduction of external water demand.
Potential negative impacts	Increased investments costs.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to initial investment.
Robustness	Yes; once installed, cost of investment obliges to maintain the system as long as possible even if conditions change.
Flexibility	No, this is a grey measure, not easy to adapt to new conditions.
Costs	Implementation costs: Medium (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 271 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 16 000 €/year. The cost estimation is based on the following assumptions: • Full PhD program student during three years in order to elaborate the information and engage industries in the initiative. • Development of a publication reporting lessons learned and dissemination of findings to target audience.

Synergies and conflicts with policy objectives	No conflicts Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[143]
Acceptance	High There is not significant reason a priori for anyone to reject the option if proper funding is provided.
Suggested stakeholder involvement	ACA, CCB, county council and industries.
Preconditions for success	Economic and technical feasibility, water tariffs limiting the use or limited water use permits
Concrete examples where applied	- SELWA project[144]

[143] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[144] http://www.selva.cat/selwa/wp-content/uploads/2007/09/croda_iberica_sa.pdf - http://www.selva.cat/selwa/wp-content/uploads/2007/09/laboratorios_hipra.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[145]	B2014 (demand management, non conventional water and energy use) B3003 (prioritization in case of drought) B3004 (access to reclaimed water during drought) B4001 (subventions for reclaimed water use and	Economic and technical feasibility
European Innovation Partnership InduRe - Industrial Water Re-use and Recycling (AG045)146	Promotion of water recycling	
Eco-innovation program of the European Commission[147]	Multiply business innovations that strengthen the competitiveness of the recycling industries	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan Water Agency or Consorci Costa Brava	Promote the pilot case(s)	Gather information	Difficult to generalize the results for other cases at basin level	Would support measure
Agriculture department or Institut de Recerca i Technologies Agraries (IRTA)	Promote the pilot case(s)	Gather information	Reluctance to deliver economic data on performance	Would support measure
County Council (corresponding the area where the pilot is located)	Promote the pilot case(s)	Visibility	Funding availability	Would support measure
Industry willing to do a pilot	Implement the pilot	Water saving opportunity	Concentration of pollutants	Would support measure if funding is available

[145] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[146] http://www.eip-water.eu/InduRe
[147] http://ec.europa.eu/environment/eco-innovation/discover/funding-areas/index_en.htm

11. Water management option: Create Water User Associations (WUA)

Overall description of the WMO

Short explanation	Groundwater bodies in the Tordera Basin are over-exploited, given that the level of extractions is superior to the recharge rate. Even if recent figures indicate a positive trend, new forms of governance are needed in order to allow generating a balance between extractions and good quantitative status of the water bodies. The creation of a Water User Association was promoted in the past, decreed by the 2003 edict of over-exploitation[148], without success.
	
	This option wants to promote:
	• Elaborate a study to evaluate the barriers and opportunities to build a WUA in the Tordera basin, including:
	  ○ Literature review on the role of WUA in adaptive management,
	  ○ Analysis of the history of WUA in Tordera engaging relevant actors,
	  ○ Formulation of proposals to promote a WUA in the Tordera basin.
	• Interventions to increase the availability and transparency of information on the extractions in the basin.
	• Promotion of a specific deliberative space and decision making of people/entities that have an entitlement (WUA) in order to:
	  ○ Coordinate and agree on sustainable extraction rates,
	  ○ Manage the IT water management/accounting tool described in option number 5,
	  ○ Monitor and follow up the measures agreed,
	• Behave as an interlocutor between the water authority and local entities.

Addressed challenges	(D) Integrated water management. In particular: water governance.
Target locations and water uses	Location: River as a whole. The option targets all water use sectors.
Benefits	Increased water governance quality allows solving structural problems due to socio-economic dynamics. In this case, a WUA would enhance reduced extraction rates and enhance water accounting.
Potential negative impacts	The WUA is an association of entitlement beholders only. Impossibility to include citizens who do not have an entitlement in this association may potentially consolidate decisions based on the defence of vested interests and pervert the objectives of the WUA.
Timeline of implementation	Short (under 5 years' time)

[148] http://aca-web.gencat.cat/aca/documents/ca/legislacio/edicte/edicte_26092003.pdf

Feasibility	No major obstacles, but affected by political constraints and implementation of WMO 5.
Robustness	No, association can be reformulated in any moment.
Flexibility	Yes, the WUA may enhance flexibility in decision taking in case an increased adaptation effort is required.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 161 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 60 300 €/year. The cost estimation is based on the following assumptions: • Researcher dedication during two years to elaborate the diagnostic study. • A permanent staff at manager level to run and coordinate the WUA. • Promotion of the WUA with 4 annual meetings.
Synergies and conflicts with policy objectives	No conflicts Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[149]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA and actors beholding a water use entitlement.
Preconditions for success	Legitimacy of the WUA, clear conditions and process of decision taking.
Concrete examples where applied	- Llobregat Delta WUA[150] - Reporting on the creation of a WUA in the Tordera River[151] - International experience of EU funded projects on WUA[152]

[149] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[150] www.cuadll.org/
[151] http://www.ccma.cat/324/laca-vol-crear-una-comunitat-dusuaris-per-controlar-el-consum-daigua-de-la-tordera/noticia/85362/
[152] http://www.swim-sm.eu/files/ASSESSMENT_WUAs_FINAL.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[153]	G0007 foster WUAs G0013 coordinated water exploitation	Favourable political environment
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[154])	Creation of citizen associations to enhance adaptation	
Spanish water law (TRL art. 81[155])	Establishes the protocol for the creation of WUAs	
Marie Sklodowska-Curie actions[156]	Reaseach grants	

[153] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[154] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[155] http://hispagua.cedex.es/instituciones/regantes
[156] http://ec.europa.eu/research/mariecurieactions/

World Bank[157]	Supports projects to enhance water user associations

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan water agency	Competent authority to promote the measure	Enhance conditions for better local water governance	Political and funding constraints	Would support the measure
Water users	Participate	Maintenance of groundwater body status	Willing to participate	Limited willingness due to economic, legal and political constraints

[157] http://www.worldbank.org/projects/P107617/water-users-association-development-support-project?lang=en

12. Water management option: Create a Permanent Participation Centre (PPC)

Overall description of the WMO

Short explanation	Currently there is a gap between calls for participation established by the WFD implementation calendar for Catalan RBMPs, planned every 6 years. This disconnection implies citizens are not engaged in following up the implementation of measures, don't have access to relevant information in accessible formats and communication is hindered between the territory and public administration. This option wants to promote: • The constitution of a "Permanent Participation Centre" with the objective to enhance better conditions for citizens to participate in the design and revision of water policies. • Create a documentation centre allowing: ○ To promote dissemination of relevant information for the basin, ○ To promote local debate and coordinate citizen's contributions, ○ Inform about the uptake of those contributions, ○ Foster conflict mediation.
Addressed challenges	(D) Integrated water management. In particular: enhance the quality of water governance.
Target locations and water uses	Location: River as a whole. The option targets all water use sectors, and all land uses.
Benefits	Increased water governance quality allows solving structural problems due to socio-economic dynamics.
Potential negative impacts	Longer periods needed for adopting policies
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the legitimisation of the space and effective participation of the Tordera society.
Robustness	No, centre can be reformulated in any moment.
Flexibility	Yes, the PPC may enhance better response to changing environment.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 80 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 70 000 €/year. The cost estimation is based on the following assumptions: • Creation of local office where a documentation centre is created and correspondent activities can be developed.

	• Specialized professional at manager level to implement and maintain the activities developed at the documentation centre.
Synergies and conflicts with policy objectives	No conflicts. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[158] - Catalan Adaptation Strategy[159] - Catalonian transparency law[160]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA and local entities.
Preconditions for success	Legitimacy of the PPC, take up of the issues resulting the debate into policy and management.
Concrete examples where applied	- Proposal to institute "Basin Councils" for permanent participation for the first RBM planning cycle[161] - Catalan Water Agency participation processes[162] - Catalan Adaptation Strategy participation process[163]

[158] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[159] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[160] https://www.boe.es/buscar/pdf/2015/BOE-A-2015-470-consolidado.pdf
[161] https://aca-web.gencat.cat/aca/documents/ca/planificacio/directiva_marc/pla_gestio_calendari_consulta.pdf
[162] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P46600176421381934582085
[163] http://canviclimatic.gencat.cat/ca/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[164]	Implements compulsory participation processes as transposed from the WFD	Favourable political environment
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[165])	Enhance citizen participation	
Catalonian transparency law (Ley 19/2014, de 29 de diciembre, de transparencia, acceso a la información pública y buen gobierno[166].)	Supports the consolidation of participation in Catalonia.	
Europe for Citizens Program[167]	Structural support for European public policy research organisations (think tanks) and for civil society organisations at European level	

[164] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[165] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[166] https://www.boe.es/buscar/pdf/2015/BOE-A-2015-470-consolidado.pdf
[167] http://ec.europa.eu/citizenship/about-the-europe-for-citizens-programme/future-programme-2014-2020/index_en.htm

The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
Catalan water agency	Competent authority to promote the measure	Enhance conditions for better local water governance	Political and funding constraints	Reluctant to support the measure, political and institutional constraints
Tordera society	Participate	Enhance conditions for better local water governance	Time and attention needed for capacitation & participation	Would support the measure

13. Water management option: Develop a traceability label for agriculture products

Overall description of the WMO

Short explanation	For different reasons, like land ownership patterns, exploitation agreements and difficulties constituting irrigation community organizations, many farmers lack formalized water entitlements. Water use without entitlement entails significant problems for proper water accounting and extraction management, entailing groundwater over exploitation and provoking salt-water intrusion in groundwater bodies of the coastal area. In order to penalize farmers for abstracting water without a valid entitlement, this option proposes to develop a "water traceability label" for those farmers who do have regular permission, thus allowing consumers to recognize and reward producers contributing to the protection of the basin's resources.
Addressed challenges	(A) Increase water quantity. In particular: enhance water accounting.
Target locations and water uses	Location: River as a whole. The option targets specially agriculture water sector and irrigated land use.
Benefits	The label would help better awareness rising about the importance of water accounting and avoid illegal wells currently causing overexploitation of groundwater.
Potential negative impacts	Difficulty to control and free riding of some producers.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Serious obstacles, related to the process of water entitlement regularization and transparency of information.
Robustness	No, label can be changed in any moment.
Flexibility	Yes, the label may enhance more resilience for agriculture water supply.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 43 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 40 000 €/year. The cost estimation is based on the following assumptions: • Creation of the label and pertinent communication tools • Full time technician engaged to manage and promote the label for commercialization strategy development. Current cost estimation may be increased by added costs related to the establishment of the water traceability protocols, where close collaboration and information sharing needs to be put in place. These elements were not possible to estimate at this stage.

Synergies and conflicts with policy objectives	No conflicts. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[168] - Catalan Adaptation Strategy[169] - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[170]) - Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[171])
Acceptance	Low, as it would affect those producers who have no regular entitlement and enhance the revision of entitlements of the existing ones, which may entail a reduction of current extraction rates.
Suggested stakeholder involvement	ACA, county agriculture departments, farmer cooperatives.
Preconditions for success	Political will to tackle illegal well problems in the lower part of the basin.
Concrete examples where applied	- Traceability norms in EU (Regulation 178/2002) [172]

[168] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[169] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[170] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[171]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[172] http://ec.europa.eu/food/food/foodlaw/traceability/factsheet_trace_2007_en.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[173]	G0006 (revision of entitlements)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[174])	Foster water saving and accounting.	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholder	Opportunities	Barriers	Possible involvement
County Agriculture Department Vallès Oriental	Promote the measure	Increase water accounting and product value increase	Limited motivation to burden their affiliates with water law enforcement	If sufficient political backup they would enforce the measure
County Agriculture Department Maresme	Promote the measure	Increase water accounting and product value increase	Limited motivation to burden their affiliates with water law enforcement	If sufficient political backup they would enforce the measure
County Agriculture Department La Selva	Promote the measure	Increase water accounting and product value increase	Limited motivation to burden their affiliates with water law enforcement	If sufficient political backup they would enforce the measure

[173] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[174] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf

Catalan Water Agency	Support measure	Increase water accounting	High number of infringements and administrative burden	If resources are available they would support the measure
Agro-cooperatives	Implement the measure	Product value and reputation	High number of infringements and administrative burden	Limited, but if administration guarantees viability without high costs they would consider the measure

14. Water management option: Create a municipal adaptation board

Overall description of the WMO

Short explanation	Lack of resources hinder planning, funding, implementation and monitoring the effectiveness of adaptation to global change policies at municipal level. In order to foster collaboration between municipalities enhancing the implementation of municipal adaptation plans and/or adaptation measures, this option proposes the creation of a permanent adaptation board.
Addressed challenges	(D) Integrated water management: increase solidity of adaptation measures.
Target locations and water uses	Location: River as a whole. The option targets all water use sectors, and all land uses.
Benefits	The board would help better coordination, funding and implementation of adaptation measures, as well as the development of municipal adaptation plans promoted by Catalan office for Climate Change (OCCC).
Potential negative impacts	None.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the workload municipalities can handle.
Robustness	No, board can be restructured in any moment.
Flexibility	Yes, the board may enhance adaptation measures to be implemented.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 10 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 15 000 €/year. The cost estimation is based on the following assumptions: • In order to promote the participation of municipalities to the board, a kick off conference is organized. • For the duration of the WMO, 4 meetings per year and specific communication material and actions put in place. Cost estimation does not include any funding for the development of the activities the board may decide to implement as currently this is not possible to estimate.
Synergies and conflicts with policy objectives	No conflicts.

	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[175] - Catalan Adaptation Strategy[176]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Municipalities and OCCC
Preconditions for success	Willingness of a sufficient number of municipalities to take part of the board.
Concrete examples where applied	- Example from Bages region of municipalities associated to face wastewater treatment[177]. - EU initiative of Majors coordination for adaptation[178] - Catalan declaration for Municipalities for adaptation[179]

[175] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[176] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[177] http://www.mnbagessanejament.
[178] http://canviclimatic.gencat.cat/ca/politiques/politiques_dels_governs_locals/pacte_alcaldes_per_canvi_climatic/
[179] http://xarxaenxarxa.diba.cat/sites/xarxaenxarxa.diba.cat/files/05_declaracio_de_vilanova_aprovat.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[180]	(B2012) Supports supra- municipal collaborations (B2008) support to the development of municipal water master plans.	Extra burden for municipalities.
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[181])	Enhance coordination between municipalities	
European Economic Area Grants[182]	Strengthen bilateral relations with 16 EU countries and reduce economic and social disparities in the European Economic Area	
Mayors Adapt[183]	Comprehensive local adaptation strategy or integrating adaptation to climate change into relevant existing plans.	

[180] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[181] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[182] http://eeagrants.org/
[183] http://mayors-adapt.eu/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Barcelona Council (Diputació) - network of towns and villages for sustainability	Political and funding backup	Generate a clear process to implement specific policies	Coordination effort	If political profit and funding is clarified they would
Municipalities	Create and participate to the board	Reduce implementation costs of adaptation measures; increase coordination and political recognition	Extra burden for limited resources available	If political profit and funding is clarified they would

15. Water management option: Enhance phytodepuration in small towns and scattered houses.

Overall description of the WMO

Short explanation	Treatment of wastewater produced by small towns and scattered houses are a significant challenge in the basin. Soft treatment plants like artificial wetlands, green filters and similar, can be a valuable option to overcome design and funding problems of adequate water treatment plants, but currently there are few references underpinning the viability of such solutions. This option aims to promote: • Pilot cases in small municipalities (< 2000 inh.) and scattered houses in order to improve data availability on different examples of phytodepuration. • A specific knowledge transfer program to disseminate information obtained targeting public administration, academia and relevant actors identified by a specific dissemination strategy.
Addressed challenges	(C) Increase water quality. In particular: enhance low techsolutions in order to overcome proelms related to wastewater treatment.
Target locations and water uses	Location: River as a whole. The option targets local population, tourism and water management sector, all built-up land use.
Benefits	Allows water sanitation where currently no facility is provided; low tech investment required; low energy and maintenance costs.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the process of adaptation to new practices.
Robustness	Yes, the pilots are designed under certain conditions and are difficult to change in a short time lag.
Flexibility	No. Altough modularity of treatments plots can be introduced.
Costs	Implementation costs: high (between 100,000 - 1,000,000 €) – cost assessment (WP3): around 1 003 000 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): 40 000 €/year. The cost estimation is based on the following assumptions: • Three pilot cases, established in the upper part of the basin • 6 years of pilot design and development with support of a researcher and a technician with full time dedication.

	• The elaboration of a publication indicating lessons learned and dissemination to enhance the application of soft depuration in similar conditions. This cost estimation des not include the cost of property of land where soft depuration plants would be installed, as in the current assumption these are already owned by municipalities.
Synergies and conflicts with policy objectives	No conflicts. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[184] - Catalan Adaptation Strategy[185] - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[186])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA and Municipalities.
Preconditions for success	Possibility to integrate the proposal into Municipal water management roadmap, as these may be subject to constraints.
Concrete examples where applied	- Phytodepuration in Catalonia[187] - A review of cases around Europe[188]

[184] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[185] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[186] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[187] http://premsa.gencat.cat/pres_fsvp/AppJava/notapremsavw/276591/ca/catalunya-disposa-30-sistemes-daiguamolls-construits-tecnologia-depuracio-bon-rendiment-cost.do
[188] http://www.researchgate.net/publication/228407635_Constructed_Wetlands_for_Wastewater_Treatment_A_Review

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[189]	urban wastewater treatment plan (PSARU)[190]	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[191])	Enhance water depuration and low energy input solutions	
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[192])	Measure c.1.3. on depuration	
Life program EU	supporting environmental, nature conservation and climate action projects throughout the EU	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

[189] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
190 http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204654461208200526170&profileLocale=ca
[191]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[192] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan Water Agency	Competent authority for discharged water quality	Enhance low cost and low input facilities	Coordination effort with municipalities and water users	Would support measure if funding is available
Montseny park authorities	Support the pilot cases	Solve water quality problem in Santa Fe dam reservoir and Tordera stream	Coordination effort with municipalities and water users	Would support measure if funding is available
Montseny Municipality	Competent authority for depuration facilities and Pilot	Solve water quality problem	Uncertainty about soft depuration plant technology	Would support measure if funding is available
Can Casades and can Leonard (park administration offices)	Pilot	Solve water quality problem	Uncertainty about soft depuration plant technology	Would support measure if funding is available
Santa Fe Hotel	Pilot	Solve water quality problem	Uncertainty about soft depuration plant technology	Would support measure if funding is available
Restaurant Avet Blau	Pilot	Solve water quality problem	Uncertainty about soft depuration plant technology	Would support measure if funding is available

16. Water management option: Create an integrated plan for the protection of the Tordera Delta.

Overall description of the WMO

Short explanation	In order to protect the whole delta area in an integrated manner, this option proposes to enhance a specific process of elaboration of an Integrated Protection Plan. The proposal involves a set of actions to recover sediment dynamics of dunes and beaches, constrain land uses, decrease water extractions, increase depuration and enhance biodiversity protection.
Addressed challenges	(B) Health of forests and water ecosystems
Target locations and water uses	Location: lower part. The option targets all water uses and all land use sectors.
Benefits	Creates the conditions to design and implement a strong and focused set of measures for this particular territory.
Potential negative impacts	None
Timeline of implementation	Medium (5-20 yrs)
Feasibility	Minor obstacles, related to the trust in the process.
Robustness	No.
Flexibility	Yes, citizen participation process can include changes due to climate change.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 89 000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • Cost estimation focuses on the development of a 3-year participation process, with professional facilitation. • Specialized technician is hired to design the process and develop the necessary information, as well as a manager to coordinate and promote the process, both with part time dedication. • One-year communication program to disseminate results. Cost estimation does not contemplate a fund to implement the actions resulting the participation process, which was not possible to envision today.
Synergies and conflicts with policy objectives	May induce conflicts with sectoral planning Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[193]

[193] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322

	- Catalan Adaptation Strategy[194] - Catalan coastal law[195] - Urban planning plan[196] - All environmental protection policies.
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA, OCCC, DAAM and citizen platforms
Preconditions for success	Legitimation of the participatory process.
Concrete examples where applied	- Integrated Plan for the Protection of the Ebro Delta[197]

[194] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[195] http://territori.gencat.cat/ca/01_departament/03_atencio_a_la_ciutadania_i_participacio/06_processos_de_participacio/proces-de-participacio-per-a-una-llei-del-litoral/
[196] http://territori.gencat.cat/es/01_departament/05_plans/01_planificacio_territorial/
[197] http://www.magrama.gob.es/es/agua/temas/planificacion-hidrologica/documentobasevfinal3_tcm7-29340.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[198]	A2051 sediment management A5009 to face regression in 5 years A5010 to face regression in 10 years A5032 ecological status of dunes A5041 Spanish coastal adaptation strategy G0013 (Plan for the coordinated exploitation of Surface and groundwater in the delta region aquifers)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[199])	Promotion of integrated adaptation solutions	
Coastal law	Integrated strategies for coastal protection	
Life program EU	Supporting environmental, nature conservation and climate action projects throughout the EU	

[198] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[199]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf

The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan office for climate change (OCCC)	Promote the measure	Create conditions for adaptation measures to be taken up	Limited capacity to get all actors on board	With appropriate funding they would promote the measure
UPC coastal research centre	Promote the measure	Consolidate their proposals and data produced for the Tordera Delta	Need for coordination	They already expressed their support
Ministry for agriculture and environment MAGRAMA (Dirección General de Sostenibilidad de la Costa y del Mar)	Support the measure	Consolidate their proposals and data produced for the Tordera Delta	Need for coordination	Would be engaged through UPC as project outline is already established
Catalan Water Agency (ACA)	Support the measure	Consolidate their proposals and data produced for the Tordera Delta	Need for coordination	They already expressed their support
Agriculture Department of Catalan Government (DAAM)	Support the measure	Consolidate their proposals and data produced for the Tordera Delta	Need for coordination	Feeble support
Citizen platform, municipalities and NGOS (Preservem el Litoral)	Veil for implementation and foster citizen participation	Peruse environmental recovery	Time and attention needed for capacitation & participation	They already expressed their support

17. Water management option selective fishing

Overall description of the WMO

Short explanation	In order to engage citizens in the protection of the basin's biodiversity and help reducing the pressure of alien species in the river, this option proposes selective fishing programs entailed by fisher associations.
Addressed challenges	(B) Health of forests and water ecosystems. In particular: invasive species.
Target locations and water uses	Location: River as a whole. Water uses: local population, tourism and Agriculture.
Benefits	Increase in biodiversity.
Potential negative impacts	More difficult control on fishing practices in protected areas where today any fishing is banned.
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacle
Robustness	No. Measure is highly dependent on socio-economical, as well as environmental constraints.
Flexibility	Yes. Guide can be updated anytime.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 35.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • The elaboration of a specific fishing guide for the Tordera basin. • Dissemination of the publication and awareness rising amongst target audience of the key messages.
Synergies and conflicts with policy objectives	Conflicts with - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[200]) Synergies with - Continental fishing law (Llei 22/2009, de 23 de desembre)[201]
Acceptance	High (There is not significant reason a priori for anyone to reject the option.) Strong doubts were raised during second workshop on an over-estimation of the effectiveness of the measure.
Suggested stakeholder	Fishing associations, natural park authorities and agriculture department of Catalan government.

[200] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[201] http://dogc.gencat.cat/ca/pdogc_canals_interns/pdogc_resultats_fitxa/?action=fitxa&mode=single&documentId=686472&language=ca_ES

involvement	
Preconditions for success	Capacitation of fishers to execute the good practices and increased control.
Concrete examples where applied	- Publication by fishing association AEMS –rìos con vida[202] - book García de Jalón, Diego y Schmidt, Guido (coords.): “Manual práctico para la gestión sostenible de la pesca fluvial”. AEMS. Madrid. 1995. Sthis reports includes administrative, biological and economical management issues and consitutes an important refernce in Spain.

[202] http://www.riosconvida.es/paginas/butique/add.php?id=0003&opc=add

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Continental fishing law[203]	Funding for awareness raising	Specific environmental protection rules in certain river sections

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Agriculture Department	Competent authority	Enhance measures for continental fish population recovery	Limited economic importance of the sector	Given the new regulation, they would promote
Comissió per a la Conservació de les Espècies Aqüícoles	Organ of inter-departmental coordination on continental fish health	Implement coordinated and concrete measures of the new fishing decree	In natural park areas there is the prohibition of fishing inflicting death.	Willing to participate
Fishing association of the Basin	Implementation of the measure	Increase awareness on fishing impacts on the environment	In natural park areas there is the prohibition of fishing inflicting death.	This stakeholder would take the lead of the measure

[203] http://agricultura.gencat.cat/web/.content/06-medi-natural/consell-proteccio-natura/enllacos-documents/informes/2014/fitxers-binaris/2014_01_140411_Reglament-de-Pesca_aprovat-PLE-corr.pdf

18. Water management option: Foster local use of global change indicators

Overall description of the WMO

Short explanation	Global change is a complex challenge and currently is not sufficiently taken into account when building infrastructure and developing interventions in the territory. General indicators have been developed to evaluate the effects of global change, but these are not integrated into local decision making processes, entailing reduced accounting for these impacts in local policy design and implementation. This option wants to promote: • A study to evaluate the opportunities to adapt existing indicators to the specific reality of the Tordera Basin and identify opportunities to integrate its use in local development decision-making processes. • Design pilot cases on the application of these indicators in a local vulnerability to global change analysis. • A specific knowledge transfer program to disseminate information obtained targeting public administration, academia and relevant actors.
Addressed challenges	(D) Integrated water management. In particular: better design and monitoring of adaptation measures.
Target locations and water uses	Location: River as a whole. It targets all water use sectors and land uses.
Benefits	Increase consideration of adaptation challenges in all local policy implementation processes would benefit the whole basin dynamics and would enhance awareness raising at different levels on the need to adapt to global change, inclusive the administration.
Potential negative impacts	Using indicators may induce extra workload for municipalities.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles related to the incorporation in normal policy implementation procedures of the indicators & capacity building of administrative personnel.
Robustness	No.
Flexibility	Yes. Indicators can be updated anytime.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 162.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 2500 €/year. The cost estimation is based on the following assumptions: • Researcher developing during the first year a diagnostic study • A three-year PhD program dedicated to design and development of the pilot cases

	• Elaboration of a publication and dissemination of the lessons learned. • Promotion of the uptake of findings at municipal level, 1 PM of specialize technician of the Catalan office for climate change.
Synergies and conflicts with policy objectives	No Conflicts Synergies with - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[204]) - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[205] - Catalan Adaptation Strategy[206] - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[207])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	OCCC and Municipalities
Preconditions for success	Clear information and capacity building of local entities to adopt the indicators.
Concrete examples where applied	Catalan global change indicator[208]

[204] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[205] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[206] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[207] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[208] http://canviclimatic.gencat.cat/web/.content/home/actualitat/docs/Doc-Index-complet.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[209]	E1001 research and development	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[210])	Development and promotion of global change indicator	
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[211])	Measure 01 on information and knowledge transfer	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[212]	Supports increasing knowledge on adaptation	
European climate adaptation platform (Climate-ADAPT) and EU-Cities Adapt	support adaptation policy and decision making	
Mayors Adapt[213]	Comprehensive local adaptation strategy or integrating adaptation to climate change into relevant existing plans.	

[209] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[210]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[211] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[212] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[213] http://mayors-adapt.eu/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan Climate change office	Developed the indicators	Promote the use of the indicators	Coordination effort	Positive towards the measure
Local entities and municipalities	Adopt the indicators	Increase monitoring and awareness on adaptation	Workload burden	In case they have subvention they would

19. Water management option: awareness raising

Overall description of the WMO

Short explanation	In order to offer concrete opportunities for people to be involved in the river's protection, this option proposes a set of actions, such as: design specific programs at basin scale for schools and adult education, create environmental pathways, fostering natural heritage, strengthen voluntary services and promote initiatives aiming at diversifying seasonal tourism.
Addressed challenges	(D) Integrated water management. Awareness rising can enhance a broad spectrum of improvements of management conditions.
Target locations and water uses	Location: River as a whole. It targets all water use sectors and land uses.
Benefits	Increased consideration of adaptation challenges in all local policy implementation processes would benefit all FCM factors and would raise awareness at different levels on the need to adapt to global change, inclusive the administration.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacles.
Robustness	No.
Flexibility	Yes. The more awareness raising, the more resilience.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 250.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 6000 €/year. The cost estimation is based on the following assumptions: • Compilation of existing data to feed in different awareness raising programs • Specialized communication work, including the development of pertinent material • Elaboration of an APP by 6Pm technician work • Development of educational pathways along the river areas • Development of a specific program "Foster your river" employing full time technician • Increased coordination between existing volunteer programs employing full time technician • A conference on adaptation seasonal opportunities for tourism sector 6PM of a technician to foster the uptake of the proposal that arise and a dissemination program to enhance results to be implemented.
Synergies and conflicts	No Conflicts

with policy objectives	Synergies with - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[214]) - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[215] - Catalan Adaptation Strategy[216] - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[217])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	Touristic, education, volunteer and environmental organizations, municipalities.
Preconditions for success	Clear information to disseminate, people's willingness to participate.
Concrete examples where applied	- Network of green schools[218] - Environmental NGOs[219] - Knowledge transfer[220] Monitoring environmental state[221]

[214] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[215] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[216] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[217] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[218] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/educacio_i_sostenibilitat/educacio_per_a_la_sostenibilitat/escoles_verdes/
[219] http://natura-tordera.blogspot.com.es/2008/05/el-projecte-orenetes.html
[220] http://pagines.uab.cat/illustraciocientifica/content/lobservatori-de-la-tordera
[221] http://www.projecterius.cat/

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[222]	Awareness raising on A4007 invasive species A5027 beaches B2010 water saving for local entities	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[223])	Promotes awareness raising on global change issues	
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[224])	Measure 01 on information and knowledge transfer	
Department for education and awareness raising of Catalan Government[225]	Support all kinds of awareness raising activities	
Catalan network for territorial custody[226]	Supports concrete projects for socio-environmental awareness raising	
Spanish centre for environmental education(Centro Nacional de Educación Ambiental - CENEAM)[227]	Support all kinds of awareness rising activities	

[222] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[223] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[224] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[225] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/educacio_i_sostenibilitat/campanyes_i_exposicions/campanyes_de_sensibilitzacio_ambiental/
[226] http://custodiaterritori.org/
[227] http://www.magrama.gob.es/es/ceneam/

National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[228]	Promotes awareness raising on climate change issues	
Biodiversity Foundation[229]	Promotes awareness raising on all kind of environmental issues	
European Economic Area Grants[230]	Strengthen bilateral relations with 16 EU countries and reduce economic and social disparities in the European Economic Area	
Mayors Adapt[231]	Comprehensive local adaptation strategy or integrating adaptation to climate change into relevant existing plans.	
Sustainable tourism[232]	Promotes and support initiatives to increase sustainable tourism	
European Voluntary service[233]	Support all kinds of awareness raising activities	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

[228] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[229] http://fundacion-biodiversidad.es/ca
[230] http://eeagrants.org/
[231] http://mayors-adapt.eu/
[232] http://www.sustainabletourism.net/
[233] http://europa.eu/youreurope/citizens/education/volunteering/index_en.htm

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Environmental NGOs (ex. Observatori de la Tordera)	Leader different awareness raising activities, most likely: preparing educational material, fostering program, pathways, awareness on tourism)	Visibility, reach more people	Funding	Willing to foster part of the activities proposed by the measure
Municipalities	Leader different awareness raising activities, most likely: pathways, awareness on tourism	Bring citizens closer to natural heritage	Funding	Willing to foster part of the activities proposed by the measure
Centre for educational material	Adopt materials produced	Increase material available	Make the materials be adopted by teachers	Willing to foster part of the activities proposed by the measure
Volunteer organizations	Leader different awareness raising activities, most likely: preparing pathways, awareness on tourism and riparian vegetation maintenance	Increase activities promoted	Funding	Willing to foster part of the activities proposed by the measure
Touristic sector	Give input on seasonal tourism	Re-distribute activities during the year, stabilize income	Touristic installations/proposals need to be adapted to new frequency patterns	Willing to foster part of the activities proposed by the measure

20. Water management option: Modernization of irrigation technologies

Overall description of the WMO

Short explanation	In order to optimize water use by agriculture sector, this option proposes to install pressurized irrigation devices or refurbish gravity irrigation systems in accordance with option 5 on the basin water accounting tool and option 6 on entitlement conditions.
Addressed challenges	(A) Increase water quantity. In particular: reduce pressure of agriculture water use on water bodies.
Target locations and water uses	Location: River as a whole. Target water use sector agriculture and irrigated land uses.
Benefits	Reduction of water derived for irrigation.
Potential negative impacts	Increased efficiency implies a reduction of water returning to water bodies. These irrigation returns and other leaks of the distribution system are currently maintaining associated ecosystems. Therefore this measure should be implemented in combination with WMO 5, 6 and 31, dealing with reduction of abstractions and revision of entitlements.
Timeline of implementation	Medium (5-20 years)
Feasibility	Minor obstacles, related to the constitution of the user association required by Spanish law.
Robustness	Yes; once installed, cost of investment obliges to maintain the system as long as possible, even if conditions change.
Flexibility	No, this is a grey measure, not easy to adapt to new conditions.
Costs	Implementation costs: Medium/high (between 100,000 and 1,000,000 €) – cost assessment (WP3): around 390,000 € Running/Operational costs: Medium/high (between 100,000 and 1,000,000 €) – cost assessment (WP3): 156,000€/year The cost estimation is based on the following assumptions: • 25% of current irrigation area potentially to be modernized (156 Ha) • Investment and running cost estimated taking as a reference existing subventions to the sector in Catalonia.
Synergies and conflicts with policy objectives	Potential conflicts may be significant depending on the technology chosen, I.e. pressurized irrigation, which increases energy consumption, and intensification of agronomic models. This would not be the case with refurbished gravity irrigation systems, where pollution is on e of the main factors of conflictive objectives. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[234] - Catalan Adaptation Strategy[235]

[234] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322

	- Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[236])
Acceptance	High (There is not significant reason a priori for anyone to reject the option.)
Suggested stakeholder involvement	ACA, DAAM and farmer associations.
Preconditions for success	Creation of a farmer association.
Concrete examples where applied	- Traditionally modernization is the main measure used for reducing environmental impact of irrigation in Spain - Report on problems related to irrigation and modernization in Spain[237] - Report on conditionality linked to FEADER funds for irrigation (Regulation 1305/2013) [238]

[235] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[236] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[237] http://awsassets.wwf.es/downloads/modernizacion_regadios.pdf
[238] http://www.iagua.es/blogs/alberto-hernandez-garcia/ayudas-modernizacion-regadios-estaran-condicionadas-al-ahorro-agua

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[239]). Terms and conditions for the period 2015-2018: ORDRE ARP/270/2015[240]	Supports modernization to drip irrigation	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[241])	Supports modernization with any technological alternative	
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[242]	Takes up the measures included in RDP	
National irrigation Plan[243]	Supports modernization to drip irrigation	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[244]	Supports modernization with any technological alternative	
FEADER program[245]	Funds RDPs	

[239] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[240] http://portaljuridic.gencat.cat/ca/pjur_ocults/pjur_resultats_fitxa/?action=fitxa&mode=single&documentId=701470&language=ca_ES
[241] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[242] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[243] http://www.magrama.gob.es/es/desarrollo-rural/temas/gestion-sostenible-regadios/plan-nacional-regadios/texto-completo/
[244] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[245] http://eur-lex.europa.eu/legal-content/ES/TXT/?uri=uriserv:l60032

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Agriculture Department	Leader possible interventions	Extend irrigation efficiency measures already envisioned	Funding and proving/monitoring efficiency	Limited economic importance of the sector in higher and central part of the basin, lower part most opportunities
Farm Associations	Adopt interventions	Adopt irrigation efficiency measures already envisioned	Economic viability/ energy costs	Willing to adopt if funding provided
Catalan Water Agency	Coordinate interventions with option 5 and 6	Water savings	Effectiveness of measure on water bodies not proven	Coordination effort is a burden

21. Water management option: Integrate adaptation principles into water service provider contracts

Overall description of the WMO

Short explanation	Currently water service provider contracts established between public administration and private companies include binding conditions on sources entitled, quantities allowed to extract and have very long duration. In case any variation is needed on these contractual conditions, companies would have the right to claim refunding equal to lost benefits. Under the foreseen global change conditions for Catalonia it is crucial to dispose of the needed water management and exploitation regime flexibility to allow the protection of general interest: preservation of strategic water bodies for enhancing resilience. This option aims to promote: • A study on the opportunities to integrate adaptation to global change principles into current juridical framework regulating externalization of water provision services. • Dissemination of the results of the study with a specific knowledge transfer program targeting relevant actors.
Addressed challenges	(D) Integrated water management. In particular: increase of flexibility in water management.
Target locations and water uses	Location: River as a whole. It targets bulk water providers and other water service contracts.
Benefits	Public administration would recover opportunities and funds for adaptive management it does not have today.
Potential negative impacts	Increase business risk for service provider companies.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Serious obstacles related to the economic implications of the measure.
Robustness	No. the measure wants to introduce flexibility in current water service contracts.
Flexibility	Yes. Adaptation principles would increase management flexibility.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 163.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • Three year full time research program

	• Publication and dissemination of results to target audience at the end of the research program.
Synergies and conflicts with policy objectives	Conflict with current water service contract protocols, like currently the case for the biggest bulk water service provider in Catalonia [246] Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[247] - Catalan Adaptation Strategy[248]
Acceptance	Low
Suggested stakeholder involvement	Government of Catalonia and water service providers.
Preconditions for success	Political will to prioritize adaptation to global change in water management.
Concrete examples where applied	- Barcelona Metropolitan area is revising service contracts[249]

[246] http://www.theeconomyjournal.com/en/notices/2015/02/the-atll-an-example-of-a-bad-privatisation-052.php
[247] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[248] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[249] http://ccaa.elpais.com/ccaa/2015/07/29/catalunya/1438179197_339506.html

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[250]	B2001 supply management B2003 new supply contracts B2006 reformulation of bulk water supply contracts B2008 Master plan redaction for municipalities	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[251])	Supports the take up of adaptation principles by all sectors	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[252]	Supports increasing knowledge on adaptation	
European climate adaptation platform (Climate-ADAPT) and EU-Cities Adapt	Support adaptation policy and decision making	
Mayors Adapt[253]	Comprehensive local adaptation strategy or integrating adaptation to climate change into relevant existing plans.	

[250] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[251]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[252] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[253] http://mayors-adapt.eu/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Government of Catalonia	Promote the measure	Would enable to implement adaptive management	Economic and political	If there is a strong citizen demand it may take into consideration
Catalan Water Agency	Promote the measure	Better supply management, WFD compliance	Legal and administrative constraints, economic burden	Needs strong political support
Water service providers (private or public)	Adopt the measure	Increase sustainability of service	Legal and administrative constraints, economic burden	Needs strong political support

22. Water management option: increase environmental protected areas

Overall description of the WMO

Short explanation	The Tordera basin is characterized by special habitat richness, but territorial development and related infrastructures have fragmented strategic areas for many species, reducing their mobility. This option wants to promote: • A participatory process with relevant actors with the aim to revise the current cartography of protected areas and integrate strategic ecologic corridors to connect terrestrial ecosystems. • Gather results obtained from the participatory process and establish adequate forms of environmental protection in the identified areas (new and existing).
Addressed challenges	(B) Health of forests and water ecosystems. In particular: enhance protected habitats and their connectivity.
Target locations and water uses	Location: basin as a whole. Targets all water use sectors and all land uses.
Benefits	Increase in biodiversity.
Potential negative impacts	High opportunity costs.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles related to the opportunity costs of protected areas and with the difficulties of monitoring and control of the compliance of established protection norms.
Robustness	No. Protection norms can be changed any time.
Flexibility	Yes. Increased protection enhances resilience.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 88.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • One-year participation process with professional facilitation and design by half time employed technician • Design and maintenance of the process by manager half time employed • Elaboration of communication material and dissemination activities • Uptake of produced information fostered by employing a technician full time
Synergies and conflicts with policy objectives	Conflict with urban planning may occur.

	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[254] - Catalan Adaptation Strategy[255] - System of environmental protection in Catalonia[256]
Acceptance	High
Suggested stakeholder involvement	Department of Territory and sustainability, Natural park authorities, municipalities and NGOs, as well as general public.
Preconditions for success	Implementation of a sound monitoring and control planning and funds.
Concrete examples where applied	- Different cartographies are available in order to evaluate the habitat connectivity[257] - Plan for the recovery of river connectivity[258]

[254] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[255] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[256] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/senp_catalunya/
[257] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/sistemes_dinformacio/habitats/habitats_terrestres/cartografia_dels_habitats_ver_2/
[258] https://aca-web.gencat.cat/aca/documents/ca/aigua_medi/cabals_manteniment/Pla_millora_connec_Memoria.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[259]	A2031 (recovery of riparian areas) A2015 (compensation measures)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[260])	Supports the recovery of ecological connectivity	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[261]	Supports the recovery of ecological connectivity	
European climate adaptation platform (Climate-ADAPT) and EU-Cities Adapt	Support adaptation policy and decision making	
Life program EU	Supporting environmental, nature conservation and climate action projects throughout the EU	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

[259] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[260]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[261] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Department of Territory and sustainability	Competent authority, leader of the measure, data provision	Update cartography, better scope protected areas	Coordination with local authorities, legal constraints, funding	If funding is provided they would promote the measure
Natural park authorities	Competent authority, support measure, data provision	Update cartography, better scope protected areas	Coordination with local authorities, legal constraints, funding	If funding is provided they would promote the measure
Municipalities	Competent authority, support measure, data provision	Update cartography, better scope protected areas	Administrative burden, funding	If funding is provided they would promote the measure
Environmental NGOs	Support measure, data provision	Update cartography, better scope protected areas, increased areas to manage	Funding	If funding is provided they would promote the measure

23. Water management option: Water provision guarantee as a precondition for urban expansion

Overall description of the WMO

Short explanation	Urban expansion entails a significant challenge for local authorities to warrant adequate water supply service. Current legislation decrees that water authorities should elaborate a viability report evaluating the water supply and sanitation provision for new buildings, but its results are not binding. This condition causes the construction of buildings without water supply guarantee, boosting new water demand based on fait accompli policies. This option aims to promote: • A specific program targeting municipalities evaluating: • The level of water supply provision guarantee of new urban planning, • Limitations and opportunities for a better supply guarantee, • Availability of legal tools to reduce pressure on water bodies by urban expansion. • Dissemination of the results of the study with a specific knowledge transfer program targeting public administration, academia and relevant actors.
Addressed challenges	(D) Integrated water management. In particular the relation between water provision and urban expansion.
Target locations and water uses	Location: basin as a whole. Targets local population, tourism and water management use sectors and built-up land uses.
Benefits	Increase water supply guarantee for residents.
Potential negative impacts	Increased pressure on ACA to authorize water uses.
Timeline of implementation	Short (under 5 years' time)
Feasibility	no mayor obstacles
Robustness	No.
Flexibility	Yes. The new procedure would create more room for adaptive management.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 112.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • One year full time researcher program to design proposals • One year juridical advice from water agency staff dedicated to the program

	• Elaboration of a publication and dissemination of results to target audience
Synergies and conflicts with policy objectives	Conflict with urban planning may occur. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[262] - Catalan Adaptation Strategy[263]
Acceptance	High, the debate on water as a limiting factor for urban expansion is urgent.
Suggested stakeholder involvement	Municipalities and ACA
Preconditions for success	Political willingness.
Concrete examples where applied	- Link to current reporting characteristics of the "Informe del Planeamiento"[264] - Juridical guide for municipalities on water and urban planning[265] - Analysis on territory and water[266]

[262] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[263] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[264] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P14600878071237984978942&profileLocale=es
[265] https://www.defensordelpueblo.es/wp-content/uploads/2015/05/2010-03-Agua-y-ordenaci%C3%B3n-del-territorio.pdf
[266] http://www.unizar.es/fnca/varios/panel/41.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[267]	B2013 design and contributions to bulk water supply for municipalities.	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[268])	Water demand management	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático -PNACC)[269]	Water demand management	

[267] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[268]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[269] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan Water Agency	Lead the measure	Reduce pressure of demand on water resources	Legal and political constraints	Should need political backup to support the measure
Municipalities	Support the measure	Provide data and support the measure	Legal and political constraints, coordination with promotors of urbanization projects	Should need political backup to support the measure

24. Water management option: Recovery of wetlands and their connectivity

Overall description of the WMO

Short explanation	In different areas of the basin wetlands are degraded – inter alia – because of lacking hydrologic connectivity to related aquifers. Its recovery is also crucial to maintain adequate habitats for many species.
	
	This option aims to promote:
	
	• Strategic pilot cases aiming to
	  ○ Test different ways to optimize ecologic and hydrologic functionality of water bodies recovering their connectivity.
	  ○ Analyse appropriate indicators for the Tordera basin to evaluate the ecologic status of wetlands.
	• Dissemination of the results of the study with a specific knowledge transfer program targeting public administration, academia and relevant actors.

Addressed challenges	(B) Health of forests and water ecosystems. In particular: recover water bodies functionality.
Target locations and water uses	Location: basin as a whole. Targets local forest and water management use sectors.
Benefits	Increased health of water ecosystems and resilience.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacles.
Robustness	Yes. The option can maintain its effectiveness under different climatic and socio-economic development scenarios.
Flexibility	No. Recovery depends on solid decisions affecting groundwater extractions.
Costs	Implementation costs: Medium/high (between 100 000 and 1 000 000 €) – cost assessment (WP3): around 582 500 € Running/Operational costs: medium (between 100 000 and 1 000 000 €) – cost assessment (WP3): around 15 000 €/year The cost estimation is based on the following assumptions: • Development of 3 pilot cases, employing a full time technician and researcher for a 6-year period for design and implementation. • Three-year lasting dissemination program.

Synergies and conflicts with policy objectives	Conflict with vested interest based on water extractions of all sector policies. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[270] - Catalan Adaptation Strategy[271] - System of environmental protection in Catalonia[272]
Acceptance	High.
Suggested stakeholder involvement	Municipalities and ACA
Preconditions for success	Political willingness.
Concrete examples where applied	- Estanys de Sils recovery[273] - L'illa de la Tordera recovery[274]

[270] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[271] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[272] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/senp_catalunya/
[273] http://estanydesils.cat/en/
[274] http://www.tordera.cat/document.php?id=740

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[275]	A2006 (following up efficiency of recovered connectivity) A2007 (increase the quality of data bases) A2008 (dissemination of experiences) A3004 (extraction control Bancells wetlands) A3010 (custody agreements) A3011 (wetland recovery) A3021 (humid zones delimitation)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[276])	Recover connectivity	
System of environmental protection in Catalonia[277]	Recover connectivity	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[278]	Recover connectivity	
FEADER program[279]	Funds RDPs	
Life program EU	Supporting environmental, nature conservation and climate action projects throughout the EU.	Difficulties to constitute a consortium, competition between projects
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

[275] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[276] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[277] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/senp_catalunya/
[278] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[279] http://eur-lex.europa.eu/legal-content/ES/TXT/?uri=uriserv:l60032

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan Water Agency	Lead the measure	Wetland recovery, WFD compliance	Interrelation with other challenges	Difficulties to implement without strong collaboration of other stakeholders

25. Water management options: Elimination of toxic substances used in Municipal parks and gardening practices

Overall description of the WMO

Short explanation	In different areas of the basin, municipal park and gardening maintenance protocols use water-polluting substances entailing health risks. In particular, the highly toxic component glyphosate is generally used in municipal playgrounds, provoking serious citizen concerns. This option aims to: • Develop a guide indicating alternative products and best practices that allow avoiding the use of agro-toxic substances for gardening purposes. • Disseminate the guide to public administration in charge of municipal parks and gardens, as well as general public. • Foster a commitment signed by the basin's municipalities to adopt the advice contained in the guide.
Addressed challenges	(C) Increase water quality. In particular: prevent pollution caused by pesticides.
Target locations and water uses	Location: basin as a whole. Targets local agriculture, forest use sectors and all land use sectors.
Benefits	Pollution prevention.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the transition to new products and practices.
Robustness	No.
Flexibility	Yes. Practices can be adapted.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 82.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • One year research full time program for the development of a guide to substitute currently used agro-toxic substances • 3 PM technician to enhance municipalities to change management practices with new products.

	• Elaboration of a publication and a specific dissemination program
Synergies and conflicts with policy objectives	No conflicts. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[280] - Catalan Adaptation Strategy[281] - Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[282])
Acceptance	High
Suggested stakeholder involvement	Municipalities and Department of Territory and sustainability
Preconditions for success	Municipal willingness to collaborate
Concrete examples where applied	- “Som Lo Que Sembrem” campaign : Sant Celoni and Sant maria de Palautordera already eliminated the use of this toxic product from their muicipal garndening practices[283].

[280] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[281] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[282] http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
[283] http://www.santceloni.cat/ARXIUS/informacio_ajuntament/plens/2013/_02__21_marc_2013.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[284]	(C6001) Use and commercialization of pesticides	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[285])	Pollution prevention	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático – PNACC)[286]	Prevent pollution	
Groundwater protection directive Directiva 2006/118/EC	Prevent pollution	
Priority substances framework[287]	Prevent pollution	

[284] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[285] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[286] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[287] http://ec.europa.eu/environment/water/water-dangersub/lib_pri_substances.htm

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Department of Territory and sustainability	Competent authority on green area maintenance	Promote reduction of water pollution	Multitude of entities that need to change behaviour	If funded, would support the measure
Municipalities	Implement the measure	Environmental policy consolidation, political visibility in support of NGOs who denounced current practices	Cost of changing practices	If funded, would support the measure

26. Water management option: Create a catchment agreement to reduce diffuse pollution

Overall description of the WMO

Short explanation	Diffuse pollution of water bodies with nutrients caused by crop fertilization is a relevant challenge for water quality in the basin entailing an important environmental degradation and high drinkwater purification costs. The lack of co-responsibility between sectors to increase water quality implies continuous environmental degradation and urban users carrying most of the economic burden for needed water treatments. This option aims to engage both the agriculture sector and urban water users in recovering water quality through a specific agreement that would allow changing to a lower impact production pattern.
Addressed challenges	(C) Increase water quality. In particular: preventing diffuse pollution.
Target locations and water uses	Location: basin as a whole. Targets agriculture and local population water use sectors.
Benefits	Pollution prevention.
Potential negative impacts	Increased costs for drinkwater users.
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor obstacles, related to the transition to new practices.
Robustness	No.
Flexibility	Yes. Agreement can be adapted.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €) – cost assessment (WP3): around 148.000 € Running/Operational costs: medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 30 000 €/year. The cost estimation is based on the following assumptions: • During the first year of implementation, the agreement protocol is designed employing for the duration of one year a full time researcher and a technician from agriculture department and one for water agency who would operate in collaboration. • 2 person-month of specific juridical advice for the negotiation process. • Maintenance of the agreement employing a full time technician. • Dissemination program to inform society about the process.

	• Revision of the process and agreement at 6 year from first implementation.
Synergies and conflicts with policy objectives	Conflict with Rural Development Program for Catalonia (Programa de Desenvolupament Rural 2014-2020[288]) aiming to increase agriculture intensification. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[289] - Catalan Adaptation Strategy[290] - Priority substances[291]
Acceptance	High
Suggested stakeholder involvement	IRTA and ACA should lead the measure's design and implementation.
Preconditions for success	Implementation of a sound monitoring and control
Concrete examples where applied	• First success story in NY water catchment, later disseminated practice in Latin America[292] • Governance of Water-Related Conflicts in Agriculture (2003). Floor Brouwer,Ingo Heinz,Thomas Zabel (Eds,) • On German cases[293]

288 http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/
289 http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
290 http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
291 http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm
292 http://www.onthecommons.org/work/protecting-drinking-water-preventing-pollution-upstream-communities
293 https://books.google.de/books?id=tJQ9AWh4W-UC&pg=PA203&lpg=PA203&dq=agri-environmental+measures+germany+water&source=bl&ots=dN9wnzC1lj&sig=lGDgPwZgpF9_zZKF9EqwLjL6U30&hl=de&sa=X&ved=0CGAQ6AEwCGoVChMIoqzcw_ayyAIVhlYUCh0ldgra#v=onepage&q=agri-environmental%20measures%20germany%20water&f=false

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[294]	(C5001) characterization of diffuse pollution areas (C6001) Use and commercialization of pesticides	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[295])	Pollution prevention and ecosystem services based solutions	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[296]	Prevent pollution	
Priority substances framework[297]	Prevent pollution	

[294] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[295] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[296] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[297] http://ec.europa.eu/environment/water/water-dangersub/lib_pri_substances.htm

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Agriculture department	Lead the measure	Innovative measure, political profit	Willingness of farmers to participate	Under clear conditions would participate
Institut de Recerca i Technologies Agraries (IRTA)	Provide data,	Co-design terms of agreement, valuable information	Technical difficulties	Would support the measure
Farmer associations	Provide data, support the measure	Co-design terms of agreement, convert to more sustainable practices	Economic difficulties, farm design and market changes	Limited availability given economical constraints
Catalan Water agency	Provide/ gather data, lead the measure	Co-design terms of agreement, valuable information	Monitoring of effects	Under clear conditions would participate
Municipalities	Provide data, support the measure	Co-design terms of agreement, convert to more sustainable practices	Political constraints	Limited availability given economical constraints

27. Water management option: Centralize and facilitate access to relevant data on the basin water bodies’ status and uses.

Overall description of the WMO

Short explanation	Different relevant data series exist about the Tordera basin elaborated by different entities monitoring the river’s conditions, like public authorities, NGOs or research projects. BeWater project detected that the basin’s actors often are not informed about the nature, scope, update and publication access of these figures, and consultancy is hindered by publication format. This options aims to promote the creation of a webpage were all relevant information concerning the Tordera River basin produced by public authorities, NGOs or research projects is published in an accessible format.
Addressed challenges	(C) Increase water quality. In particular: comprehensive information to evaluate ecological state of the river and related water bodies, inclusive data on water quantity.
Target locations and water uses	Location: basin as a whole. Targets local population water use sector.
Benefits	Awareness and better focus of citizen’s initiatives and claims, optimization of new data produced.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years’ time)
Feasibility	Minor obstacles, related to authorship and formats.
Robustness	No.
Flexibility	Yes. Website and data can be adapted.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €)– cost assessment (WP3): around 38.000 € Running/Operational costs: medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 18 000 €/year. The cost estimation is based on the following assumptions: • Full time employed technician in order to gather existing information and formulate this in accordance with website and dissemination necessities. • 2 person-month technician dedicated to maintain the webpage for the rest the duration of the program.
Synergies and conflicts with policy objectives	No conflict

	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[298] - Catalan Adaptation Strategy[299] - Catalonian transparency law[300]
Acceptance	High
Suggested stakeholder involvement	ACA and local entities.
Preconditions for success	Willingness to share information by all actors
Concrete examples where applied	Not available.

[298] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[299] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[300] https://www.boe.es/buscar/pdf/2015/BOE-A-2015-470-consolidado.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[301])	Clearly prioritizes data gathering and information management to increase resilience.	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[302]	Supports enhancing knowledge on adaptation	
Catalonian transparency law[303]	Supports to enhance access to information	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Lead the measure/gather data	Visibility, stimulate more pro-active engagement of local entities in monitoring tasks	Evidence of lacking data or unfulfilled duties	Support the measure
Local entities (municipalities, NGOs)	Gather data	Increased availability of information	Coordination effort	Support the measure

[301] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[302] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[303] https://www.boe.es/buscar/pdf/2015/BOE-A-2015-470-consolidado.pdf

28. Water management option: Protect groundwater recharge areas.

Overall description of the WMO

Short explanation	Current legislation provides specific protection of catchment areas around drinking water wells, but in the basin there are different specific areas where rainwater infiltrates in the subsoil and recharges aquifers. Often these areas are not taken into account in zone planning, positioning infrastructure, industrial areas, parking, fuel stations, etc. in these sensible areas. This options aims to integrate Municipal zone planning protocols with special protection measures, based on existing groundwater cartography, and aiming to avoid the degradation of strategic recharge areas in the territory.
Addressed challenges	(A/C) Increase water quantity/ quality. In particular: integrate territorial planning and water management.
Target locations and water uses	Location: basin as a whole. Targets local population, tourism, agriculture, energy and water management use sectors.
Benefits	Increased health of water ecosystems and increased water availability to face droughts.
Potential negative impacts	None
Timeline of implementation	Medium (5-20 years)
Feasibility	Minor obstacles, related to land propriety and overlapping territorial development programs.
Robustness	Yes, protection zones, once established are quite robust to socio-economic changes.
Flexibility	No. Recharge areas are geological formations that cannot be changed.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €)– cost assessment (WP3): around 70.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): no running cost contemplated. The cost estimation is based on the following assumptions: • Specific communication program to enhance administrative and normative coordination. • A fund to provide resources for the implementation of protection zones. Organization of a conference to evaluate if the program has been successful.
Synergies and conflicts with policy objectives	Conflicts with urban planning and RDP may occur

	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[304] - Catalan Adaptation Strategy[305] - Territorial Plan for Catalonia[306]
Acceptance	High
Suggested stakeholder involvement	ACA and municipalities
Preconditions for success	Availability of all information
Concrete examples where applied	Not available

[304] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[305] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[306] http://territori.gencat.cat/es/01_departament/05_plans/01_planificacio_territorial/

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[307]	A6003 (water accounting) A6008 (cartography of extractions) A6011 (designation of water bodies)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[308])	Clearly prioritizes data gathering and information management to increase resilience.	
Department of Territory and Sustainability[309]	Urban and territorial planning	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[310]	Groundwater protection	
Mayors Adapt[311]	Comprehensive local adaptation strategy or integrating adaptation to climate change into relevant existing plans.	
Seventh Environment Action Programme[312]	Integrates actions for soil restoration	

[307] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[308] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[309] http://territori.gencat.cat/es/01_departament/05_plans/01_planificacio_territorial/
[310] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx
[311] http://mayors-adapt.eu/
[312] http://ec.europa.eu/environment/soil/index_en.htm

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Provide information and legal assistance	Increased groundwater protection and prevent degradation	Monitoring effects	Positive towards the measure
Municipalities	Implement the measure	Increased groundwater protection and prevent degradation	Enforcement needs coordination and clear information	Positive towards the measure

29. Water management option: Implement environmental flows.

Overall description of the WMO

Short explanation	The River Tordera has a torrential flow regime and is characterized by high hydrological variability. Moreover water demand pressures hinder the implementation of an environmental flow regime in coherence with its ecological necessities. This option aims to promote actions along the river focussed on recovering flows, taking into account different possibilities of intervention: • Elimination of direct catchments in the high river section (farmers, scattered houses, …) • Elimination of in stream barriers (Montclùs, Santa Fe and other dam permeability) • Interventions for better catchment efficiency • Flow limiting and peak flow control devices in catchment points • Refurbishment of gauging stations • Creation of regulation ponds for irrigation systems • Increased coordination between relevant departments from public administration. • Calibration between local and regional supply systems • Enforcement of public hydraulic domain regulation
Addressed challenges	(A/C) Increase water quantity/ quality. In particular: multiple challenges related to the lack of water flow.
Target locations and water uses	Location: basin as a whole, but specially the upper part. Targets all water use sectors except forests, and irrigated agriculture and built up areas.
Benefits	The benefits of this option entail the recovery of most river functionalities and indirectly tackle all challenges.
Potential negative impacts	None
Timeline of implementation	Medium (5-20 years)
Feasibility	Minor obstacles, related to water entitlements, but new legislation can help enforcement.
Robustness	Yes, environmental flows, once established are quite robust to socio-economic changes.
Flexibility	No. Flows are determined by precise contracts and water use right management.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €)– cost assessment (WP3): around 452 530 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 2500 €/year.

	The cost estimation is based on the following assumptions: • Implementation of combined measures for environmental flow regime restoration as planned in the RBMP currently in place, including compensation costs for hydropower plants and other users as well as a negotiation process on water title adjustments needed. • Better water efficiency at catchment level through technological adaptation • Monitoring and control of implementation by 1 person-month technician for the whole period.
Synergies and conflicts with policy objectives	Conflicts with sector planning, claiming to consolidate and increase water uses. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[313] - Catalan Adaptation Strategy[314] - Hydraulic domain regulation[315]
Acceptance	High
Suggested stakeholder involvement	ACA, municipalities and all water users
Preconditions for success	Political willingness
Concrete examples where applied	Unfortunately no examples of proper implementation of environmental flows exist in Catalunya.

[313] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[314] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[315] http://www.magrama.gob.es/es/agua/participacion-publica/Agua_Modificacion_RDPH_julio.aspx

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[316]	A1001 (adaptation of irrigation infrastructures) A1002 (concertation) B3015 (rainwater harvest) B5009 (better regulation)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[317])	Supports implementation of environmental flows	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[318]	Supports implementation of environmental flows	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Design and implementation	Crucial for WFD compliance	Funding, legal and political constraints	Positive towards the measure
Municipalities and water users in general	Revise water use patterns	River functionalities restored	Political and coordination effort	Limited willingness, but aware it is something to face

[316] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[317] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[318] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx

30. Water management option: Recover and protect river space

Overall description of the WMO

Short explanation	The presence of a high quantity of infrastructures in the basin implies the necessity to protect and recover river spaces in coherence with its strategic ecologic and hydraulic functionality in the territory.
	
	This option aims to promote:
	
	• The protection of concrete areas with high strategic value, like for example:
	    ○ The river section called “La Ferreria”
	    ○ Most important flooding zones in the central and lower sections of the basin
	    ○ Headwaters
	• The creation of river sections declared as “River Reserve” for those sections in good environmental state.

Addressed challenges	(B) Health of Forests and water ecosystems. In particular: restore prper river functionality to face floods and sediment flows.
Target locations and water uses	Location: central section of the river. Targets local population, tourism, agriculture, energy and water management sectors, and all land use sectors except forests.
Benefits	The benefits of this option entail positive effects on sediment flows, flood risk, biodiversity and connectivity.
Potential negative impacts	None
Timeline of implementation	Medium (5-20 years)
Feasibility	Minor obstacles, related to constructions in the riverbed and zonal planning.
Robustness	Yes, once river space has been recovered, these are quite robust to socio-economic changes.
Flexibility	No.
Costs	Implementation costs: Medium/high (between 100,000 and 1 000,000 €)– cost assessment (WP3): around 147.500 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 3000 €/year. The cost estimation is based on the following assumptions: • Two technicians and one engineer half time employed to identify areas with high strategic value. • Fund for restoration and protection of identified areas. • Identification and establishment of a specific “river Reserve” in upstream sections of the basin employing 6

	person-months researcher program and a full time technician during one year for the formalization and implementation of reserve protocols. • Maintenance of the River Reserve employing 1 person- month technician during whole period of the program. • Organization of a conference to evaluate and disseminate results of the actions. • Publication of a brochure on the experience.
Synergies and conflicts with policy objectives	Conflict with zonal planning policies, especially transport and industrial development. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[319] - Catalan Flood risk plan (Pla de gestió de risc d'inundacions)[320] - Catalan Adaptation Strategy[321] - System of environmental protection in Catalonia[322]
Acceptance	High
Suggested stakeholder involvement	ACA and municipalities
Preconditions for success	Political willingness
Concrete examples where applied	- All different river space protection forms contemplated today in Catalonia[323] - Spanish river reserves[324]

[319] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[320] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P52400263221431526671255
[321] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[322] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/senp_catalunya/
[323] http://aca-web.gencat.cat/aca/documents/ca/legislacio/projectes/PDG_2016_2021/PGestio/12_AnnexIX_PG_zones_protegides.pdf
[324] https://acceso360.acceso.com/territori/ca-ES/?mod=TrackingPressViewer&task=default&external=1&companyNewsId=338139410&newsDate=1448924400&sig=90555fc0d06205710b89c2780144a4bdd1fc2572d46ff7e45767a68f3f7d668e

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[325]	A2012 (riparian vegetation exploitation) A2014 (control of interventions in river space) A2021 (characterization of water bodies) A2034 (strategic sites to recover) A2052 (riparian morphological restoration) D1001 (flood protection)	
Flood Risk Management Plan[326]	Aims to protect river space and recover functionality	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[327])	Supports river space recovery	
System of environmental protection in Catalonia[328]	Supports river space recovery	
National adaptation Plan (Plan Nacional de Adaptación al Cambio Climático - PNACC)[329]	Supports river space recovery	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.	Difficulties to constitute a consortium, competition between projects

[325] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[326] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P52400263221431526671255
[327] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[328] http://mediambient.gencat.cat/ca/05_ambits_dactuacio/patrimoni_natural/senp_catalunya/
[329] http://www.magrama.gob.es/ca/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/plan-nacional-adaptacion-cambio-climatico/default.aspx

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Design and implementation	Crucial for WFD compliance	Funding, legal and political constraints	Positive towards the measure
Municipalities	Revise river space use	River functionalities restored, reduce flood damage	Political and coordination effort	Limited willingness, but aware it is something to face

31. Water management option: Revision and actualization of water entitlements

Overall description of the WMO

Short explanation	In order to tackle the high number of out-dated entitlements, many containing important irregularities, this option aims to support the updating process of entitlements promoted by the water authority. In order to enhance the reduction of extractions and increase the availability and transparency of information, this option aims to promote: • The creation of a communication and coordination channel between local entities and the water authority in order to foster a pro-active collaboration of municipalities and local entities updating the water use entitlement register in accordance with actual uses. • Online publication of water entitlement register.
Addressed challenges	(D) Integrated water management: In particular: reduction of mismatch between water consumption and water entitlements.
Target locations and water uses	Location: River as a whole. Targets local population, tourism, agriculture, energy and water management sectors, and all irrigated and built up land use sectors.
Benefits	The benefits of this option entail very strong positive effects on all factors of the river basin dynamics, except agriculture land use and flooding damage.
Potential negative impacts	None
Timeline of implementation	Medium (5-20 years)
Feasibility	Serious obstacles, related to the compensations for lost benefits requested by water entitlement beholders.
Robustness	Yes, once entitlements revision process is done, these will be quite robust to socio-economic changes.
Flexibility	No.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €)– cost assessment (WP3): around 78.000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 3000 €/year. The cost estimation is based on the following assumptions: • Coordination between local entities and the water authority through the organization of 4 meetings with around 50 participants, during 2 years and including working material. • Fund to enhance actions to revise and reformulate concrete entitlements.

	• Creation of an online access of the Tordera water entitlement register.
Synergies and conflicts with policy objectives	Conflicts with sector policies aiming for development entailing water demand growth. Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[330] - Catalan Adaptation Strategy[331] - Spanish water law[332] (Art. 65.1.C TRLA)
Acceptance	Low, because most people don't want to change current water entitlement characteristics, often allowing free riding, as old entitlements are generous and accounting for real use is very rough.
Suggested stakeholder involvement	ACA, municipalities and all water users.
Preconditions for success	Political willingness
Concrete examples where applied	- ALBERCA program of Spanish Ministry.[333]

[330] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[331] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[332]
[333] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/uso-privativo-del-agua-registro-del-aguas/alberca/

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[334]	G0006 Update of water register	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[335])	Supports revision of entitlements	
ALBERCA program of Spanish Ministry. (Real Decreto 670/2013, de 6 de septiembre)[336]	Is revising entitlements at national level	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Design and implementation	Crucial for WFD compliance	Funding, legal and political constraints	Positive towards the measure
Municipalities and water users in general	Revise water use patterns	Better water accounting	Political and coordination effort	Limited willingness, but aware it is something to face

[334] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[335]http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[336] http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/uso-privativo-del-agua-registro-del-aguas/alberca/

32. Water management option: develop river custody agreements

Overall description of the WMO

Short explanation	In order to foster citizens and local entities to collaborate recovering and protecting river space, this option proposes generating the conditions for creating and providing continuity to effective River Custody Agreements. These agreements are direct contracts between local entities and citizens to commit to the protection and restoration of a concrete river section.
Addressed challenges	(D) Integrated water management. In particular: engage local population in river management.
Target locations and water uses	Location: River as a whole. Targets all water management sectors, and all land use sectors.
Benefits	The benefits of this option are localized restoration of river conditions and engagement of local population.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacles.
Robustness	No, custody projects are highly related to socio-economic factors.
Flexibility	Yes, custody agreements can be re-formulated or adjusted any time.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €)– cost assessment (WP3): around 268.230 € Running/Operational costs: Medium (between 10,000 and 100,000 €) – cost assessment (WP3): around 30 000 €/year. The cost estimation is based on the following assumptions: • Full technician employed to manage funding opportunities and custody projects in the basin. • Funding by RBMP to implement and maintain the custody programs for 6 years.
Synergies and conflicts with policy objectives	No conflicts Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[337] - Catalan Adaptation Strategy[338]

[337] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[338] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322

Acceptance	High
Suggested stakeholder involvement	ACA, municipalities and all water users.
Preconditions for success	Political willingness
Concrete examples where applied	- River custody projects in Catalunya.[339] - River Ter[340] - River custody projects[341]

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[342]	A2013 and A2029 (Custody Agreements) A3009 (wetlands custody)	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[343])	Supports river custody projects	
Life program EU	Supporting environmental, nature conservation and climate action projects throughout the EU	
MEEDDM Official Ministère de l'Écologie, de l'Énergie, du Développement Durable et de la Mer (MEEDDM)	Grant subsidizes a range of Eurosite activities, including, annual meetings of French members, translation of network publications, and the provision of live interpretation at network events such as workshops and conferences.	

[339] http://www.xct.cat/ca/grupsdetreball/gtcf_la_custodia_fluvial.html
[340] http://www.museudelter.cat/cerm/custodia
[341] https://custodiafluvial.wordpress.com/category/acords-i-convenis/
[342] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[343] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf

EECONET Action Fund[344]	The goal of the EECONET Action Fund (EAF) is to fund third parties (semi-state governmental organisations e.g. National Parks - and non-governmental organisations) to buy or lease important natural sites that contribute to the Pan-European Ecological Network. The EAF operates as an independent fund for urgent conservation actions. It is a joint fund of Eurosite, EUCC The Coastal Union, Euronatur (European Natural Heritage Fund) and the ECNC (European Centre for Nature Conservation).
European Voluntary service[345]	Support all kinds of hands-on activities
Private investment (CSR, special programs by banks or Foundations…)	Local experiences developing similar actions to those proposed in the WMO were funded by private initiatives[346].

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Catalan water agency	Lead the measure	Visibility, stimulate more pro-active engagement of local entities in maintenance tasks	Scattered interventions	Support the measure
Local entities (municipalities, NGOs)	Implement measure	Visibility and environmental restoration	Coordination effort	Support the measure

[344] http://www.eurosite.org/en-UK/content/eeconet-action-fund
[345] http://europa.eu/youreurope/citizens/education/volunteering/index_en.htm
[346] For example: http://lacaixaparcs.diba.cat/

33. Water management options: adaptive forest management agreements

Overall description of the WMO

Short explanation	The lack of active forest management entails an increase of the density of plant cover and undergrowth, increasing in this way total biomass in the forest. Reducing uncontrolled biomass can help to improve the health of forests, while also reducing evapotranspiration and wildfire risk. In order to enhance adaptive measures to be implemented, this option proposes to foster pilot cases for specific adaptive forest management agreements between forestland owners and the administration. Agreements can entail a range of actions, in accordance to the concrete forest management needs.
Addressed challenges	(B) Health of forest and water ecosystems. In particular: increase forest management.
Target locations and water uses	Location: River as a whole. Targets all water management sectors, except industry and energy sectors, and grass and forestland use sectors.
Benefits	Focused, precise and flexible forest management practices. This measure had highest scores in the MCA analysis.
Potential negative impacts	None
Timeline of implementation	Short (under 5 years' time)
Feasibility	No major obstacles.
Robustness	No. Adaptive forest agreements are highly related to socio-economic factors.
Flexibility	Yes, Adaptive forest agreements can be re-formulated or adjusted any time.
Costs	Implementation costs: Medium (between 10,000 and 100,000 €)– cost assessment (WP3): around 174 000 € Running/Operational costs: low (> 10,000 €) – cost assessment (WP3): around 15 000 €/year. The cost estimation is based on the following assumptions: • Amplification of agreement patterns already available by a three-year PhD program. • Negotiation and agreements established employing a full time technician. • Fund to establish specific actions included in the agreements. • Organization of a conference on results obtained and presentation of monitoring data.
Synergies and conflicts with policy objectives	No conflicts

	Synergies with - Catalan River Basin Management Plan (Pla de gestió del districte de conca fluvial de Catalunya (PGDCFC)[347] - Catalan Adaptation Strategy[348] - General Forestry Policy Plan (Pla General de Política Forestal 2014-2024[349]) - Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny[350])
Acceptance	High
Suggested stakeholder involvement	Natural park entities and landowners
Preconditions for success	Clear contractual conditions and engagement process.
Concrete examples where applied	- “Stove Plan” of Catalan government[351]

[347] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[348] http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P1204554461208200513322
[349] http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[350] http://parcs.diba.cat/documents/155678/21045014/PlaConservacioMontseny.pdf/1f9cb5e7-50d7-4da2-8735-89ad4b52cfc3
[351] http://www.govern.cat/pres_gov/AppJava/govern/notespremsa/287960/govern-promou-gestio-forestal-sostenible-laprofitament-energetic-biomassa.html

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Montseny Biosphere Reserve Conservation Plan (Pla de conservació del Parc Natural i Reserva de la Biosfera del Montseny)	Supports adaptive forest management	
General Forestry Policy Plan (Pla General de Política Forestal 2014-2024[352])	Supports adaptive forest management	
Catalan Adaptation Strategy (Estrategia d'adaptació al canvi climàtic[353])	Supports adaptive forest management	
Life program EU	supporting environmental, nature conservation and climate action projects throughout the EU	
Biodiversity Foundation[354]	Supports adaptive forest management	
EECONET Action Fund[355]	The goal of the EECONET Action Fund (EAF) is to fund third parties (semi-state governmental organisations e.g. National Parks – and non-governmental organisations) to buy or lease important natural sites that contribute to the Pan-European Ecological Network. The EAF operates as an independent fund for urgent conservation actions. It is a joint fund of Eurosite, EUCC The Coastal Union, Euronatur (European Natural Heritage Fund) and the ECNC (European Centre for Nature Conservation).	
Private investment (CSR, special programs by banks or Foundations…)	Local experiences developing similar actions to those proposed in the WMO were funded by private initiatives[356].	

[352] http://agricultura.gencat.cat/web/.content/mn_medi_natural/mn08_gestio_forestal/documents/planificacio/fitxers_estatics/01_annex_01_memoria_informativa.pdf
[353] http://canviclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/proces_escacc/docs/escacc_versio_juny_2.pdf
[354] http://fundacion-biodiversidad.es/
[355] http://www.eurosite.org/en-UK/content/eeconet-action-fund

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

		Stakeholder attitude toward WMO		
Relevant stakeholders	Role of stakeholders	Opportunities	Barriers	Possible involvement
Natural Park authorities	Design and promote the agreements	Better forest management, precise intervention, reduced wildfire risk	Willingness of landowners to collaborate, funding	Positive towards the measure
Association of forest landowners	Implement agreements	Better forest management, reduced wildfire risk	Cost, coordination effort	Limited availability, but when funded, positive
Agriculture Department of Catalan Government	Support activities to reduce biomass			

[356] For example: http://lacaixaparcs.diba.cat/

3. Vipava River Basin, Slovenia

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3.1 Introduction

The Vipava River Basin (RB) is located in south-west Slovenia (see Figure 1.1) and it covers an area of 589 km^2. According to national legislation [1] it comprises three surface water-bodies (see Figure 1.2) and one heavily modified water-body (Water reservoir Vogrščec).

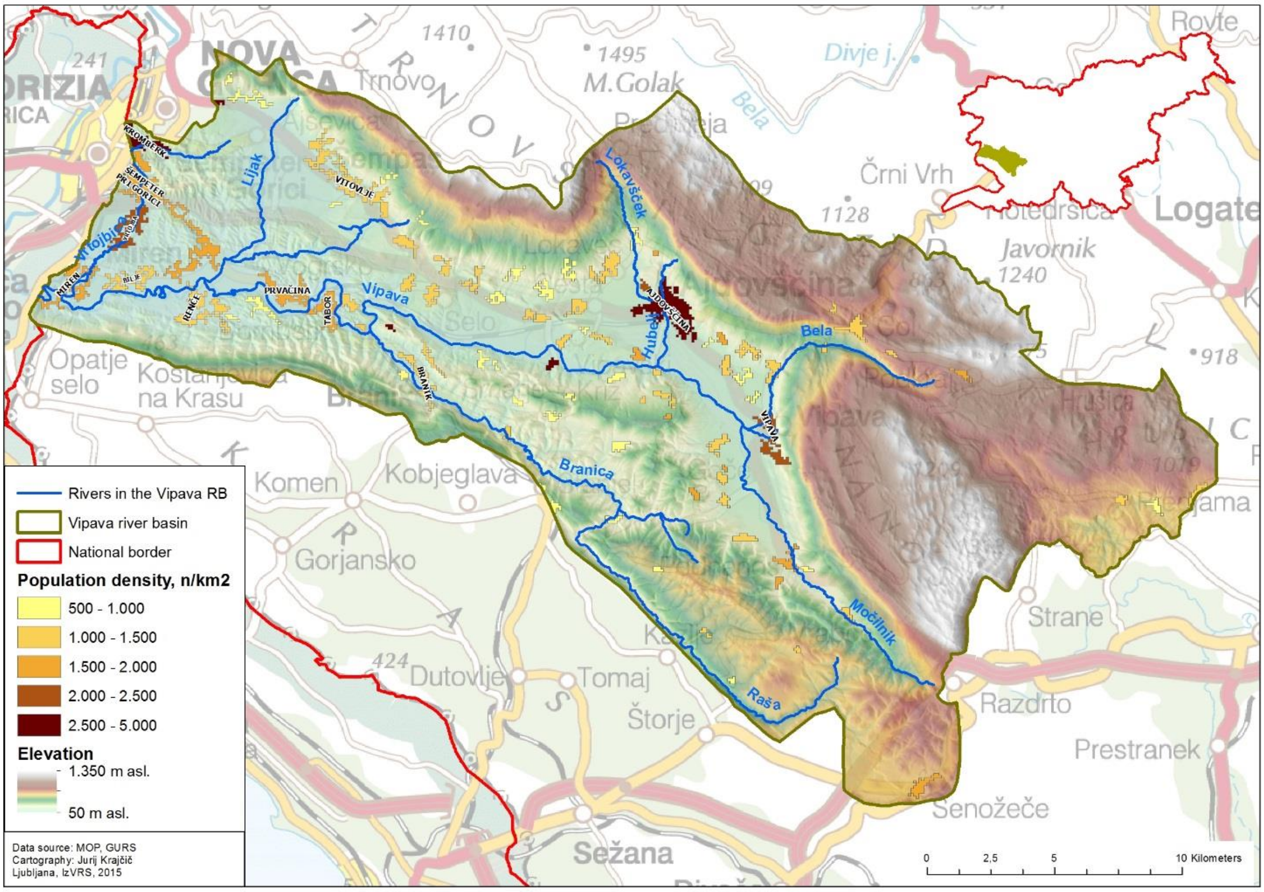

Figure 1.1: Location of the Vipava River Basin in Slovenia

Geographically the Vipava RB covers the entire Vipava Valley, part of the Karst region, the Trnovo Forest, Nanos Plateau and Hrušica Plateau. It extends over a territory of 11 municipalities (Divača, Sežana, Idrija, Postojna, Vipava, Ajdovščina, Nova Gorica, Komen, Miren - Kostanjevica, Renče - Vogrsko and Šempeter – Vrtojba) with a total of 172 settlements [2]] and a population of approximately 52,000 inhabitants.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 612385

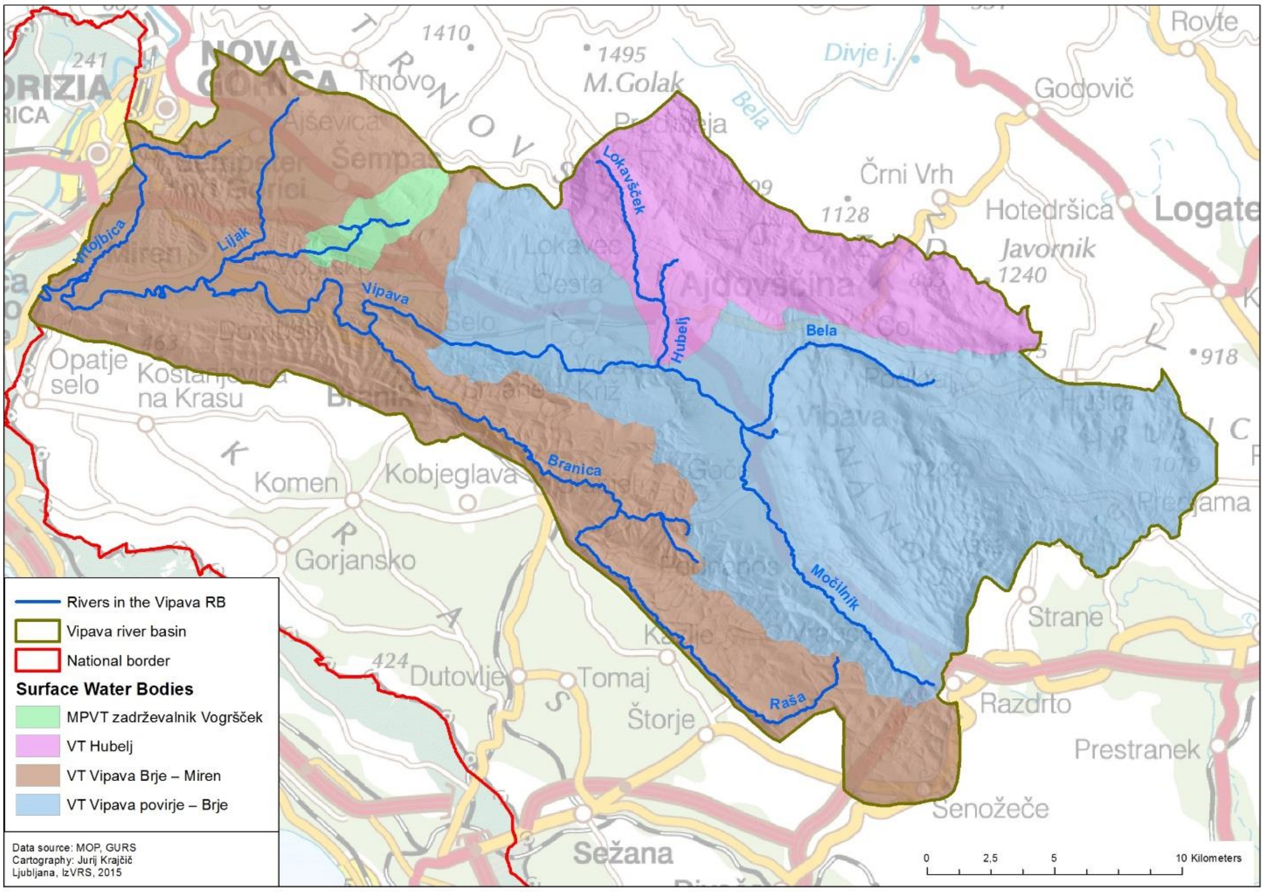

Figure 1.2: Surface water bodies of Vipava River Basin

The main water body in the Vipava RB is the Vipava River, which is 47 km long with an average annual flow of 17.3 m^3/s [3]. The water level of the Vipava River is subject to big oscillations in flow due to torrential surface tributaries (e.g. Lijak and Hubelj). During the period of regulation and canalization (1983-1986), a large area of the Vipava Valley was transformed for agriculture purposes, profoundly changing the water regime in the valley. The amelioration works included the construction of the largest Slovenian water reservoir Vogrščček primarily dedicated to providing irrigation for agricultural land and flood protection to communities.

In the Vipava Valley, as in the rest of the Mediterranean, climate change projections indicate an increasing number of extreme events such as droughts and floods. Data from the Slovenian Environment Agency suggest that the average annual temperature in the Vipava Valley could increase by 1.3°C or more by 2030. Consequently, precipitation could diminish in the summer and increase in the winter. Over the past 40 years, Slovenia including the Vipava Valley experienced many droughts and floods, most of which occurred in the last 15 years.

In 2011 the River Basin Management Plan (2009 - 2015) was adopted in Slovenia in accordance with the WFD [4]. A draft of the National Climate Change Strategy was developed in the same year and was thus not adopted by the RBMP. Nevertheles, there are two specific supplementary measures, included in the RBMP Program of Measures linked to climate change adaptation i) the preparation of a strategy and operative program for adapting water management to climate change until the year 2027 on the level of river basins and sub-basins, and ii) the development of a water use strategy that takes climate change into consideration.

In this context, sustainable water management strategies, leading to increased resilience of the social-ecological system of a river basin, are needed urgently. In order to maximise their effectiveness, regional and local characteristics need to be considered together with engaging local communities to play an active role in the development of these strategies. The combination of good governance, improved awareness and shared responsibility of the civil society and

stakeholders in the water sector are key to ensuring successful adaptation strategies, plans and their implementation. Institute for Water of the Republic of Slovenia (IzVRS) encourages the development of an innovative water policy in Slovenia by taking part in the BeWater project and thus launching process of societal transition towards a more sustainable, resilient and adaptive river basin management in the Vipava RB.

The BeWater project is a 3.5-year project financed through the 7th Framework Programme of the European Commission, under the Science in Society initiative (project no. 612385 - SIS.2013.1.2-1European Commission). The BeWater project promotes an iterative dialogue and mutual learning collaboration processes between science and society to establish, using a multidisciplinary, bottom-up and participatory approach, plans for sustainable water management and global change adaptation in four Mediterranean case study RBs. The specific aim of the project is to increase the resilience of social and ecological systems linked to each RB and to allow a proactive response to emerging global changes and related challenges. Results of the BeWater project are on the local, national and Mediterranean scale.

The Vipava RB, one of four BeWater case study RBs, was chosen due to a number of hydrological, morphological and biological pressures and water pollution.

Overview of contents

In the introduction, the Vipava RB is presented with its main features together with the reasons and local aspirations for developing the River Basin Adaptation Plan (RBAP), a short overview of the Bewater project with the approach and objectives of RBAP. Chapter 2 provides the background information on legislation and policies affecting water management planning of the Vipava RB together with the mandates of relevant public authorities and main actor groups and their roles/competing interests in the river basin. Chapter 2 provides also short overview of the methodology and procedures used to evaluate and select Water Management Options (WMOs) and the RBAP planning process with information on stakeholders engagement process. Chapter 3 presents the Vipava RB more in detail with current and possible future state developments of the main social-ecologic systems (land, climate and water, biodiversity and people). It includes also the main challenges. Chapter 4 provides a list of the options for water management that were designed, evaluated and validated together with the stakeholders.

3.2 The development of the river basin adaptation plan

3.2.1 Living in the Vipava River Basin

3.2.1.1 The main actor groups in the Vipava River Basin in water related issues

Water used for irrigation of agricultural land in the Vipava RB is derived from two main water sources i) the Vipava River (and its tributaries) for the upper part of the basin, and ii) water reservoir Vogršček for the lower part of the basin. In order to use water for irrigation purposes water rights in a form of water permits or concessions issued by Slovenian Environmental Agency (ARSO) needs to be obtained.

Although there are numerous water permits on the Vipava River, water users (mostly farmers) are prohibited to abstract water in dry periods due to ecological acceptable flow. Nevertheless, illegal water abstractions from the Vipava River exists also during low flows thus exacerbating the negative impacts of drought on aquatic, riparian and wetland ecosystems (e.g. reduced water flow, flow cessation).

Water reservoir Vogršček with corresponding irrigation systems represents the main water source for irrigation in the lower part of the RB. Vogršček as a functionally complete unit (water reservoir and irrigation system) is managed by two ministries, the Ministry of Agriculture, Forestry and Food of the Republic of Slovenia (MKGP) (irrigation systems) and the Ministry of the Environment and Spatial Planning (MOP) (water reservoir), meaning two sectors, agriculture and water, respectively. Due to shared ownership, disagreements in managing Vogršček are affecting much needed reconstruction works that would solve problems with not optimal functioning of irrigation systems [5].

As such, Water reservoir Vogršček has according to MOP [6] two main uses, irrigation (primary use) and flood protection (secondary use), and with the costs shared in relation to the benefits received: 84.5% of funds is provided by MKGP and 15.5% by MOP. Since 2012, all funds for the operation and maintenance of the water reservoir are provided from the budget line for maintenance of water infrastructure (Water Fund). Oppose to this method of financing is mostly water sector (e.g. hydrologists) due to lower budget allocated to other parts of the Soča RB, including water reservoir Vogršček [7]. There are also other uses of water reservoir that can be contradictory to its two main uses: fishery, nature conservation and tourism. With separate operation and management of the two parts of the system and independent operation of existing and potential new users of the system does not bring progress in the efficient use and management system [7].

With insufficient water source for irrigation in the upper part of the Vipava RB and problems with water reservoir Vogršček, there are clear demands for construction of new water reservoirs in the upper part of the Vipava RB. As most of the Vipava River as well as a large part of the Vipava Valley is included in Natura 2000 together with a large number of nature conservation areas (e.g. valuable natural features, protected areas), construction of such reservoirs represents a major intervention that is contrary to the objectives nature protection pursued by the Institute of the Republic of Slovenia for Nature Conservation, Nova Gorica Regional Unit.

The Vipava River and its tributaries were in past regulated for two main purposes, to claim suitable arable land, and to reduce floods. Maintenace of watercourses and water infrastructure is carried out by a concessionaire on the basis of annual program confirmed by ARSO. Environmentalists believed that the existing management directed only to increase the runoff of watercourses is not appropriate and propose using more sustainable techniques when designing interventions on watercourses. Namely, it is believed that rigid technical regulations lead to loss of functionality of existing natural aquatic and also riparian ecosystems. Lacking the ability to reduce the flow velocity, water rapidly drains downstream causing severe floods in the lower valley that will due to increasing number of extreme weather events (heavy rainfal) floods are occurring more frequently and at a larger scale.

3.2.1.2 National legislation regulating water management planning

The Water Framework Directive (WFD) [8] as well as the Groundwater Directive [9], the Nitrates Directive [10] and the Floods Directive [11] sets out the framework for the protection of inland surface waters and groundwater, as well as transitional and coastal waters with the aim to prevent and reduce pollution, promote sustainable water use, protect and improve the aquatic ecosystems and mitigate the effects of floods and droughts. In accordance with the Nitrate Directive, the entire territory of the Republic of Slovenia is designated as Nitrate Vulnerable Zone.

The Republic of Slovenia has completely integrated the WFD into national legislation through the Waters Act [12]as a key act in water management. According to the Waters Act, the objective of water management is to achieve a good condition of waters and other water-related ecosystems, to ensure protection against the adverse effects of waters (flood/erosion protection), to preserve and balance water quantities, and to promote the sustainable use of waters for various types of use, facilitating a variety of water uses by taking into account the long-term protection of available water sources and their quality.

Adopted in 2011, the RBMP (2009 – 2015) together with the Programme of Measures represents a national strategic planning document in the field of water management. The RBMP specifies the mechanisms for carrying out policies by which good status of water bodies will be achieved. Based on the determination of basin districts characteristics and status, management objectives in the field of water protection, water management and water use are defined. In Slovenia there are two basin districts: the Danube basin district and the Adriatic sea basin district. The Vipava RB as part of the Soča RB belongs to the Adriatic sea basin district (see Figure 2.1) [13]].

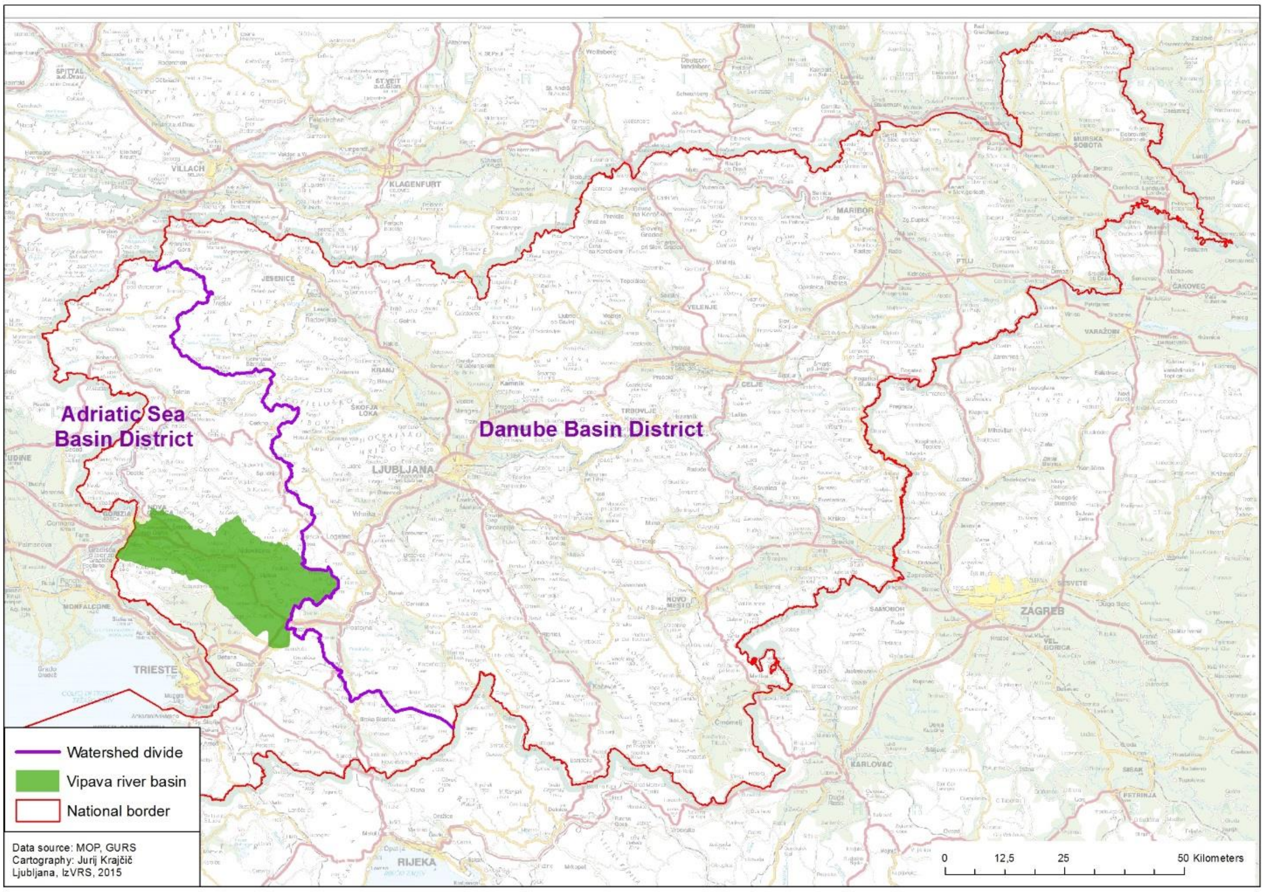

Figure 2.1: Location of the Vipava River Basin in the Adriatic sea basin district[357]

[357] NOTE: The national border between the Republic of Slovenia and the Republic of Croatia is the boundary of the regions for which the Republic of Slovenia was managing land cadastre and register of spatial units on the 25th of June, 1991. Source: The surveying and mapping authority of the Republic of Slovenia

Because of the transboundary character of the Soča RB a transboundary water cooperation between Slovenia and Italy was a establish by foundation of a Permanent Slovenian-Italian Commission for Hydro-economy as an official public organism to discuss transboundary water problems (art. 3 of WFD). The main aim of the Commission is to harmonize water management in the basin, solve conficts (e.g. different water resource use), exchange data on water regime and water pollution and on implementation of the WFD and Floods Directive [13] [14]. The first step of the Commission was to set up an expert group to prepare a road map for the implementation of the "First Italian Slovenian Isonzo-Soča Common Management Plan". A wide monitoring network has been set up in order to defne the quality and quantity of water bodies in accordance with the WFD, and it has been decided that a transboundary monitoring network should be operating from 2015. For the Vipava River a common agreement is that the ecological aceptable flow at the Italian border must be guaranteed.

Other relevant national legislation governing water management is listed in Annex I.

3.2.1.3 Public authorities responsible for water management

MOP represents the main institution in the field of water management and is responsible for the preparation and implementation of environmental policies and legislation. MOP is responsible for implemention of the WFD and preparation of the RBMP. The Waters Act defines the structure and content of the RBMP, which incorporate the WFD requirements. The RBMP is implemented on the basis of the Decree on the river basin management plan for the Danube Basin and the Adriatic Sea Basin [4]. MOP is also responsible for the preparation and implementation of other important management plans, affecting management also in the Vipava RB a) The Natura 2000 Management programme for Slovenia for the period 2015-2020 (LIFE11 NAT/SI/880) adopted in April 2015 [15], and b) the Flood Risk Management Plan 2015-2021(in preparation)) [ ].

There are four bodies affiliated to MOP [16], among which Slovenian Water Agency (DRSV) and ARSO are most important. Due to the process of reorganization, DRSV, as most recent constituted body, will take over a large part of the tasks that are currently performed by ARSO. DRSV will after 1st of Januar 2016 amongst other perform administrative, expert and development tasks in the field of water management, in accordance with the regulations governing water. It will perform tasks as spatial planning authority in the field of water management, consent authority and other tasks within the context of the procedures in the field of spatial planning, construction of buildings, environmental impact assessments and other assessments. After 1st of January 2016 ARSO will still perform expert, analytical, regulatory and administrative tasks related to the environment at the national level except for tasks that are the responsibility of the DRSV.

ARSO is divided into six offices of which the Water Management Office is most relevant. After 1st of January 2016, the Water Management Office will be together with its main tasks passed to the DRSV. Main tasks of Water Management Office are [17]:

- to conduct procedures related to water rights (water permits and concession contracts) for the use of water and marine assets and alluvium,
- to conduct procedures and issue water approvals and information on construction requirements for all spatial interventions that may influence the water regime or the condition of water in protected and at-risk areas (bathing water, protected water, flood, erosion, landslide and avalanche areas) or have a bearing on water and waterside land. Such interventions include activities carried out for reasons of wastewater drainage, activities that might affect ground water, interventions necessary to exercise a water right or to provide public services pursuant to the Waters Act, water amelioration and other operations, forestry work, mining work and other activities that might affect the water regime,
- to conduct procedures and issue permits for research into groundwaters,
- to draft guidelines and opinions on water management when spatial planning documents are being adopted, and to participate in procedures of determining water land boundaries.

ARSO's Hydrology and State of the environment Office is in charge for monitoring natural phenomena and pollution monitoring (immission monitoring), in compliance with the legislation and international conventions. In the Vipava RB there is a complete monitoring network, with meteorological stations within the area of influence of the basin and gauging stations on the Vipava River and on its tributaries.

The tasks of maintenance (and monitoring) of aquatic and riparian land is carried out through public utility services. ARSO directs and manages the operation of public utilities through the mechanism of concessions as the awarding authority, and yearly action programmes in eight areas: four in the Sava, Drava, Mura and Soča RBs and in the catchment area of Adriatic rivers and the sea [18]. According to Article 13 of Decree on the provision of obligatory state services of general economic interest for water management and on concessions and public services [19] the concession is conferred for a period of four years. The tasks assigned to concession contracts are regulated by the Rules on the types and scope of tasks of mandatory state public utility services in the field of water management [20]. The main tasks according to the Rules are (1) operation and maintenance of water infrastructure, (2) monitoring of water infrastructure, (3) the implementation of emergency measures during increased levels of threat of harmful effects of water and (4) maintenance of aquatic and riparian land of inland and marine waters. In the Vipava RB as part of the Soča RB, the conssesion is carried out by Hidrotehnik d.d., Water management, Ljubljana, Slovenia. Hidrotehnik d.d. is in charge of managing all watercourses and water infrastructure built to manage watercourses. This includes dams (e.g on Water reservoir Vogrščček), embankments, weirs, reservoirs, facilities for water monitoring, etc.

On national level two main institution, The Institute for Water of the Republic of Slovenia (IzVRS) (in Slovene: "Inštitut za vode Republike Slovenije") and the Geological Survey of Slovenia (in Slovene: "Geološki zavod Republike Slovenije") provide MOP with support in data analysis and expert knowledge in the field of surface water bodies and groundwater, respectively.

Beside MOP also Ministry of Agriculture, Forestry and Food of the Republic of Slovenia (MKGP) is relevant for water management in Slovenia. MKGP performs among others tasks in the areas of agriculture, rural development, plant protection, forestry, hunting and fisheries. MKGP is also responsible for the implementation of the Common Agricultural Policy (CAP). The current Rural Development Programme (RDP) 2014-2020 focuses on two main areas i) improvement of biodiversity, and ii) improvement of water status and soil quality [21].

Representatives of MOP, ARSO and MKGP have been directly or indirectly involved in the preparation of Vipava RBAP by providing relevant information on water use conflicts and desired state for the Vipava RB. Policy-makers within MOP and MKGP have also provided information on the current situation of adaptation to climate changes on national and RB level, their experience with public participation in the design of policies and potential conflicts that may appear.

3.2.1.4 Regional and local level

In Slovenia, regional policy and measures are implemented by 12 development regions (regional development agencies) [22] within the framework of the Operational Programme for Strengthening Regional Development Potentials (OPSRDP). OPSRDP represents the implementation document for drawing on the funds from the European Regional Development Fund which is primarily focused on strengthening development opportunities with the objective of promoting competitiveness of the entire economy and reducing development differences between the Slovenian regions. Development initiatives are focused on the projects of general infrastructure, innovations and investments, with the emphasis on competitiveness, creation and preservation of sustainable jobs and insurance of sustainable development [23]. For example, public drinking water regional supply development plans and waste water management plans with programme of measures are included in OPSRD and approved by the government. The Vipava RB belongs to Goriška development region for which Regional Development Programme of Northern Primorska 2014-2020 was adopted in March 2015 by four regional development agencies [24]. Two of them

are present in the Vipava RB: Regional Development Agency of Northern Primorska Ltd Nova Gorica and Regional agency ROD Ajdovščina. Regional Development Programme of Northern Primorska 2014-2020 represents a fundamental program document on the regional level and is prepared by coordinating regional, national and European priorities with the aim to achieve common goals. In addition to the objectives set out on national level, the specific objectives arising from regional development potentials are identified. Regional Development Programme of Northern Primorska 2014-2020 provides several measures to adapt to challenges stemming from climate change among which irrigation development in the Vipava Valley and achieving flood safety of the area adjacent to the Vipava River are most relevant.

Slovenia has a long tradition of regionalism and local self-government. The Local Self-Government Act [25] stipulates that a municipality is the basic self-governing local community, with at least 5,000 inhabitants; an urban municipality has at least 20,000 inhabitants. Municipalities have among other the authority to manage the municipality`s assets, facilitate conditions for economic development, plan spatial development, create conditions for building dwellings, manage local public services, establish primary and nursery schools, and build and maintain local roads.

The area of the Vipava RB is devided between 11 municipalities (see Table 3.1).
Spatial Planning Act [26] determines following competences of municipality:

- to set objectives and guidelines for spatial development,
- to determine land-use and the conditions for the placement of developments into space,
- to plan spatial arrangements of local importance.

The jurisdiction of the Municipality is defined by Municipal Spatial Plan (OPN) or a Detailed Municipal Spatial Plan (OPPN) for individual areas within the municipality. OPN consists of strategic and operational part. Operational part of OPN determines[27]:

- land use allocation (in Slovene: “namenska raba prostora”),
- spatial implementation conditions and
- area where OPPN needs to be prepared.

Except for municipality Ajdovščina and Divača, all municipalities have adopted OPN according to Spatial Planning Act. For municipality Ajdovščina Spatial Plan adopted by the previous legislation called Spatial Plan of Municipality Ajdovščina with amendments [28] is still in force. Decision on wheather the OPN or OPPN must go through SEA process is taken by MOP in cooperation with all national authorities within their ministries and organisations also known as Spatial Planning Authorities (in Slovene: “Nosilci urejanja prostora”).

When preparing Vipava RBAP, measures from Regional Development Programme of Northern Primorska 2014-2020 and requirements and restrictions determined in OPN have been examined and taken into consideration.

In accordance with Article 149 of Environmental Protection Act [29], two mandatory municipal public utility services in the field of environmental protection are present in the Vipava RB:

- Komunala Nova Gorica d.d. in municipalities Nova Gorica, Šempeter-Vrtojba, Miren-Kostanjevica and Renče-Vogrsko;
- Komunalno stanovanjska družba d. o. o. Ajdovščina in municipalities Vipava and Ajdovščina.

The main responsibilities of municipal public utility services are drinking water supply, collection and treatment of wastewaters and collection, treatment and disposal of municipal waste.

In the Vipava RB there are 45 drinking water catchments with designated water protection zones, protected by 15 valid municipal Ordinances [30]. Water protection zones are in addition protected by national Rules on criteria for the designation of a water protection zone [31].

Representatives of Municipalities together with public utility services have been directly involved in the preparation of Vipava RBAP by providing relevant information on current water use problems and desired state for the Vipava RB.

3.2.2 RBAP development and stakeholder engagement

Participation and engagement of a wide group of stakeholders had a crucial role in identification and evaluation of Water Management Options (WMOs) and in preparation of adaptation plan for the Vipava RB.

Stakeholders represent any group or individual who is affected by or can affect the achievement of the objectives of the adaptation plan for the Vipava RB. To overcome challenges in participatory science-stakeholder processes with different levels of knowledge, and differing values, assumptions and terminologies among scientists and stakeholders, a methodology for identification and selection of stakeholders was developed [32].

The first step of a stakeholder engagement process was to identify relevant stakeholders in the Vipava RB from national to local level, including civil society, scientists, public administrators (policy makers and implementers, institutional administrations and local governments), water sector actors (e.g. service providers) and other related sectors (e.g. agriculture, tourism, energy). A stakeholder database represents a supporting management tool and consists of not only stakeholders who can provide insightful, original and credible input regarding water management, but also stakeholders of a wider backgrounds [32]. Database was and is still used for identification and selection of stakeholders when designing an engagement processes.

In the frame of the stakeholder engagement process several professionally facilitated workshops, interviews, group session and events were and will be organized in the Vipava RB (Table 2.1 and Table 2.2). Parallel to the stakeholder engagement, an awareness campaign in the form of tailor-made mobile exhibition is taking place in Vipava RB with the aim to raise social awareness and to encourage capacity building, empowerment and social formation in water management challenges and adaptation.

A short summary of WMOs formulation and evaluation steps are given below. For a detailed description please see Annex II where we refer to Verkerk et al. (2015) [33].

WMOs, as a crucial part of RBAP, were formulated in detail, evaluated and discussed with multiple stakeholders within two highly interactive stakeholder workshops (WS), additional interviews and individual or group sessions. In the first stakeholder WS in 2014 and additional interviews, information on the current state and future expectations regarding water management in the Vipava RB were identified. Afterwards, written and graphical narrative in the form of a Fuzzy Cognitive Map (FCM; a graphical representation of a system) (see Figure 3.4) of the Vipava RB was developed with active stakeholder participation based on main challenges identified. The development of the FCMs was done in parallel to the identification and formulation of WMOs to allow assessment of the impact of different WMOs. The WMOs were characterized using a fixed set of descriptors. Within the second stakeholder WS carried out in 2015, discussion and evaluation of WMOs with key stakeholders was performed. So called social evaluation of WMOs was carried out with the help of multicriteria analysis (MCA), where factors derived from the basin's FCM, and WMOs characterization criteria were used. As a last step, economic evaluation of WMOs was conducted with the help of expert consultations. It has to stressed out that the cost of each option was estimated by using numerous assumptions on how the option could be implemented. Therefore, the outcome should be considered a rough indication for scoping purposes, but should not be considered as exact.

WMOs that are promising in terms of giving a positive results in social and economic evaluation give a preliminary information for the elaboration of the RBAP.

3.2.3 List of engagement and dissemination activities

In the frame of the stakeholder engagement process several professionally facilitated workshops, interviews and consultations were and will be organized in the Vipava RB (Table 2.1).

Table 2.1: List of stakeholder engagement activities

Dissemination/engagement activity	Objective	Target group	Dates
First stakeholder workshop	Identification of challenges regarding water management in the Vipava RB, drawing an outline for future WMOs in the Vipava RB.	A wide group of local, regional and national stakeholders.	6th June 2014
Stakeholder interviews	Collection of information from policy-makers on the current situation of adaptation to climate changes on national and RB level, their experience with public participation in the design of policies and potential conflicts that may appear. Discussion on current water use problems and desired state for the Vipava RB.	Policy-makers and other relevant stakeholders not able to attend the first workshop in June.	September – November 2014
Stakeholder consultations (I)	Validation and harmonization of FCM as a result of the first stakeholder workshop and stakeholder interviews.	A group of local, regional and national stakeholders actively engaged in the BeWater project.	February 2015
Second stakeholder workshop	Evaluation of WMOs as a result of the first stakeholder workshop.	A group of local, regional and national stakeholders actively engaged in the BeWater project.	27th May 2015
Expert/stakeholder consultations	Supplementation of information on implementation steps and costs of WMOs.	Selected experts and stakeholder actively engaged in the BeWater project from national instutites, agencies, university and companies.	August – October 2015
Stakeholder consultations (II)	Presentation and discussion of final list of WMOs.	A wide group of local, regional and national stakeholders.	12th October 2015
Third stakeholder workshop (1st seminar)	Validation of draft adaptation plan for the Vipava RB.	To be decided.	23rd March 2016
Fourth stakeholder worshop (2nd seminar)	Presentation of adaptation plan for the Vipava RB.	A group of national stakeholders. / To be decided.	February 2017

Parallel to the stakeholder engagement, other dissemination activities are taking place in the Vipava RB with the aim to forward results of the BeWater project, to expand the list of stakeholders, to raise social awareness and to encourage capacity building, empowerment and social formation in water management challenges and adaptation (Table 2.2).

Table 2.2: List of main dissemination activities contributing to preparation of River Basin Adaptation Plan

Dissemination activity	Content	Target group	Dates
GEP/BeWater meeting	Presentation of results of GEP Project, focusing on hydrogeological and spatial surveys on the Slovenian border area.	GEP and BeWater project team.	26th September 2014
Awareness Campaign	A mobile exhibition comprising of seven roll-up posters on display at key venues in critical communities throughout the Vipava RB and in Ljubljana.	Venues: Development Agency ROD in Ajdovscina, MKGP (in cooperation with MOP) in Ljubljana, Municipalities Ajdovščina, Vipava, Miren-Kostanjevica and Šempeter-Vrtojba, Central public library called “Lavričeva knjižnica Ajdovščina” in Ajdovščina and Vipava.	27th November 2014 - ongoing
Event called „Water days of Primorska“	Presentation of BeWater project on 12th February in the session on ongoing projects and plans for the region.	A wide group of local, regional and national stakeholders.	11th – 12th February 2015
Awareness Campaign for Highschool Students	Presentation of BeWater project and organization of field trip to the Vipava RB.	Students of Biotechnical Secondary School Nova Gorica.	15th April 2015
International workshop in the frame of 7FP Cropsustain	Presention of the objectives and results of BeWater Project, especially the participatory approach.	A wide group of international experts in the field of agriculture and environment.	24th November 2015

3.3 The Vipava River Basin

3.3.1 Current and future state of the river basin

3.3.1.1 Land

Large part of the Vipava RB is covered by forest (61%), mostly on slopes and higher altitudes around the main valley, and in the north and south periphery of the lower part of the basin. The second main land use in the Vipava RB is agriculture (33%), mostly in the flatland around the Vipava River and its tributaries. Within the agricultural land grassland is prevailing (16%), followed by arable land (5%), vineyards (4%), and orchards (2%). Urban areas represent only 5% of land use [34].

The comparison between land use in 2002 and 2015 shows noticeable changes such as a) transformation of arable land into grassland and urban area (2.1% of the total river basin area from 2002 to 2015), and b) transformation of grassland into forests or shrubland (further 3.5% of total area). A further share of 0.8% of the total river basin area has changed from overgrown farmland into forest [34] [35]. The process of changing the land use from farmland to forest is common in Slovenia in the past two or three decades, due to slowly but steadily abandonment of agriculture activities.Apart from built-up areas which have slightly gained in terms of total area, pressures on the environment in the Vipava RB have decreased if comparing year 2002 and 2015, because the input-intensive arable land (inputs of fertilisers, phytopharmaceuticals, water for irrigation, and agromeliorations) has been converting into less intense grasslands, and grasslands has been converting into shrubland or forest which is the primary type of natural vegetation in Slovenia and as such imposes no human-induced pressure.

The most important agricultural products in the valley are fruits (especially peaches) and grapes for wine production. An important product is also early vegetables (salad, potato, cabbage, carrot, onion, garlic and strawberries) due to favourable climate conditions and a vegetation period that is significantly longer compared to the continental parts of Slovenia [36].

Besides agriculture, industry is also an important sector in the Vipava RB (31% of the total GDP in the Goriška region). Industry is present in all major cities of the Vipava Valley (e.g. Ajdovščina, Vipava, Šempeter, Nova Gorica), although it is more condensed in the lower part of the basin. In Ajdovščina, there are two important food processing factories i) Fructal producing juice from the fruit grown in the valley, ii) Mlinotest producing flour products with focus on pasta; and one of the biggest Slovenian textile factory Tekstina. Important industrial sectors in the valley are also electronics, construction industry and transport services. The number of new established micro, small, and medium companies is increasing in the last decade as people are developing new income opportunities, following the abandonment of agricultural activities and ever decreasing employment in large industry complexes. Such employment changes imply pressures that will probably become more condensed in urban centers, however the development of an increasing number of small and micro-companies means scattered pressures all around larger settlements instead of very localised large scale pressures implied by big companies.

Geologically, the bottom of the valley is located between two tectonic faults that run in the NW-SE direction, one in the north and one in the south and was formed by tectonic subsidence. The Vipava Valley is composed of tertiary and quaternary alluvial sediments where the soil is quite fertile. The mountain range that envelops the valley in the north is a massive mesozoic limestone accretion, covered by a thin and unstable layer of flysch. For this reason, landslides are common on the steep slopes during heavy rainfall events. The elevated but much lower plateau to the south is largely of more or less pure limestone from mesozoic era [37]. Both limestone plateaus are without any surface waters whatsoever and all the water sinks into ground creeks and canyons only to emerge again just above the impermeable valley bottom. In general, water management in such carstic regions is mostly difficult as sources of pollution may be distant and difficult to locate.

Moreover, self-purification capabilities of water in comparison to non-karstic regions are extremely limited due to the lack of proper natural filters (e.g. lush vegetation, thick layer of soil, layers of sand and gravel underneath, which are common in non-karstic environments). Due to the fact that the Vipava RB hinterland is sparsely populated and with the exception of a small number of pastures (the Trnovo Forest and the Nanos and Hrušica Plateaus), the surrounding karstic regions of the Vipava RB do not represent large scale pressures on water. To some extent, a noticeable number of vineyards in the Karst region, could present an environmental pressure.

3.3.1.2 Climate and Water

Being open to the west towards the Adriatic Sea, the Vipava RB is subject to a strong Mediterranean climate interplaying with continental climate conditions. Sub-Mediterranean climate is moderated by occasional influxes of continental air masses from the north-east across the mountain barrier. Summers are hot and dry with occasional droughts while winters tend to be mild and rainy with frequent bora wind, a prominent local wind which is dry, cold, and often comes in gusts with well over 100 km/h and can occasional exceed 200 km/h causing damage to crops, buildings and causing problems in traffic. The most affected section by bora wind is usually the upper part of the Vipava Valley, stretching from Ajdovščina to Podnanos.

The bottom of the valley rarely sees freezing temperatures and snow is a rare occurrence as well. The average annual temperature at the bottom of the valley is 12-13 °C. The hottest month is July with the average temperature of around 22 °C, and the coldest months is January with the average of around 3 °C. Temperatures drop with altitude; on an annual level, they are up to 2 °C lower on the Karst plateau and up to 6 °C lower in the highlands of the Trnovo Forest mountain range. Average annual precipitations in the upper part of the Vipava Valley are around 2,000 mm per year, and in the lower part and the Vipava Hills around 1,500 mm per year.

The Vipava River, with approximately 47 km and mean yearly discharge of 17.3 m^3/s (the 1971 – 2000 period) has a pluvial or pluvio-nival flow regime. From its right river bank it is fed by several tributaries with strong karstic springs (e.g. Lijak, Hubelj) which are fed from the wet Trnovo Forest mountain range. The Vipava River has a short but noticeable low flow in late winter due to snowfall in the mountains, a long and persistent low flow during the summer, and two high flows, one in early spring and one in late autumn. Low-scale floods are frequent in the lower part of the valey during late autumn and larger-scale floods occur every couple of years [38*[38*].

In Slovenia, temperature measurements clearly show that the climate is heating up [39] . In the period 1951-2000 air temperature increased by 1.1 °C, and in the last 30 years, the heating exceeded the limit of 1.5 °C [40]. Analysis of water balance in Slovenia for the period 1971–2000 [3] show changes of the precipitation regime in the last years, with the increasingly pronounced autumn peak of precipitations and decreased amount of precipitation in other seasons. Evaporation is also changing with pronounced increase in comparison with period 1961-1990 [3]. As the consequence water flow regimes are changing with diminishing differences of river water flow regime on a regional level. Water flow trends are generally declining. The comparison of the elements of the water balance in the 1971–2000 period with that in the 1961–1990 period [3] also indicate an increase in evaporation and a reduction in the surface water runoff. In the short-term, above listed climate changes on a regional level have not yet caused water shortages, though locally they are increasing the risks to the provision of water.

Although uncertain and depending on used global circulation models [41], climate change projections for Slovenia published by the Slovenian Environment Agency suggest that the average annual temperature in the Vipava Valley could increase by 1.3°C under the scenario A1B (Special Report on Emissions Scenarios (SRES)) or more by 2030 together with reduction of precipitation in the summer and increase in the winter.The biggest positive trend in temperature is seen during the summer months [42]. On average, snow has been becoming rarer and snow boundary has been occurring on ever higher altitudes, preventing the water to be retained until spring. Thus, low flows or occasional water shortages as soon as at the start of vegetation season have become more common, jeopardising crop yields. Even though the annual precipitation levels do not show any

trend, it tends to be ever less equally distributed throughout the year; winters have been getting wetter and summers drier. Under the scenario A1B a 2% rise in precipitation for winter months and a 4% reduction for summer months until 2030 is projected [42]. Moreover, summer precipitation tends to fall in ever shorter but more intense rainfall of convectional type with storms and torrential downpours, forcing the water to run off rapidly and preventing infiltration into the soil. As such, summers have been becoming increasingly vulnerable to droughts [38] [43] [44]. Extreme hydrological events have been becoming more frequent, too. In the last couple of years the Vipava RB has been experiencing persistent extreme low-flow events during the summer months as well as relatively short but extreme peak discharges during heavy rainfall causing sometimes devastating torrential floods [38] [44].

In the process of implementation of the Floods Directive, total of 56 areas of potentially significant flood risks were demarcated in 2012 across Slovenia with regard to human health, environment, cultural heritage and economic activity [45]. In the Vipava RB there are five such areas (see Figure 3.1). In the process of implementation of the Floods Directive, lead by the MOP, the Flood Risk Management Plan is planned for these areas (Figure 3.1). According to the preliminary Hazard Indication Map, there are also very rare floods (HQ 50 and more) registered in the Vipava RB in total area of 19.21 km^2 (3.3% of the total Vipava RB area) (Figure 3.1).

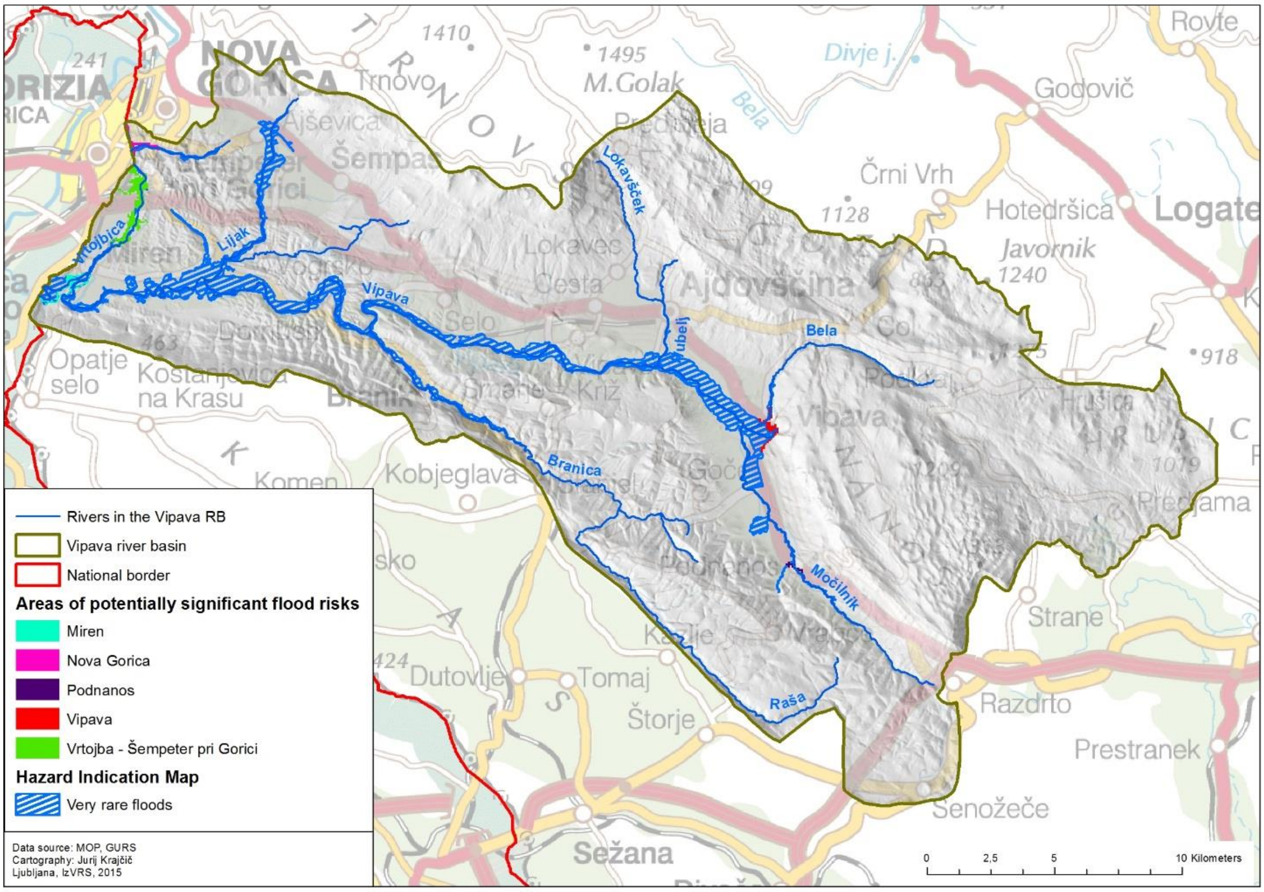

Figure 3.1: Areas of potentially significant flood risks and very rare floods (HQ50 and more, marked in blue) in the Vipava River Basin

According to the data from the RBMP (2015 – 2021) of Slovenia (in preparation) [13], the chemical status of surface waters in the basin is good, whereas the ecological status or ecological potential of the Vipava River is moderate in the lower part and good in the upper part. Ecological conditions of the lower part of the Vipava River are deteriorated due to high levels of nutrients and presence of specific pollutants. The chemical status of three groundwater bodies in the Vipava RB (Coast and Karts with Brkini, Karts Ljubljanica and Gorizia Hills and Trnovo-Banjščica plateau) is good [*46*] . However, the chemical status of groundwater aquifer system "Vrtojbensko polje" is questionable due to high levels of nitrate [47] , which was confirmed also by the ASTIS project [

48] . The results of the ASTIS project showed besides nitrates also increased levels of specific pollutants of antropogenic origin in the groundwater aquifer system “Vrtojbensko polje”.

Slovenia is one of the 8 Member States, that have failed to comply with their obligations under the Urban Waste Water Treatment Directive [49]. This is the main reason that municipal wastewater treatment in the basin is not sufficient, which is reflected in poorer ecological status, especially during ex treme low flows. Buildings in most of the smaller settlements still have (permeable) septic tanks instead of sewerage systems or small wastewater treatment plants. However, two municipal wastewater treatment plants (WWTP) for a total of 56,500 population equivalents together with sewerage systems were constructed most recently in the basin (1) WWTP Vipava in the upper part of the basin and (2) WWTP Nova Gorica (Vrtojba) in the lower part of the basin. Surface water quality is expected to improve. Nevertheles, more WWTPs are needed in the basin, mostly on smaller scale.

The Vipava RB is one of the most profoundly influenced areas by human activity in Slovenia. The upper stream of the Vipava River and its tributaries were technically regulated in the past because of floods and to increase the area of arable land. Flood protection in the upper part or the basin has been improved however it causes a quicker run-off towards the lower part of the basin where floods have become more frequent [50] and several catastrophic floods occurred in past years which resulted from changes in the precipitation regime, one of the consequences of climate change. There is one large water reservoir Vogršček, built on a rather weak watercourse with the same name. Total designed volume (both lower and upper reservoir) of Vogršček is 8.5 million m^3 of water. Vogršček has been designed to provide water for the irrigation of the lower Vipava Valley, amounting 84.5% of the total useful volume (6.8 million m^3). 15.5% of the total useful volume is intended to prevent hydropeaking and flooding during high flows [51]. Although planned (Republic Green plan, 1970-1980) all the corresponding irrigation systems were not constructed. Today’s capacity of Vogršček is only 1.8 million m^3 water per year, which mean possible irrigation of 1,400 ha of agricultural land. Due to sub-optimal functioning of the Vogršček (leakage of the barrier, low water level resulting in low pressure for optimal irrigation) only approximately 1.3 million m^3 of water per year (1,000 ha of agricultural land) is used for irrigation.

3.3.1.3 Biodiversity

Although the Vipava Valley represents one of the most anthropogenically influenced areas in Slovenia with high level of alien fish species in river bodies, yet the Vipava River still represents a shelter for endangered autochthonous fish species unique to this area. Due to a number of autochthonous or rare animal and plant species as well as endangered and unique habitats, the Vipava RB is included into the European network of Natura 2000 protection plan (Figure 3.2) [52]. Due to the specific geology and morphology of the area, a large number of nature conservation areas (e.g. valuable natural features, protected areas), protected on a national level with Nature Conservation Act [53], are present in the Vipava RB. There is however no national park or any other form of park in the basin.

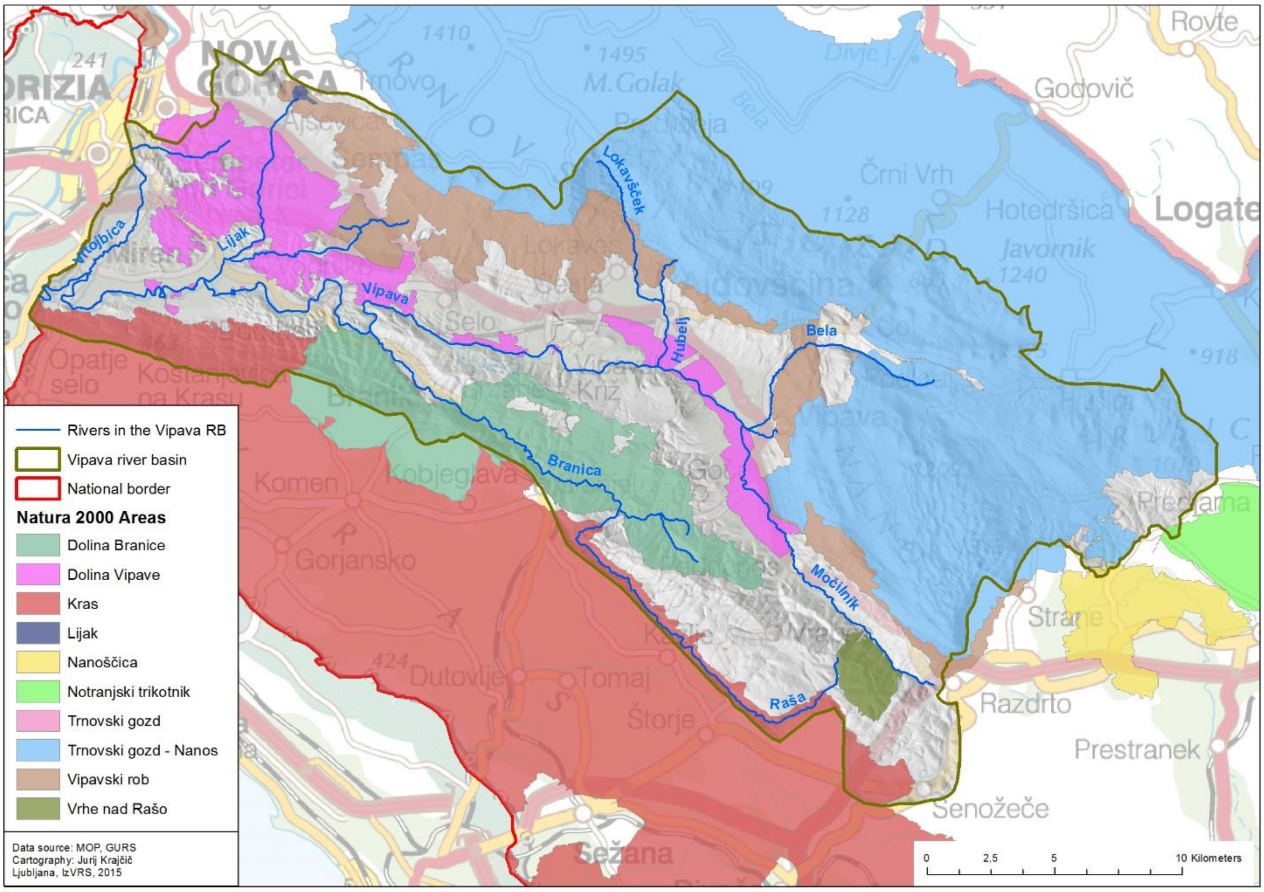

Figure 3.2: Natura 2000 sites in the Vipava River Basin

3.3.1.4 People

Urbanisation in the Vipava RB is moderate. There is only one town, Ajdovščina, of more than 5,000 residents with a combined population of 25,000. The population density is quite high in the bottom of the valley and lower on the slopes that enclose the valley [2].

The area of the Vipava RB is devided between 11 municipalities. Three of them are located only in the area of the Vipava RB, while most of them are located partly in the Vipava RB and partly in other RBs (see Table 3.1).

Table 3.1: Municipalities in the area of the Vipava River Basin (GURS, 2014).

Municipality	Area (km^2)	Area in the Vipava RB (km^2)	Area in the Vipava RB (%)
Vipava	107.4	107.4	100.0
Renče - Vogrsko	29.5	29.5	100.0
Šempeter - Vrtojba	14.9	14.9	100.0
Ajdovščina	245.2	201.4	82.1
Nova Gorica	279.5	86.0	30.8
Miren - Kostanjevica	62.8	11.8	18.8
Postojna	270	57.1	21.1
Divača	145	27.4	18.9
Sežana	217.4	36.1	16.6
Komen	102.7	11.0	10.7
Idrija	294	6.7	2.3

Overall water supply on an annual level is in abundance. However, there are shortages of surface water during the summer months. Occasional droughts result in damage on crops and in yield loss, but underground aquifers which represent the vast majority of potable water supplies are rarely severely affected [54].

The total annual discharge of the basin is approximately 545 million m^3. There are two important terms regarding authorized water withdrawals. Water use is the total amount of water used for a particular activity, whereas water consumption is the total amount of used water that is not returned to the water resource [55].

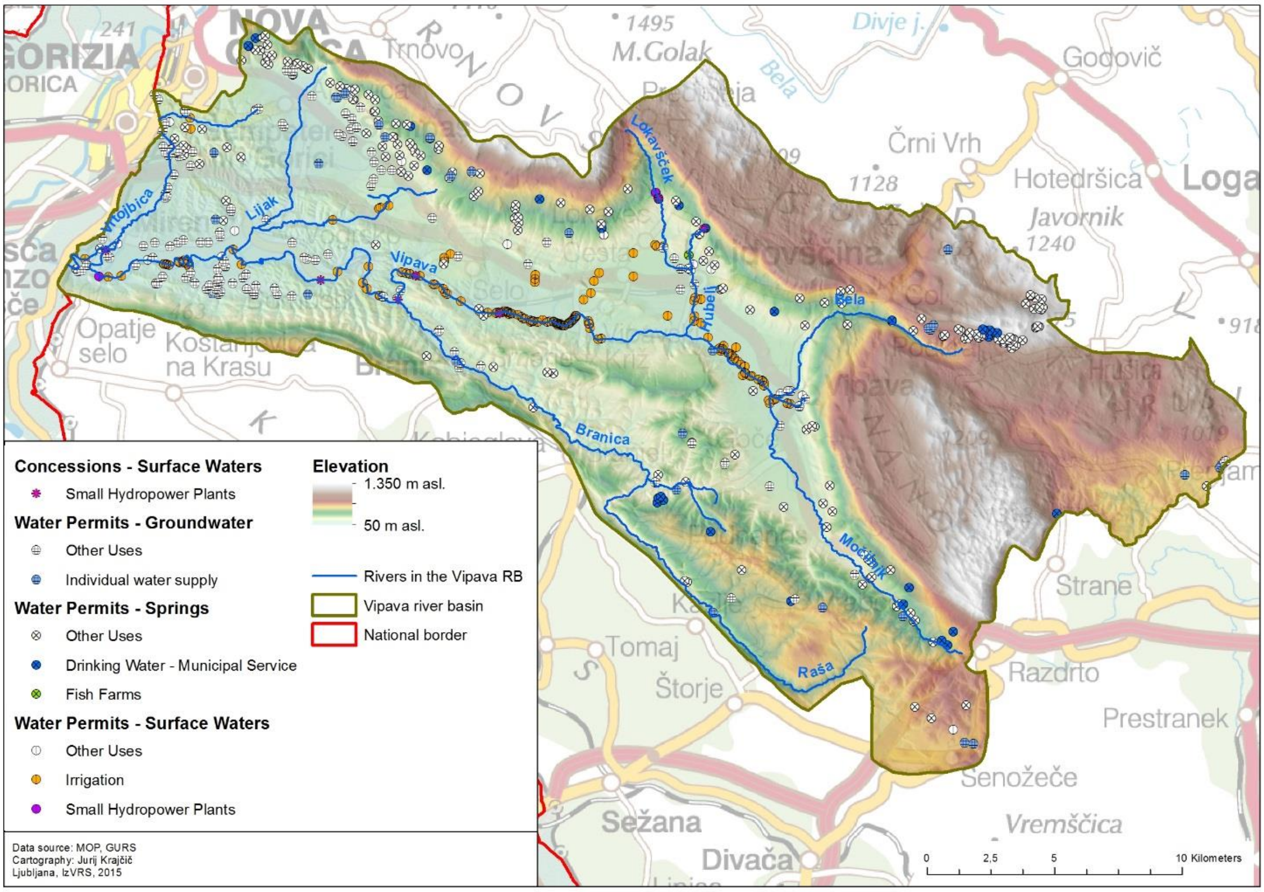

Figure 3.3: Water permits granted in the Vipava River Basin

In 2013, the total granted water consumption from surface waters through water permits amounted arround 33.5 million m^3, meaning only around 6% of all water available from surface waters. Almost all of this quantity was allocated to irrigation. On the other hand, the total water use from surface waters granted by water permits was around 509 million m^3, with more than 99% of which was allocated to small hydropower plants. An additional annual granted amount of 2.09 billion m^3 was allocated to small hydropower plants with concessions. Other uses of surface water include aquaculture, fisheries, saw/mill, water used by technological plants, and individual water supply; combined they account for less than 1% of all withdrawals [56] .

Drinking water for households is provided by mandatory municipal public utility services (Komunala Nova Gorica d.d. in municipalities Nova Gorica, Šempeter-Vrtojba, Miren-Kostanjevica and Renče-Vogrsko and Komunalno stanovanjska družba d. o. o. Ajdovščina in municipalities Vipava and Ajdovščina) and is obtained from springs (e.g. Hubelj). The total granted withdrawal in the Vipava RB in 2013 amounted around 6.2 million m^3 through water permits. Additional 0.08 million m^3 were allocated to individual water supplies. The two uses combined presents more than 99% of all water consumption from springs. An additional granted amount of 3.9 million m^3 was allocated to aquaculture [56].

Water use from groundwater sources others than springs is low. In 2013 only 7 thousand m^3 of withdrawal was granted through water permits for individual water supplies, and additional 64 thousand m^3 for technological purposes. There were no concessions awarded for use of ground water in 2013 [56].

Water demand for households is expected to stay at approximately the same level, while water demand for agriculture, especially irrigation, is expected to rise in the years to come since there are plans to encourage irrigation and decrease vulnerability of crops to droughts [57].

With its rich natural and cultural heritage, the Vipava Valley especially in the upper part has a great potential for the development of ecotourism. Besides surroundings in the lower part of the basin, Vipava wine road is a good starting point for countryside ecotourism. The importance of tourism for the local economy has been increasing. The number of visitors is rising every year reaching 176,000 in 2014, the main attractions being landscape, wine tasting and gastronomy [36].

The importance of hydropower is small. There are nine small hydropower plants in the basin, most of them are on the Vipava River [56].

3.3.2 Main challenges and their interlinkages

The challenges identified by stakeholders during the first stakeholder workshop were analysed and consolidated within the BeWater Project team into three overarching challenges the Vipava RB is facing: (a) Water availability during droughts in growing season, (b) Flood risk reduction, (c) Appropriate water quality.

3.3.2.1 Challenge A: Water availability during droughts in growing season

The main challenge indicated by stakeholders is water availability during drought occurrences, especially in growing season. In the Vipava RB meteorological, agrometeorological and hydrological droughts are present, each having a specific impact on the environment.

When droughts occur, there can be a problem of water availability for a variety of activities, sectors (water users) and for the ecosystems. The main problems why water is unavailable during droughts in growing season are listed below:

I. In the past droughts were always present in the Vipava RB, but in the last few years they are occurring more frequently and larger areas are affected. Beside climate changes, one of the reason are changes in the river regime caused by regulations of watercourses (Vipava, Hubelj, Lijak) in 1980s and earlier, and amelioration works to drain excessive water from soil. The consequences are more rapid surface water runoff from the basin, increased flow velocity, decreased retention function of the riverbed and soil and reduced water infiltration causing lowering groundwater level. As a result of all above listed, the water cycle in the basin has changed.

II. Although several water reservoirs and irrigation systems were planned to be constructed in the Vipava Valley (e.g. Branica, Pasji rep, Močilnik, Malenšček-Kamenski potok, Vrtovinšček, Lokavšček, Koševec) in the 70's due to a program to increase the level of self-sufficiency in food (called Republic Green plan, 1970-1980) only the water reservoir Vogršček with corresponding irrigation systems for the lower part of the valley were actually constructed. The reasons were changed priorities of the Republic of Slovenia and thus available funds at that time were transferred into construction of highways. After that, several plans of different water reservoirs were discussed, but not yet realized.

III. Water reservoir Vogršček represents a major intervention in the valley's water cycle, yet with undesirable results, attracting political and professional criticism for many years. The main problem is unclarified ownership of the reservoir and its infrastructure between government and the private sector, which, in the past 20 years, has resulted in poor management, improper functioning, lack of operation and maintenance funding. Today's capacity of Vogršček is only 1.8 million m^3 water per year, which mean possible irrigation of

1,400 ha of agricultural land. Due to sub-optimal functioning of the Vogršček (leakage of the barrier, low water level resulting in low pressure for optimal irrigation) only approximately 1.3 million m^3 of water per year (1,000 ha of agricultural land) is used for irrigation. There are also illegal connections to irrigation system which are additionally worsening the functioning of the system, and making water less available for those users who are paying for water used. There are many challenges that need attention in Vogršček (a) better understanding of the system functioning, (b) more transparent functioning of the system (with no illegal connections); (c) cooperation between the users (16 irrigation communities), (d) organization of optimal irrigation (irrigation time plan) and (e) technological renovation and modernization of the reservoir and connected irrigation systems.

IV. The Vipava River, as the only water source for irrigation in the upper Vipava RB, features a rainfall regime (flow is directly dependent on the precipitation regime in the catchment area). In dry periods when water is needed for agriculture irrigation, there are restrictions for water abstraction from the river due to maintenance of the ecological flow (WFD). Nevertheless, illegal water abstractions from the Vipava River exists also during low flows thus exacerbating the negative impacts of drought on aquatic, riparian and wetland ecosystems (reduced water flow, flow cessation, eventually complete desiccation; resulting in not achieving good ecological status of surface waters according to WFD). Already, some experts claim that the irrigation needs in the Vipava Valley are greater than the available water quantities and other water sources beside water reservoir Vogršček would be needed.

When droughts occur, they can cause damages to water distribution systems infrastructure – damaged, broken water pipes, causing unavailability of drinking water on some areas of the Vipava RB.

In the frame of Republic Green plan (1970-1980), shelterbelts (wind barriers) were planted to minimize the impact of wind on agriculture by reducing evaporation and the impact of summer winds on soils (drying, loss of water in soil). Due to illegal removal of already planted shelterbelts by farmers (lack of awareness) and improper agricultural practice, deflationary effects of bora wind, especially in winter is even stronger.

3.3.2.2 Challenge B: Flood risk reduction

Floods were always present in the Vipava RB and represent a bigger problem in the lower part of the RB, but due to climate change, changes of the river regime due to regulations of the watercourses in 1980s and building of settlements too close to the watercourses (deprivation of riparian area) severe floods are occurring more frequently and at a larger scale. Due to trapped and rigidly regulated watercourses (concrete banks) in the upper valley, which are lacking the needed space and the ability to reduce the flow velocity, water rapidly drains downstream causing severe floods in the lower valley.

One of the main challenges identified by stakeholders regarding flood risk management is lack of competences between local and national authorities mostly due to vague legislation. Most problematic are smaller watercourses not recorded in the water cadastre. Additionally, when talking about flood risks in the Vipava RB, municipal spatial planning and its effect on flood occurrence needs to be mentioned. In the Vipava RB there are 11 municipalities, but not all of them are influenced by floods. Each municipality is managing its own area without considering the impacts of their measures upstream or/and downstream of the watercourses and thus increasing flood risks outside their area.

Landslides, which occur everywhere in the Vipava Valley where the terrain is sloping, have also an impact on floods occurrence although indirectly. The biggest and most dangerous areas for landslides occurrence are on the northern slope of the valley that descend from the Trnovo Forest (Trnovski gozd) into the valley. The landslides and also many other slope-movement phenomena

originate in the current geological structure of the valley and in the formation of the terrain. However, most landslides are triggered by heavy rainfall.

In the Vipava RB due to inappropriate spatial planning urbanisation of the valley slopes increased the possibility of triggering landslides mostly due to inappropriate regulation of storm water and hinterland water drainage. Also poor maintenance of drainage system built more than 30 (or 50) years ago like regulations of torrents and inadequate drainage of storm waters, contribute to triggering landslides more often. Landslides does not only threaten buildings and infrastructure, but also causes morphological changes of the terrain. Landslides often move large amounts of sediments, which does not only stay on the slopes, but also reaches the fluvial network. Under extreme weather conditions, landslides may lead to torrential outbursts, debris flows or dam-break waves after a dam-breach of natural dams. As a result, floods of larger scope occur.

3.3.2.3 Challenge C: Appropriate water quality

The ecological status of the Vipava River is moderate due to high levels of nutrients and presence of specific pollutants (insufficient municipal wastewater treatment and agriculture).
One of the main reasons for inappropriate water quality in the Vipava RB is insufficient municipal wastewater treatment. In order to solve the current situation and most importantly due to compliance with legislative requirements, two waste water treatment plants (WWTPs) were constructed recently, in the upper valley WWTP Vipava (at the stage of trial operation) and in the lower valley WWTP Nova Gorica (Vrtojba). However, there is still unsolved problem of insufficient municipal wastewater treatment in small and dispersed settlements.

When Vipava River and its tributaries (Lijak, Hubelj, etc.) were regulated and canalized in 1980s in order to increase area of arable land, the length of the Vipava River was shortened from 50 to 47.7 kilometres mostly due to the elimination of meanders. Due to regulations, many habitats for aquatic and riparian plants and animals disappear. The result is lower self-cleaning ability of watercourses resulting also in moderate ecological status.

When talking about the Vipava River and agriculture in the Vipava RB, challenges of too excessive water abstraction need to be mentioned. Abstractions of water for irrigation purposes are the largest on the Vipava River. Also deficient supervision of water abstractions and problem of excessive number of concessionairies on the same watercourse is identified. Hence it could be a problem to maintain ecologically acceptable flows and good ecological status.

Monitoring of water quality in Vogrščček reservoir confirmed presence of faecal coliforms [58]. The source of contamination are most probably septic tanks overflows in the catchment area. Since water in the water reservoir Vogrščček occasionally contains too many coliforms, the use of water for irrigation purposes is limited.

Another cause for sub-optimal functioning of the Vogrščček is the improper connection of the irrigation system to the reservoir due to floor outlet, resulting in (a) exceptionally cold water unsuitable for irrigation, and (b) water full of sediments also unsuitable for irrigation (fruits like peaches and vegetables must be cleaned constantly) [59] [60].

A pre-condition for water ecotourism development like natural bathing sites on the Vipava River is appropriate bathing water quality. With bathing waters on the Vipava River microbiologically inappropriate, desired ecotourism cannot develop.

3.3.2.4 Basin dynamics

The fuzzy cognitive map (FCM) presented in Figure 3.4 is centred on the three challenges described above and it includes eighteen (18) factors connected with each other. Based on stakeholders comments, six main drivers of the system were identified 1) precipitation, 2) industrial production, 3) wind, 4) water infrastructure and forest management, 5) river basin management,

and 6) air temperature in growing season that affect either directly or indirectly the three aforementioned challenges in the basin.

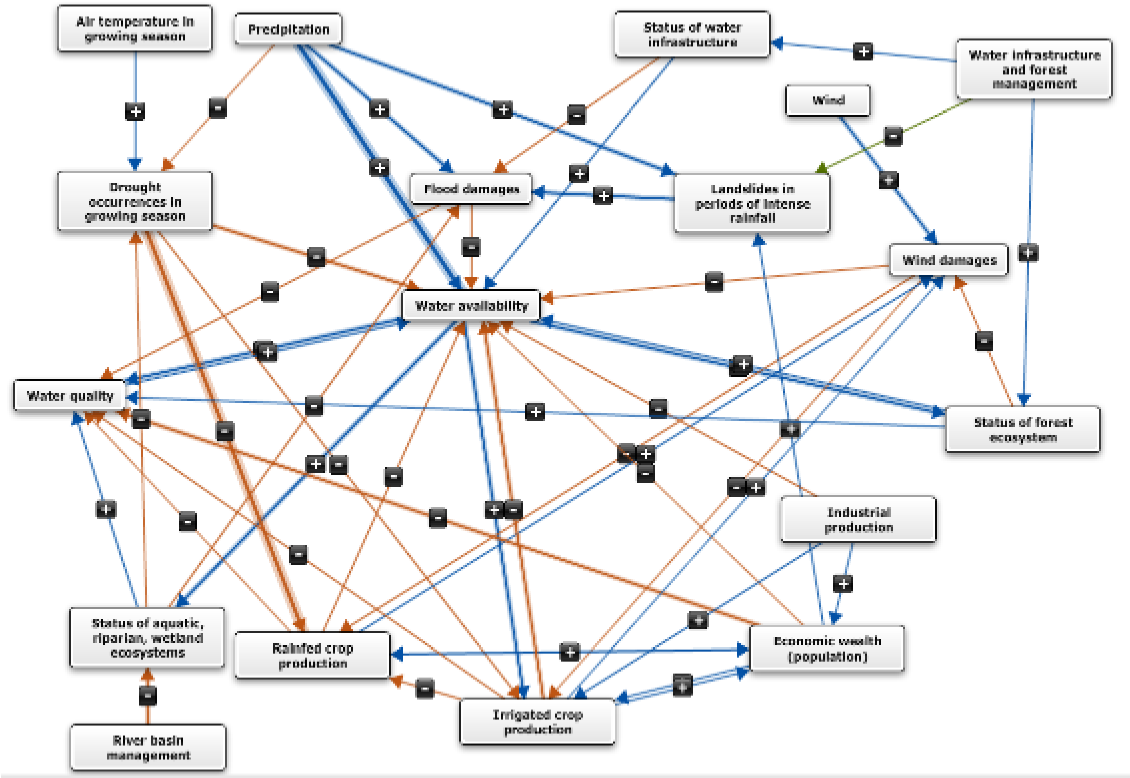

Figure 3.4: Fuzzy cognitive map of the Vipava River Basin

Water availability is the main factor in Vipava cognitive map due to the highest number of interactions with other factors (Figure 3.4). Water availability is positively affected by precipitation, water quality, status of water infrastructure and status of forest ecosystem. Precipitation has the strongest positive influence on water availability, because precipitation is the main source of water in the valley. Namely, precipitation on plateaus north and north-east side of the basin recharge numerous karst springs (e.g. Hubelj) that are important for water supply. Water availability is positively (medium strength) influenced by water quality since more water of better quality means more water available for users (e.g. drinking water, water for irrigation and industry). Finally, the status of forest ecosystems positively affects water availability in the lower part of the basin, because the main catchment area of the Vipava River are plateaus in the north, north-east side covered with forest that retains water and releases it slowly. Water availability is most strongly negatively affected by drought occurrences in growing season, and the intensity of rainfed and irrigated crop production. More drought occurrences result in less water being available in the basin. The strength of drought occurrences on water availability is medium as the main catchment area of the Vipava River is less vulnerable to the conditions in the flat part of the basin (from Vipava's springs downstream). In the flat part of the basin, where agricultural land is present rainfed crop production prevails. More rainfed crop production means higher water uptake by plants and less water available for water-dependent ecosystems and sectors. With regards to irrigated crop production, water used for irrigation means irreversible water use and it therefore negatively affects water availability. Irrigated crop production is present mostly in the lower part of the basin, near water reservoir Vogršček and where irrigation systems are present and functioning. In the upper part of the basin, irrigation of agricultural land is also present and the Vipava River is the only water source for irrigation.

Water availability is affecting other factors in the basin. Water availability positively influences 1) aquatic, riparian, wetland and forest ecosystems and 2) water quality. Water availability positively influences irrigation crop production in the Vipava RB and status of aquatic, riparian and wetland ecosystems. If more water is available in streams, soil and groundwater, basin ecosystems (aquatic, riparian, wetland and forest) are in better state. Furthermore, when there is more water in watercourses and groundwater, water is of better quality mostly due to dilution of (potential) pollutants. Finally, if more water is available in watercourses, which are the main water sources for irrigation (the Vipava River and the water reservoir Vogršček), irrigated crop production is higher. Medium strong relationship between water availability and irrigated crop production is determined as irrigation in the basin is not developed to its full capacity and other factors have bigger effect on irrigated crop production like the development and condition of irrigation systems.

Water quality besides water availability interacts with seven factors. Water quality is affected negatively by economic wealth, including population and settlements development in the RB and agriculture (rainfed and irrigated crop production). Due to small and dispersed settlements in basin with insufficient drainage and municipal wastewater treatment, organic pollution is affecting negatively the water quality. Agriculture with the use of plant protection products and fertilizers is also one the sectors affecting negatively the water quality.

Last but not least are flood damages, related to the basin challenge Flood risk reduction. Precipitation positively affect flood damages because longer periods of rainfall or even shorter periods of heavy rainfall usually lead to flood events causing damages mostly to infrastructure and also trigger landslides. When landslides trigger they move large amounts of sediments, which not only stay on slopes, but also reach the fluvial network. Under this conditions, land sliding may lead to torrential outbursts, debris flows or dam-break waves after a dam-breach of natural dams. As a result, floods of larger scope occur.

Negatively, flood damages equally strong affect water availability and water quality. Namely, floods cause damages to water supply systems and turbidity of water at the source. Due to inactivity of pumps and water treatment, less drinking water of proper quality is available for its users.

3.4 Water management options for Vipava River Basin

Based on stakeholders input 20 WMOs were identified in total, listed in Table 4.1 and described in detail in Annex 3. There are 16 options addressing *Water availability during droughts in growing season* (challenge A), 10 options addressing *Flood risk reduction* (challenge B) and 12 options addressing *Appropriate water quality* (challenge C), however several WMOs are addressing more than one challenge.

Water Management Options (WMOs), already indicated by stakeholders on 1st stakeholder workshop, have been formulated to address these three challenges. At the beginning of the process 23 WMOs were identified, which were reduced to 20 based on the refinement process and stakeholders input (2nd stakeholder workshop). Due to traceability, the original numbers of WMOs are kept in all documents.

Table 4.1: overview of the identified water management options for the Vipava river basin

#	Name of Water Management Option	Challenges
1	The creation of inter-municipal expert working group for the Vipava RB	A, B, C
2	Awareness campaign focused on educating experts involved in surface water management for sustainable water management (impacts of their actions)	A, B, C
3	Awareness campaign focused on optimizing water use for farmers, for proper irrigation and minimize impacts on water quality through proper agricultural practices	A, C
4	Awareness campaign for local public on impact of their activities on the river	A, B, C
5	Improve the system of financing water infrastructure (of aquatic and riparian land)	A, B
6	Upgrade and update the existing measurement network for monitoring the state of water environment	A, B
7	Setting up monitoring to reduce hydro-morphological pressures on aquatic ecosystems	A, C
8	Construction of water reservoirs on the watercourses in the upper part of the RB	A, B
9	Construction of dry reservoirs	B
10	Reconstruction of existing water reservoir Vogršč ek	A
11	Development of new irrigation systems	A
12	Reconstruction of existing irrigation system	A
13	Restoration of Vipava river and its tributaries	A, B, C
14	Restoration of old meanders and oxbows of Vipava river and its tributaries	A, B, C
17	Reconstruction of cascading barriers from natural stone in the smaller tributaries of Vipava river	B
19	Improving the system of payment for water used for irrigation	A, C
20	Preservation of existing and introduction of new shelterbelts	A, C
21	Removal of invasive non-native species	C
22	Construction of municipal wastewater treatment plants and sewage systems	C
23	The cultivation of crops that are resistant to climate changes (drought, pests and diseases)	A, C

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[63] Decree on the river basin management plan for the Danube Basin and the Adriatic Sea Basin (OG RS, No. 61/11, 49/12). (in Slovene)

[64] European Commission: Report from the Commission to European parliament and the Council on Implementation of the Water Framework Directive (2000/60/EC) River basin management Plans (COM 2012 670 final), Brussels, 14.11.2012

[65] Waters Act (OG RS, No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14) (in Slovene)

Annex 1 List of relevant national legislation governing water management

Main implementing regulations of Waters Act and their main objectives are:

- Decree on criteria for determination and on the mode of monitoring and reporting of ecologically acceptable flow (OG RS, no. 97/09) supports determination of ecological acceptable flow;
- Decree on content and preparation of detailed plan on mitigation of flood risk (OG RS, no. 7/10) in accordance with the Floods Directive (2007/60/EC) determines the content and method of the Flood Risk Management Plan;
- Decree on conditions and limitations for constructions and activities on flood risk areas (OG RS, no. 89/08) manages land use in spatial planning;
- Decree on the provision of obligatory state services of general economic interest for water management and on concessions and public services (OG RS, no. 109/10, 98/11, 102/12 and 89/14) regulates the mode of implementation, the organization, financing and concession for the mandatory public utility services in the field of water management;
- Rules laying down water infrastructure (OG RS, no. 46/05) sets down which water facilities, appliances or regulations are considered as water infrastructure;
- Rules on the types and scope of tasks of mandatory state public utility services in the field of water management (OG RS, no. 57/06);
- Numerous Decrees on water use rights or uses on watercourses or riparian areas and on protection areas.

Water management is in specific parts governed also by:

- Environmental Protection Act (OG RS, no. 39/06 - consolidated text, 49/06 - ZMetD 66/06 - dec. U.S. 33/07 - ZPNačrt, 57/08 - ZFO-1A, 70/08, 108/09, 108/09 - ZPNačrt-A, 48/12, 57/12, 92/13 and 56/15) as key act supporting environmental protection activities and objectives. Its main implementing regulations are:
    - Decree laying down the content of environmental report and on detailed procedure for the assessment of the effects on certain plans and programmes on the environment (OG RS, no. 73/05) – supporting comprehensive or strategic environmental impact assessment (SEA);
    - Decree on the activities (interventions) for which an environmental impact assessment is mandatory (OG RS, no. 51/41) - supporting environmental impact assessment (EIA).
- Nature Conservation Act (OG RS, no. 96/04 - official consolidated text, 61/06 - ZDru-1 8/10 - ZSKZ-B and 46/14) as key act supporting objectives of nature and habitat protection;
- Freshwater Fisheries Act (OG RS, no. 61/06) as a key act regulating freshwater fishery and management of fishery resources in inland waters;
- Spatial Planning Act (OG RS, no. 33/07, 70/08 – ZVO-1B, 108/09, 80/10 – ZUPUDPP, 43/11 – ZKZ-C, 57/12, 57/12 – ZUPUDPP-A, 109/12, 76/14 – odl. US and 14/15 – ZUUJFO) as a key act supporting spatial planning;
- Construction Act (OG RS, no. 102/04 – official consolidated text, 14/05 – popr., 92/05 – ZJC-B, 93/05 – ZVMS, 111/05 – odl. US, 126/07, 108/09, 61/10 – ZRud-1, 20/11 – odl. US, 57/12, 101/13 – ZDavNepr, 110/13 and 19/15) as a key act supporting technical design, construction and operational phase. Its main implementing regulations are:
    - Decree on the uniform methodology for the preparation and treatment of investment documentation in the field of public finance (OG RS, no. 60/06, 54/10);
    - Decree amending the Regulation on classification of construction with regard to their complexity (OG RS, no. 18/13, 24/13 and 26/13).
- Wildlife and Hunting Act (OG RS, no. 16/04 - official consolidated text, 61/06 - ZDru-1 8/10 - ZSKZ-B and 46/14) as a key act supporting regulation of watercourses and timing of the (construction) works;
- Decree on the protection of waters against pollution caused by nitrates from agricultural sources (OG RS, no. 113/09, 5/13 and 22/15) transposing Nitrates Directive (91/676/EEC)

sets measures to reduce and prevent water pollution caused by nitrates from agricultural sources.

Annex 2 Detailed presentation of formulation and evaluation of Water Management Options

The steps of formulation and evaluation of the WMOs described briefly below are refer to Verkerk et. al. (2015).

Building the narrative of the Vipava river basin through Fuzzy cognitive map

As part of the participatory process a first stakeholder workshop was organized in the Vipava RB. Collected information on the current state and future expectation regarding water management in the Vipava RB were organized and synthesized by building a narrative of the Vipava RB. The narrative contains description of the current status of the Vipava RB, the issues and the challenges at stake in the Vipava RB. As such, the narrative provides a coherent framework for the formulation of WMOs which are understood as ways of tackling the challenges and their causes to reach the desired future status in the RB (Verkerk et. al., 2015).

The written narrative was complimented with a graphical representation of the RB in the form of a Fuzzy Cognitive Map (FCM) (see Figure 3.4). The first version of the FCM, prepared by the BeWater project team, was consulted with the stakeholders (Table 2.2: Stakeholder consultations (I)). This consultation was done in the form of individual interviews or group sessions. Stakeholders commented and suggested improvements of the FCMs which resulted in factors and relationships being added or modified. With the help of experts, the final FCM was developed with modelling software Mental Modeler tool (http://www.mentalmodeler.org/). FCM is cognitive because it is a representation of a belief system, i.e. it represents the dynamics in a system based on the understanding of individuals (Kok, 2009, Jetter and Kok, 2014), and as such represents a suitable tool to facilitate communication between stakeholders from various sectors and backgrounds. FCM is composed of boxes that represent main components of the RB (factors) and arrows that represent the relationships between the factors. The arrows reflect the sign and strength of the relationships between the factors. FCM allows organizing all the information available on the RB, providing with a clear understanding of the current status in the RB: main challenges at stake, drivers that influence them and their relationships in the system.

Formulation of Water Management Options

To address the challenges identified, stakeholders were also asked to suggest potential WMOs. Based on their suggestions given on the first stakeholder workshop, a set of WMOs were identified and formulated. Identification and formulation of WMOs was done in parallel with development of FCM to allow assessment of the impacts of different WMOs in the phase of evaluation. When formulating WMOs, a pragmatic approach was adopted requiring WMO to address one or more challenges identified by the stakeholders.

The BeWater project team characterised WMOs using a fixed set of descriptors that mainly refer to the implementation of WMOs (the parts of the RB, the sectors and land uses concerned, time frame, costs, type of approach, feasibility, acceptability, the relation to global change and to extreme events). With clustering WMOs, based on the similarity of descriptors and challenges that they address and refining process, WMOs were developed to the point that allowed further analysis.

Evaluation of Water Management Options

The evaluation of WMOs was carried out together with stakeholders in the second stakeholder workshop. WMOs were evaluated through impact assessment, performed by the BeWater project team with the help of experts and multi-criteria analysis (MCA), performed together with stakeholders.

Impact assessment was done by introducing WMOs into FCM as a) new boxes connected to FCM factors and identified sign and strenght of the new relationship or b) as changes in sign and strength of already identified relationships between the FCM factors.

MCA, as the main evaluation method in the BeWater project, was performed by involvement of stakeholders. Criteria for MCA included FCM factors (except drivers) and a set of descriptors that characterize WMOs in the formulation step. List of proposed criteria for MCA included factors from FCM and WMOs characterisation criteria. Stakeholders selected 13 criteria for MCA and reviewed the range of possible outcomes (the proposed scores), with indicating their acceptance of or change to the proposed scores. Stakeholders also determined relative importance of each criterion, by assigning points from 1 to 10 to the selected criterion, with 10 representing the greatest importance.

Stakeholders were asked to review the formulation of the WMOs and the preliminary outcome of the evaluation. Their feedback was used to improve all WMOs.

As a last step of WMO evaluation, a simplified cost assessment and cost effectiveness analysis was conducted with the help of expert consultations. The cost of each option was estimated by using numerous assumptions on how the option could be implemented. Together with cost effectiveness it represents a rough indication for scoping purposes. WMOs that are promising in terms of their costs and effectiveness give a preliminary information for the elaboration of the RBAP.

Improved WMOs were presented to and discussed with participants on the stakeholder consultation (II). Stakeholders gave feedback on further substance to WMOs, with an eye on implementation.

Annex 3 Detailed presentation of water management options

Explanation of abbreviations:

- SEA = Strategic Environmental Assessment also known as comprehensive environmental impact assessment supported by Environmental Protection Act (OG RS, no. 39/06 - consolidated text, 49/06 - ZMetD 66/06 - dec. U.S. 33/07 - ZPNačrt, 57/08 - ZFO-1A, 70/08, 108/09, 108/09 - ZPNačrt-A, 48/12, 57/12, 92/13 and 56/15) and with Decree laying down the content of environmental report and on detailed procedure for the assessment of the effects on certain plans and programmes on the environment (OG RS, no. 73/05).
- EIA = Environmental Impact Assessment supported by Environmental Protection Act (OG RS, no. 39/06 - consolidated text, 49/06 - ZMetD 66/06 - dec. U.S. 33/07 - ZPNačrt, 57/08 - ZFO-1A, 70/08, 108/09, 108/09 - ZPNačrt-A, 48/12, 57/12, 92/13 and 56/15) and with Decree on the activities (interventions) for which an environmental impact assessment is mandatory (OG RS, no. 51/41).

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WMO 1: The creation of inter-municipal expert working group for the Vipava RB

Overall description of the WMO

Short explanation	A Vipava RB working group (WG) will be established that would have an active role in water management with objectives of optimizing water use in sectors dependent on water availability through active involvement in planning sustainable techniques (water saving equipment) and water sources (alternative, more suitable techniques). The WG would be also involved in spatial planning of all involved Municipalities and so coordinating existing and planned interventions that have impact on flood safety and scope of droughts. The WG would have a role of active, promptly resolving conflicts of interest in spatial and water use (tourism, fisheries, agriculture) and would consist of experts of various fields (spatial planning, hydrology, nature conservation, economy, agronomy, agro meteorology, etc.) connected with competent state authorities (Ministry responsible for environment and its body Slovenian Environmental Agency). Objectives of working group (WG) are: • determination of objectives and targets to guide the development plans of the planning authorities; • active in processes of Municipal Spatial Plan development with the aim to ensure sustainable water management (providing expert assistance in determining land and water use); • to promptly discuss about present issues on Vipava River (and tributaries) and solving potential disagreement (conflicts) between stakeholders (conducting confrontations and seeking solutions); • to propose new ideas, initiatives, projects that would encourage sustainable development in Vipava RB; • to improve communication between Municipalities and experts (better flows of information).
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Local population (domestic), Tourism, Industry, Agriculture, Forestry, Energy, Water management, Fishery.
Benefits	Increased cooperation between municipalities and knowledge with involved experts can prevent inadequate water management and inadequate spatial planning. More coherent spatial development aims to resolve challenges of floods, water availability and water quality.
Potential negative impacts	Bigger workload of individual employees (managing various working areas and taking responsibility for the operation of the working group). Possible higher expenditures for water management can be balanced with reduced costs caused by inadequate water management and inadequate spatial planning (e.g. flood damages can be avoided if flood area and floodplains are taken into consideration when planning a development plan of a certain area).
Timeline of implementation	Short (under 5 years' time)
Feasibility	Minor barriers with organizing a group (capacity of the group manager to make people in the group agree)
Robustness	Yes
Flexibility	Yes
Costs	The total discounted cost towards year 2030: 138,506 euros (EUR 2018, discount rate: 5%) comprises of group organization and

	animation with 2 meeting per year.
Synergies and conflicts with policy objectives	No conflicts. Synergies with Resolution on the National Environmental Action Programme 2005–2012 (NEAP) (http://www.uradni-list.si/1/content?id=67017) and others; E.g.: Local Self-Government Act (http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO307 – Article 61. and 86.) allows establishment of such associations (http://uprava.fu.uni-lj.si/index.php/IPAR/article/view/42). On regional level also Regional Development Programme of Northern Primorska (Goriška development region) 2014-2020[358].
Acceptance	Medium to high (There is not significant reason a priori for anyone to reject the option.) Some doubts were raised on October 2015 event regarding jurisdiction of municipalities.
Suggested stakeholder involvement	Regional development Agency (preferably Ra ROD Ajdovščina) would on the initiative of municipality representatives animate the WG and also decide when the group has to come to a meeting (session) - resources necessary for the purpose of guidance, management of WG could potentially be provided from involved Municipalities. Upon request of Municipalities, Ministry responsible for the environment issues a decision on the nomination of inter-municipal WG for the Vipava RB.
Preconditions for success	Willingness for cooperation of all Municipalities that share Vipava River but also that are part of Vipava RB.
Concrete examples where applied	Regional working groups for irrigation; Regional Development Agencies (RDA Ra ROD, RDA of Northern Primorska Ltd Nova Gorica, Regional Development Centre Koper); Association of Municipalities and Towns of Slovenia (Skupnost občin Slovenije) In past OVS = Regional Water Community (Primorska), 1975-1990.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Municipal spatial plans	Encourage to prepare harmonized and coherent Municipal Spatial Plans that would help tackle identified challenges in Vipava RB.	Individual (investors) interests.
Regional Development Programme of Northern Primorska (Goriška development region) 2014-2020[359]	To help achieve objectives of programme 5.1 A comprehensive spatial development of the region.	
Resolution on the National Environmental Action Programme 2005–2012	Support in Point 7.2 Public participation in decision-making and objective to open political arena to all civil society stakeholders.	

[358] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
[359] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf

Name of policies *(examples)*	Opportunities	Barriers
(NEAP)		
Local Self-Government Act (Zakon o lokalni samoupravi (Uradni list RS, št. 94/07 – uradno prečiščeno besedilo, 76/08, 79/09, 51/10 , 40/12 – ZUJF in 14/15 – ZUUJFO))	Article 86. of the Act encourages the establishment of such associations.	
The Interreg MED Programme 2014-2020	The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach. Possible funding WMO within priority axis 3: MED RESOURCES (Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.)	
Horizon 2020	Societal challenges / 12. Climate action, environment, resource efficiency and raw materials / 14. Secure societies – Protecting freedom and security of Europe and its citizens Spreading excellence and widening participation (no. 15)	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
Ministry responsible for the environment	Possible shortening of SEA procedures. To get familiar with problems on local level.		Upon request of Municipalities, Ministry responsible for the environment issues a decision on the nomination of inter-municipal WG for the Vipava RB.
Ministry responsible for agriculture	Possible shortening of SEA procedures.		
Slovenian Environmental Agency	Possible shortening of SEA procedures.		Ensuring expert support.
The Institute of the Republic	Possible shortening of SEA		Ensuring expert support.

of Slovenia for Nature Conservation	procedures.		
Slovenian Forest Service	Possible shortening of SEA procedures.		Ensuring expert support.
Municipalities	Achieving clear vision of development of the RB, with clear vision for water management and support in achieving the objectives of EU directives (could be presented more an opportunity rather than burden). Find compromises among communities, sectors.	Willingness for cooperation of all Municipalities in the Vipava catchment area with all tributaries. Limited jurisdictions.	All municipalities should have one representative in the WG. Resources needed for implementation and operation of WG could potentially be provided from involved Municipalities.
Regional development agency		Managerial – with organizing a group (capacity of the group manager to make people in the group agree).	Ra ROD or RDA of Northern Primorska Ltd Nova Gorica could animate the WG and also organise the meetings (session).
Households (inhabitants)	Giving initiatives for the development to Municipalities (Bottom-up approach / public participartion in decision-making)		
Farmers	Giving initiatives for the development to Municipalities (Bottom-up approach / public participartion in decision-making)		
Tourism	Giving initiatives for the development to Municipalities (Bottom-up approach / public participartion in decision-making)		
Industry	Giving initiatives for the development to Municipalities (Bottom-up approach / public participartion in decision-making)		
Civil society (NGOs)	Giving initiatives for the development to Municipalities (Bottom-up approach / public participartion in decision-making)		

WMO 2: Awareness campaign focused on educating experts involved in surface water management for sustainable water management (impacts of their actions)

Overall description of the WMO

Short explanation	An awareness campaign would be launched to increase awareness of experts, involved in water management (concessionaires for river management) to use more sustainable techniques when designing interventions on watercourses. The campaign would also increase awareness of experts on impacts of the effects of hydromorphological pressures (inadequate implementation of construction works). Awareness campaign would be carried out in cooperation with experts in the field of ecology.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Water management.
Benefits	Increased knowledge exchange and cooperation among experts, involved in water management, aiming to resolve challenges of floods, water availability and water quality more efficiently.
Potential negative impacts	None.
Timeline of implementation	Short (under 5 years' time).
Feasibility	Minor obstacles – willingness of experts to participate, also capacity of the person leading the awareness campaign to design a quality program/process that will persuade experts to actively participate.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost towards year 2030: 226,277 euros (EUR 2018, discount rate: 5%) comprises of preparation and managing a communication strategy, creating a website and the database, publish 2 publications on best management practices, to perform scientific review and analysis.
Synergies and conflicts with policy objectives	Conflicts between the objectives of nature conservation policies (practices) and economic development (hydropower plants, water use).
Acceptance	High (There is not significant reason a priori for anyone to reject the option.).
Suggested stakeholder involvement	Ministry responsible for the environment together with Institute for Water of the Republic of Slovenia as Institution leading the awareness campaign. Involved institutions: in the field of water management, nature conservation, ecology, and forestry and spatial planning. Possible cooperation with existing associations in the field of water protection and management: e.g. Slovenian Association for Water Protection (Slovensko društvo za zaščito voda (SDZV)). Integrating the experience / knowledge of elderly inhabitants. Faculty of Civil and Geodetic Engineering.
Preconditions for success	Funds available for implementing WMO. Experts interested in cooperation/involvement in awareness campaign activities.
Concrete examples where applied	Slovenian River Restoration Centre ("Slovenski center za obnovo vodotokov").

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	Article 14 – informing and consulting all interested parties in the implementation of the WFD, in particular in the production, review and updating of the river basin management plans. Member States shall ensure that, for each river basin district, they publish and make available for comments to the public, including users	
Floods directive 2007/60/EC	Article 9 – WMO can contribute to take appropriate steps to coordinate the application of this Directive and that of Directive 2000/60/EC focusing on opportunities for improving efficiency, information exchange and for achieving common synergies and benefits having regard to the environmental objectives laid down in Article 4 of Directive 2000/60/EC	
Horizon 2020	Partially could support the implementation of this WMO – for steps 2 and 3 of WMO (research on existing practices of watercourse management) as it represents a research to support measures/knowledge on any significant water management issues. Group: Societal challenges / 12. Climate action, environment, resource efficiency and raw materials / 14. Secure societies – Protecting freedom and security of Europe and its citizens Group: Spreading excellence and widening participation (no. 15)	First WMOs in 2018 – not optimal period (programme ends in 2020)

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment		Limited financial capacities and understaffing.	
Slovenian Environmental Agency			Ensuring expert support.
Institute for Water of the			Proposing to lead awareness campaign.

Republic of Slovenia			
The Institute of the Republic of Slovenia for Nature Conservation			Ensuring expert support.
Administration of the Republic of Slovenia for Civil Protection and Disaster Relief			Ensuring expert support.
Water management companies	With concessions they are responsible for maintenance of water infrastructure and aquatic and riparian land (concessionaires).	Willingness for cooperation.	Voluntary participation.
Slovenian Association for Water Protection	Upgrading state-of-the-art knowledge on existing practices on watercourse management.	Willingness for cooperation.	Voluntary participation.

WMO 3: Awareness campaign focused on optimizing water use for farmers, for proper irrigation and minimize impacts on water quality through proper agricultural practices

Overall description of the WMO

Short explanation	An awareness campaign would be launched to increase awareness among farmers to: 1) move towards a sustainable agricultural production, to optimize water use and reduce the use of fertilizers and plant protection products;2) irrigate agricultural land in more sustainable way with the help of decision support system (optimal, targeting the type of crop and soil type) that can result also in reducing pollution of surface and groundwater caused by washouts of nutrients, fertilizers and plant protection products; 3) use climate-smart agriculture practices and 4) to minimize the effects of hydromorphological pressures by avoiding or adjusting cultivating land near watercourses (in protected zones of watercourses).
Addressed challenges	Water availability during droughts (A), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Agriculture, water supply sector.
Benefits	Higher knowledge transfer aiming to decrease negative impacts of agriculture on water quality and quantity.
Potential negative impacts	Possible loss of agricultural production.
Timeline of implementation	Short (under 5 years' time).
Feasibility	Minor obstacles – willingness of farmers to participate.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost towards year 2030: 316,408 euros (EUR 2018, discount rate: 5%) comprises of preparation and managing a communication strategy, costs of meetings, workshops, publication (5 in total) and travel costs.
Synergies and conflicts with policy objectives	Synergies with Water Framework Directive and River basin Management Plan (NUV I). No known conflicts.
Acceptance	High (There is not significant reason a priori for anyone to reject the option.).
Suggested stakeholder involvement	Leading the awareness campaign – proposing experts from University of Ljubljana, Biotechnical faculty, Department of Agronomy in close cooperation with Agricultural Institute of Slovenia and Ministry responsible for agriculture with Chamber of Agriculture and Forestry of Slovenia (CAFS) - Regional unit Nova Gorica, their agricultural advisory service. Experts from University are actively involved in irrigation projects already carried out and are part of so-called existing Working group for or the development of irrigation in Slovenia till 2020.
Preconditions for success	Active involvement of all local farmers.
Concrete examples where applied	Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS) Supportive towards measure. KGZS already organizes trainings and advisory through regional units. Farmers who apply for Agri-Environment Climate Measures must attend training.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Council Directive 91/676/EEC (Nitratna direktiva)	Article 4: paragraph 1. (b) set up where necessary a programme, including the provision of training and information for farmers, promoting the application of the code(s) of good agricultural practice.	
CAP/European Agricultural Fund for Rural Development (EAFRD)[360]	1: efficient, responsible and sustainable use of water resources in agriculture: only indirect links to Significant Water management Issues (SWMIs); cooperation and irrigation/water savings possible (Art. 17 investments, linked to irrigation). Sub measure M1.2 - support for demonstration activities and information activities. 2: ensuring that agricultural activities help/do not represent a constraint/to achieve GES and goals of the WFD: organic pollution (animal feeding/breeding lots), nutrient pollution (diffuse emissions from agriculture, animal feeding/breeding lots), hazardous substances pollution (diffuse sources from agriculture), hydromorphological alterations (reconnection of wetlands/floodplains). (Art. 28 agri-environment-climate payments and Art. 29 organic farming cover the complex issue of interlinked water, soil and biodiversity elements linked to agricultural diffuse sources; Art. 30 payments covered for areas under strict protection). 3: implementation of the ecosystem-based approach when addressing challenges linked to climate change: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 18 "restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions" .	

[360] ICPDR, 2015: Annex 15: Financing the Joint Programme of Measures of draft The Danube River Basin District Management Plan – Update 2015 International Commission for the Protection of the Danube River / www.icpdr.org

Name of policies *(examples)*	**Opportunities**	**Barriers**
	4: restoration of natural water cycle and of fresh water ecosystems and ambient ecosystems: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 17 investments in non-productive physical assets, such as achieving biodiversity conservation status of species and habitat as well as enhancing the public amenity value of a Natura 2000 area or other high nature value systems).	
Horizon 2020	Partially could support the implementation of this WMO – for steps 2 and 3 of WMO (review and preparation of a report of existing agricultural practices as technical guidelines) as it represents a research to support measures/knowledge on any significant water management issues. Group: Societal challenges / 12. Climate action, environment, resource efficiency and raw materials Group: Spreading excellence and widening participation (no. 15)	
National Adaptation strategy for forestry and agriculture (2008)[361] and its implementation document (Action plan from 2011)	Pillar II: Education, awareness and counselling. Measures that are already in place and are planned in future: 7. Raising awareness of farmers of the impact of climate change on agriculture with the program of Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS), also various publications, brochures and leaflets as well as the media.	

[361] http://www.mkgp.gov.si/fileadmin/mkgp.gov.si/pageuploads/podrocja/Kmetijstvo/Naravne_nesrece/Akcijski_nacrt_za_leti_2010_in_2011__1_.pdf

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure. Helping to adapt agriculture to climate changes.		
Ministry responsible for agriculture	Supportive towards measure		
Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS)	Supportive towards measure. KGZS already organizes trainings and advisory through regional units. Farmers who apply for Agri-Environment Climate Measures must attend training.		
Slovenian Forest Service			
Farmers	All farmers who use mineral fertilizers are obliged to make nutrient balances and farmers who participate in AgriEnvironment Climate Measures.	Willingness of farmers to participate.	Likely farmers need financial incentives - an incentive to voluntarily adopt less polluting technologies.
Civil society (NGOs)	Supportive towards measure		

WMO 4: Awareness campaign for local public on impact of their activities on the river

Overall description of the WMO

Short explanation	An awareness campaign would be launched to increase awareness of the general public on the impacts of biological, chemical, hydrological and morphological pressures (due to legal and potential illegal water abstractions and impoundments of water, inadequate interventions in the riverbed), biological pressures (due to introduction of non-native (animal and plant) species into the environment), impacts of various pollution sources, etc. Topics that need to be considered: • water related challenges in Slovenia, focusing on Vipava RB, including climate changes, ○ needs (different water users), conflicts (between users), constrains that need to be considered (floods, Natura2000 sites, waterprotection zones) in Vipava RB. • couse/effect relation (different pressures or modifications in relation to their impacts; mitigation measures planning); ○ impact of the hydromorphological pressures on aquaric, riparian ecosystems, ○ impacts of non-native species on aquatic, riparian ecosystems, ○ impacts of various pollution sources on water quality.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Local population (domestic), Tourism
Benefits	Higher knowledge transfer aiming to decrease negative impacts of different pressures on water quality and quantity.
Potential negative impacts	None.
Timeline of implementation	Short (under 5 years' time).
Feasibility	Minor obstacles – willingness of local public to participate.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost towards year 2030: 187,052 euros (EUR 2018, discount rate: 5%) comprises of preparation and managing a communication strategy, preparation of a documentary film, preparation and setup of 9 information panels and travel costs.
Synergies and conflicts with policy objectives	Synergies with Water Framework Directive and River basin Management Plan (NUV I) and Floods Directive. No known conflicts.
Acceptance	High (There is not significant reason a priori for anyone to reject the option.).
Suggested stakeholder involvement	Ministry responsible for the environment together with Institute for Water of the Republic of Slovenia as Institution leading the awareness campaign, some suggestions also that National Education Institute of the Republic of Slovenia would lead the awareness campaign. Help of Municipalities, The Institute of the Republic of Slovenia for Nature Conservation and Slovenian Environmental Agency (ARSO). Involved institutions: in the field of water management, nature conservation, forestry and spatial planning.
Preconditions for success	Funds available for implementing WMO. Local public, especially schools interested in active cooperation/involvement in awareness

	campaign activities.
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	Article 14 – informing and consulting all interested parties in the implementation of the WFD, in particular in the production, review and updating of the river basin management plans. Member States shall ensure that, for each river basin district, they publish and make available for comments to the public, including users	
Decree on the river basin management plan for the Danube Basin and the Adriatic Sea Basin[362]	Similar to measure DUPPS1: Information, awareness and education professionals and the general public about water management	
Environmental protection Act Zakon o varstvu okolja (Uradni list RS, št. 39/06 – uradno prečiščeno besedilo, 49/06 – ZMetD, 66/06 – odl. US, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09– ZPNačrt-A, 48/12, 57/12, 92/13 in 56/ 15)	Article 144. Eco Fund, Slovenian Environmental Public Fund - encourages promotion of various forms of education and public awareness.	
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent	

[362] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ODLO1596

Name of policies *(examples)*	**Opportunities**	**Barriers**
	enormous challenges to the MED area.	
Horizon 2020	Societal challenges / 12. Climate action, environment, resource efficiency and raw materials / 14. Secure societies – Protecting freedom and security of Europe and its citizens Spreading excellence and widening participation (no. 15)	First WMOs in 2018 – not optimal period (programme ends in 2020)

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Helping to implement objectives of WFD.	Understaffing.	Can help raise awareness among public.
Slovenian Environmental Agency			Ensuring expert support. Can help raise awareness among public.
Institute for Water of the Republic of Slovenia	Supportive towards measure.		Proposing to lead awareness campaign.
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure.		Ensuring expert support. Can help raise awareness among public.
Municipalities	Supportive towards measure.		Can help raise awareness among public.
Households (inhabitants)	Improving quality of life		
Civil society (NGOs)	Supportive towards measure.		
Education (Primary but also High school teachers)	Supportive towards measure.		To help develop a programme for informing high schools, elementary schools, give support in preparing audio-visual material, to accept and follow programs in schools, help organize field trips.

WMO 5: Improve the system of financing water infrastructure (of aquatic and riparian land)

Overall description of the WMO

Short explanation	Through changes in legislation, this option aims to improve and optimize the system of financing water infrastructure from the national Water fund; with the introduction of dedicated funding to finance measures to help achieve the objectives of water management and RBMP. This option can result in the sustainability of water infrastructure, prevention instead of recovery, sustainable flood protection and higher life quality, reducing the damage caused by floods and droughts to different sectors (meaning also maintenance of water reservoir Vogršček to help prevent damages to the agriculture in growing season).
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B)
Target locations and water uses	Location: River as a whole. Water uses: Water management.
Benefits	Improved status of water infrastructure serving its purpose (lower flood risk, higher water availability, etc.). Achieving the objectives of RBMP (WFD).
Potential negative impacts	None.
Timeline of implementation	Short (under 5 years' time).
Feasibility	Possible minor barriers with sectors that currently receive funds.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 178,610 euros (EUR 2018, discount rate: 5%) comprises of expert analysis, contracts with water users and performance of the obligations and preparation of policy amendments.
Synergies and conflicts with policy objectives	Synergies with Water Framework Directive and River basin Management Plan (NUV I). No known conflicts.
Acceptance	Not known – on October event no concrete answers on this question – possible low acceptance with Municipalities – this WMO would prescribe exactly for what funds should be envisaged. Also due to past experience The energy sector got most of these funds to build hydropower plants.
Suggested stakeholder involvement	Ministry responsible for environment together with users of water infrastructure; Ministry responsible for finances – an initiative must come from Ministry responsible for the environment; in cooperation also with Municipalities Ministry responsible for the environment (Water Sector) together with other ministries responsible for amending proposed policy instruments Local – regional development agencies together with Municipalities
Preconditions for success	Amendment of Financing of Municipalities Act (http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO385) on the basis of expert analysis (Report for measure 4ED, 2013). The initiative must come from Ministry responsible for the environment but it is the Ministry responsible for finances that must amend the Act.
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Floods directive 2007/60/EC	Achieving compliance with objective of Floods Directive – reducing flood risks.	
Financing of Municipalities Act[363]	Municipalities would contribute funds for all the objectives of article 2. of Waters Act; collaboration with Water Fund of the Ministry responsible for environment to set priorities for measures needed for achieving the objectives of water management.	Article 7 would need to be changed accordingly.
Water fund (Article 162 of Waters Act)	Finances the modernization of water reservoirs intended for irrigation of agricultural land, that are government water infrastructure.	WMO costs a lot of money – due to limited financial capacities reconstruction has been delayed.
Waters Act (Zakon o vodah (Uradni list RS, št. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14 in 56/15))	In accordance with the Waters Act it is necessary to conclude an agreement and arrange relations in respect of mutual rights and obligations, use and maintenance of water infrastructure (Article 48).	

identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure.		Initiative to amend Financing of Municipalities Act[364] and relevant policy instruments that affect financing of Water Fund
Ministry responsible for finances			Amendment of Financing of Municipalities Act[365]
Ministry responsible for agriculture			
Slovenian Environmental Agency			

[363] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO385
[364] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO385
[365] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO385

WMO 6: Upgrade and update the existing measurement network for monitoring the state of water environment

Overall description of the WMO

Short explanation	Option aims to upgrade the monitoring network for the state of the water environment as there is a need for a good and representative monitoring of hydrological, biological and water quality-based parameters, possible meteorological and agro-meteorological parameters. This option aims to upgrade also the existing monitoring stations together with establishment of additional ones for water quality and hydrological, meteorological measurements. More representative data can help to better understand the current situation in the Vipava river basin and so improve planning measures to improve the river basin management.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B)
Target locations and water uses	Location: River as a whole. Water uses: Water management, water supply sector, agriculture
Benefits	Improved hydrological data, data on, biological and water quality aimed at better understanding the current situation in the Vipava river basin and so improve planning measures to improve the river basin management.
Potential negative impacts	None.
Timeline of implementation	Medium (between 5 and 20 years).
Feasibility	Minor barriers with finances.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 491,330 euros (EUR 2018, discount rate: 5%) comprises the costs of the planning process, implementation of 1 hydrological station, 8 monitoring stations for water quality (4 for ecological state and 4 for chemical state).
Synergies and conflicts with policy objectives	Synergies with Water Framework Directive and River basin Management Plan (NUV I). No conflicts.
Acceptance	High with local public, local community and Municipalities. Slovenian Environmental Agency has low acceptance for additional monitoring stations (beside already planned/implemented in BOBER project) due to high operational costs of existing monitoring stations. Their objective is only to comply monitoring with WFD requirements.
Suggested stakeholder involvement	Ministry responsible for the environment and its body Slovenian Environmental Agency. Possible involvement of the Municipalities and local communities, The National Laboratory of Health, Environment and Food.
Preconditions for success	Funds available for implementing WMO and later for operational costs (most important).
Concrete examples where applied	In the 2009-2015 period, the Slovenian Environmental Agency of the Republic of Slovenia is carrying out a project called BOBER, which is an acronym for Better Observation for Better Environmental Response (Boljše Opazovanje za Boljše Ekološke Rešitve). (part of a measure in RBMP, NUV I) - http://www.arso.gov.si/o%20agenciji/EU%20sofinancira/ and PUBLICATION (also text in English): http://www.arso.gov.si/o%20agenciji/EU%20sofinancira/Predstavitev%20projekta.pdf (21st September 2015). Municipality Nova Gorica already monitors the water in water reservoir Vogrščček (microbiology).

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	To know the status of watercourses and to determine precise measures for improving status of water environment.	
Horizon 2020	Research to support measures/knowledge on any significant water management issues.	First WMOs in 2018 – not optimal period (programme ends in 2020)

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	To make RBMP more adjusted to small RBs.	Limited financial capacities.	Responsible for establishment of the measure. Active involvement in processes of site selection, implementation of monitoring stations and monitoring.
Ministry responsible for agriculture	To know how much water is available for irrigation – to better plan the development of agriculture.		Participation in processes of site selection, implementation of monitoring stations and monitoring.
Ministry responsible for health/ The National Laboratory of Health, Environment and Food	To improve data on monitoring of rivers – bathing sites.		Participation in processes of site selection, implementation of monitoring stations and monitoring.
Slovenian Environmental Agency	To improve data on monitoring, to get additional data on monitoring for small rivers.		To include the data from new monitoring stations in existing database (data processing) for forecasting extreme events like droughts and floods.
Municipalities	Supportive towards measure - to know the status of watercourses – for possible development of new activities on the watercourses (bathing sites).		Participation in processes of site selection and implementation of monitoring stations.
Civil society (NGOs)	Supportive towards measure		

WMO 7: Setting up monitoring to reduce hydromorphological pressures on aquatic ecosystems

Overall description of the WMO

Short explanation	This option aims to set up monitoring of hydromorphological pressures on aquatic ecosystems to ensure appropriate water management. With this option, more comprehensive data supporting water management regarding pressures will be obtained, meaning legal and potential illegal water abstractions and impoundments of surface water. Verifying actual water consumption at holders of water rights during a period of low natural flows. Verifying of possible illegal abstractions and impoundments.
Addressed challenges	Water availability during droughts (A), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Local population, Tourism, Industry, Agriculture, Forestry , Water management
Benefits	Decrease of hydromorphological pressures on aquatic ecosystems.
Potential negative impacts	Possible negative social impact – no more possible illegal abstractions - increase in costs of water use and crop reduction due to less irrigation.
Timeline of implementation	Short (up to 5 years).
Feasibility	Minor social barriers due to restriction of water use.
Robustness	Yes.
Flexibility	Yes. Water use Is limited with ecological acceptable flow.
Costs	The total discounted cost toward year 2030: 65,507 euros (EUR 2018, discount rate: 5%) comprises the costs of verification of existing water rights, actual water consumption and possible illegal abstractions, costs of measurements and analysis of the results together with preparation of the proposal of measurements for the Government.
Synergies and conflicts with policy objectives	Synergies with water Framework Directive – RBMP; Ecological flows in the implementation of the Water Framework Directive[366] Conflicts: None.
Acceptance	Low acceptance by water users (potential illegal users). High acceptance: Politically and environmental sector.
Suggested stakeholder involvement	Ministry responsible for environment with help of the supporting services, Slovenian Environmental Agency, Institute for Water of the Republic of Slovenia, The Institute of the Republic of Slovenia for Nature Conservation and Slovenian Forest Service. Holders of water rights (hydropower plants – SENG, farmers, etc.), general public (possible illegal abstractors).
Preconditions for success	Funds available for implementing WMO. Need to have reference measuring site so to easily know the cause of lower water flow. Also need to combine with raising awareness among farmers (WMO #3), local population (WMO #4).
Concrete examples where applied	Project part of a yearly programme of IzVRS in previous years: Measurements of the quantity of abstracted water, river flow and determination of Ecological flow in Vipava RB ("Meritve količin odvzema in pretokov vode v Vipavi, določitev Qes-a.").

[366] https://circabc.europa.eu/sd/a/4063d635-957b-4b6f-bfd4-b51b0acb2570/Guidance%20No%2031%20-%20Ecological%20flows%20(final%20version).pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	To set up monitoring of hydromorphological pressures on aquatic ecosystems to ensure appropriate water management and to contribute achieving objectives (Annex V, 1.3.2. Design of operational monitoring)	
Horizon 2020	Societal challenges / 12. Climate action, environment, resource efficiency and raw materials / 14. Secure societies – Protecting freedom and security of Europe and its citizens Spreading excellence and widening participation (no. 15)	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
Ministry responsible for the environment	Achieving objectives defined in national and EU legislation. To get information in-situ.	Limited financial capacities.	Need strong political support.
Ministry responsible for agriculture Slovenian Environmental Agency	To get information in-situ.	Limited financial capacities.	Providing information of existing water users.
Municipalities		Limitation of water use during low flows	
Mandatory Municipal Public Utility Services (Drinking water)		Limitation of water use during low flows	Providing information of existing water users.
Households		Limitation of water use during low flows	
Farmers		Limitation of water use during low flows	
Fish farms		Limitation of water use during low flows	
Industry		Limitation of water use during low flows	
Civil society (NGOs)			

WMO 8: Construction of water reservoirs on the watercourses in the upper part of the RB

Overall description of the WMO

Short explanation	With construction of water reservoirs, high waters can be retained and accumulated in the colder part of the year (e.g. autumn peak of precipitations) in the upper part of the Vipava RB. When high waters occur due to short but heavy rainfall, water retention in the upper part of RB can minimize floods downstream. In the warmer part of the year (spring, summer) accumulated water can represent a water resource for two main purposes: 1) for irrigation of agricultural land and so avoiding agricultural drought and 2) water source in the function of enriching low waters by maintaining environmentally acceptable flow downstream and so avoiding hydrological drought.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B)
Target locations and water uses	Location: Upper part of RB. Water uses: Local population, Tourism, Agriculture, Water management, Fishery
Benefits	Water available for irrigation during droughts, enrichment of low flows, reducing floods downstream
Potential negative impacts	Effect on water quality (affecting structural water quality) , fragmentation of river (aquatic and riparian) ecosystem, sediment continuum
Timeline of implementation	Medium (between 5 and 20 years).
Feasibility	Serious barriers – long processes of placing water reservoirs in spatial plans of involved Municipalities; hard to economically justify the projects of building water reservoirs (e.g. Koševec – already assessed costs at 4.6 mio € without mitigation measures); negative opinion of The Institute of the Republic of Slovenia for Nature Conservation;
Robustness	No.
Flexibility	No.
Costs	The total discounted cost toward year 2030: 18,292,910 euros (EUR 2018, discount rate: 5%) comprises the costs of project documentation, implementation costs with land purchase and operational costs of 4 water reservoirs.
Synergies and conflicts with policy objectives	Synergies with Rural Development Plan 2014-2020, Resolution on the strategic orientations of development of Slovenian agriculture and food industry by 2020 - "Securing you food for tomorrow" (Official Gazette of RS, no. 25/2011)[367], Regional Development Programme of Northern Primorska (Goriška development region) 2014-2020, measure A1P2 (page 237)[368]; not yet confirmed Action plan for the development of irrigation in the RS until 2020[369], Spatial Plan of Municipality Ajdovščina and its amendments (Official Gazette of the Municipality of Ajdovščina, no. 7/1997)[370] Conflicts – Water Framework Directive, RBMP; Life+, Habitats Directive – PUN2000.
Acceptance	High acceptance by agricultural sector (farmers and their advisors). Low or no acceptance by environmental sector (The Institute of the Republic of Slovenia for Nature Conservation).

367 http://www.uradni-list.si/1/content?id=102992
368 RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
369 http://www.mkgp.gov.si/fileadmin/mkgp.gov.si/pageuploads/osnutki/2015/Nacrtnamakanjajuni2015.pdf
370 http://www.lex-localis.info/KatalogInformacij/VsebinaDokumenta.aspx?SectionID=ab488cc7-1cd5-4e9f-aa13-60edfd5cca8b

Suggested stakeholder involvement	Ministry responsible for agriculture together with Municipalities, Ministry advisory service Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units), in close cooperation of Ministry responsible for the environment (also Ministry responsible for defense) and farmers – land owners and potential users of reservoirs.
Preconditions for success	A precondition for the WMO to be implementable is the cooperation of landowners as they have to agree with giving up plots in order to create such reservoirs. Precondition is acceptance of planned reservoirs by of all Spatial Planning Authorities (Slo.: "Nosilci urejanja prostora"), especially Environmental sector (Water, Nature conservation) – SEA and EIA processes! Precondition is also assured funding – determination of financial structure – it is suggested that this reservoirs are multifunctional, not just for irrigation and flood protection, but also for developing eco-tourism, recreation sites, etc.
Concrete examples where applied	Water reservoir Vogršček in the mid-/lower part of Vipava RB in 1980s.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
SI Natura2000 Management (LIFE11 NAT/SI/880)		Possible conflict with the protection objectives relating to the provision of passability (transitivity) of watercourses for aquatic organisms and reducing the hydromorphological pressures.[371]
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy		The construction of water reservoirs on watercourses will affect structural water quality.
Resolution on the strategic orientations of development of Slovenian agriculture and food industry by 2020 - "Securing you food for tomorrow" (Official Gazette of RS, no. 25/2011)[372]	Special attention will be given to investments that will enable the development of innovative technologies and adaptation to climate change.	
Spatial Plan of Municipality Ajdovščina and its	Already planned two water reservoirs, Košivec and Vrnivec.	

[371] http://www.natura2000.si/index.php?id=330
[372] http://www.uradni-list.si/1/content?id=102992

Name of policies *(examples)*	Opportunities	Barriers
amendments (Official Gazette of the Municipality of Ajdovščina, no. 7/1997)[373]*, draft Spatial plan of the Municipality of Ajdovščina, June 2014*[374]		
Ordinance of the municipal spatial plan of the Renče-Vogrsko Municipality[375]		*Article 34. Paragraph 11: The construction of reservoirs for irrigation of agricultural land must be designed locally in order to minimize the impacts on hydrological system, taking into account the conservation of biodiversity and protection of natural features. Designing area of reservoirs should allow ingrowth of the natural ecosystem and allowing the use of other activities.*
Development Programme of Northern Primorska (Gorizia development regions) 2014-2020	Development of irrigation (measure A1P2 (page 237)[376]) Developing and strengthening of deprived areas – Flood protection of the area along the Vipava River – a comprehensive approach (measure A2P1 (page 264) [377])- selection of the optimal project solutions of flood safety measures, which will allow multipurpose use and integration of financial resources across sectors and, consequently, best solutions from a technical, environmental and economic point of view.	Measure A1P2 has some limitations - Before investing resources in the preparation of documentation for the construction of new water reservoirs it is reasonable to verify functionality and optimal utilization of existing irrigation infrastructure (eg. water reservoir Vogršček in the Vipava Valley).
Floods directive 2007/60/EC	Achieving compliance with objective of Floods Directive – reducing flood risks.	
Waters Act	In accordance with the Waters Act it is necessary to conclude an agreement and arrange relations in respect of mutual rights and obligations of users, use and maintenance of water infrastructure (Article 48).	

[373] http://www.lex-localis.info/KatalogInformacij/VsebinaDokumenta.aspx?SectionID=ab488cc7-1cd5-4e9f-aa13-60edfd5cca8b
[374] http://www.ajdovscina.si/javna_narocila_in_razpisi/druge_javne_objave/2014090214435154/
[375] http://www.rence-vogrsko.si/images/stories/obcina/obcinsko_glasilo/2014/Uradne_objave_10-2014.pdf
[376] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
[377] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment			Leads SEA processes
Ministry responsible for agriculture	Supportive towards measure.		
Slovenian Environmental Agency			Leads EIA processes
The Institute of the Republic of Slovenia for Nature Conservation	Not supportive towards measure.		Ensuring expert support in the implementation (for each intervention into the watercourse it is necessary to obtain requirements or guidelines of the Institute; guidelines must be considered in project documentation).
The Fisheries Research Institute of Slovenia			Ensuring expert support in the implementation (for each intervention into the watercourse it is necessary to obtain requirements or guidelines of the Institute; guidelines must be considered in project documentation).
Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS)	Supportive towards measure.		
Regional development agency	Supportive towards measure (Developing local supply and increasing the competitiveness of local products and services on the global market).		
(Municipalities)	Supportive towards measure - possible also to serve other purposes, in particular flood protection, irrigation of agricultural land, tourism and fishing.		
Farmers	Supportive towards measure.		
(Fishery)	Supportive towards measure.		
(Tourism)	Supportive towards measure.		
Households (inhabitants and land owners)		Willingness of landowner to give/sell their land for water reservoirs. There are also problems with mosquitos (possible health hazard) near reservoirs.	

WMO 9: Construction of dry reservoirs

Overall description of the WMO

Short explanation	With construction of dry reservoirs, high waters in the colder part of the year (e.g. autumn peak of precipitations) can be retained till the water flow normalises. Water retention in the upper and lower part of the RB would solve problems with floods downstream. If dry reservoirs would be built along watercourses, this option would represent a more sustainable solution then building dry reservoirs on watercourses.
Addressed challenges	Flood risk reduction (B)
Target locations and water uses	Location: River as a whole. Water uses: Local population, Water management
Benefits	Reducing floods downstream.
Potential negative impacts	Reducing agriculture production where reservoirs would be build (if placed on agricultural land). Depending the location of the dry reservoir – on or along watercourses – possible alteration of morphology of the watercourse.
Timeline of implementation	Medium (between 5 and 20 years).
Feasibility	Minor barriers (placement of the reservoirs in spatial plans, cooperation of landowners, land users and farmers) - more acceptable for environmental sector (The Institute of the Republic of Slovenia for Nature Conservation).
Robustness	Yes.
Flexibility	No.
Costs	The total discounted cost toward year 2030: 5,637,741 euros (EUR 2018, discount rate: 5%) comprises the costs of expert analysis for potential locations for dry reservoirs, preparation of project documentation, implementation costs with land purchase and operational costs of 4 dry reservoirs.
Synergies and conflicts with policy objectives	Synergies with Floods Directive, and in comparison with water reservoirs the dry reservoirs present more suitable solution for Natura2000. Conflicts – possible with WFD (possible alteration of morphology of the watercourse).
Acceptance	Higher acceptance by environmental sector (The Institute of the Republic of Slovenia for Nature Conservation), lower acceptance by agricultural sector (if arable land will be affected).
Suggested stakeholder involvement	Ministry responsible for the environment and its bodies, cooperation of Ministry responsible for defense (Administration of the Republic of Slovenia for Civil Protection and Disaster Relief), Ministry responsible for agriculture together with Slovenian forest service 8ZGS, OE Tolmin, KE Ajdovščina) together with Municipalities (local community) and landowners.
Preconditions for success	A precondition is a good analysis where this dry reservoirs would be placed to achieve desired results (reducing floods downstream). A precondition for the WMO to be implementable is the agreement and cooperation of landowners (farmers, land users, Mandatory Municipal Public Utility Services) as they have to agree with giving up plots in order to create such reservoirs. Funds available for implementation.
Concrete examples where applied	Dry reservoirs Pikol and Pikolud in the Municipality Nova Gorica. Also a local dry reservoir in municipality Renče-Vogrsko (Arčoni pri Renčah) – the Municipality itself manages the reservoir.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Floods directive 2007/60/EC	Achieving compliance with objective of Floods Directive – reducing flood risks.	
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy		Depending the location of the dry reservoir and construction technique– on or along watercourses – possible alteration of morphology of the watercourses.
River basin Management Plan (slo: "NUV II" implementation of the WFD) – in preparation Natura 2000 (PUN 2000)	Measure DUDDS5.2 - Sustainable regulation of the watercourse and flood control reservoirs (dry reservoirs).	Possible conflict with fundamental measure HM8 relating to the provision of good hydromorphological water status (in Slovene: "omejevanje novih ureditev vodotokov" (DUPPS 21))

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure - ensuring greater flood safety for populated areas downstream of the barrier	Limited financial capacities (implementation and maintenance).	Leading SEA procedure. Preparation and adoption of Flood Risk Management Plan (work in progress) where this measure could be potentially included within constructional flood measures. Preparation of national spatial plan (in role of investor).
Ministry responsible for agriculture		Depending on the location of dry reservoir – related to classification of agricultural land (K1, K2).	Involved in SEA procedure.
Slovenian Environmental Agency		Limited financial capacities, understaffing.	Involved in SEA procedure, but also leading EIA procedure. Institution bearing responsibility in the field of water management. Maintenance of the dry reservoirs and monitoring (data acquisition for water management).
Slovenian Forest Service		Depending on the location of dry reservoir – possible negative impact on protective forests and forests with a special purpose.	Involved in SEA/EIA procedure.

The Institute of the Republic of Slovenia for Nature Conservation	If comparing with water reservoirs, dry reservoirs are more acceptable.	Depending on the location of dry reservoir – possible negative impact on nature conservation areas (Natura2000 sites, valuable natural features, ecologically significant area, designated nature protected areas)	Involved in SEA/EIA procedure (by giving nature protection guidelines / nature conservation permit).
Ministry responsible for defence (Administration of the Republic of Slovenia for Civil Protection and Disaster Relief)	Supportive towards measure - ensuring greater flood safety for populated areas downstream of the barrier		Can raise awareness among inhabitants on the benefits.
Municipalities	Supportive towards measure - ensuring greater flood safety for populated areas downstream of the barrier.		Can raise awareness among inhabitants on the benefits.
Households	Ensuring greater flood safety for populated areas downstream of the barrier.		To give/sell land for the barrier.
Farmers	In case of normal water conditions (no floods), agricultural activities are not enabled with continuing crop production.	Willingness of farmers that cultivate land where dry reservoirs accumulate high waters. Dry reservoirs have only one function – reducing floods, no benefit for irrigated crop production. Expected loss of income on arable land.	To give/sell land for the barrier. Need financial initiative (compensation for the loss of income) – usually investor proposes three options: purchase of the land, compensation for the loss of harvest or can get substitution of agricultural land with a suitable one.

WMO 10: Reconstruction of existing water reservoir Vogrščček

Overall description of the WMO

Short explanation	With reconstruction of exsisting water reservoir Vogrščček in the lower part of Vipava RB, this options aims to improve the operation of reservoir Vogrščček and its associated facilities. Good status of water reservoir Vogrščček is the precondition for a well functioning and optimal utilization of the irrigation system. The impact of this option will be more efficient irrigation of agricultural land in lower part of the RB that can prevent agricultural drought, enable cleaner water for irrigation and healthier local food production.
Addressed challenges	Water availability during droughts (A)
Target locations and water uses	Location: Lower part of RB. Water uses: Local population, Tourism, Agriculture
Benefits	More efficient irrigation with minimizing negative impact of drought on agriculture, appropriate water quality for irrigation.
Potential negative impacts	Economically this is an expensive option, but is already planned.
Timeline of implementation	Short (up to 5 years).
Feasibility	Minor barriers (economical)
Robustness	No.
Flexibility	No.
Costs	The total discounted cost toward year 2030: 4,428,486 euros (EUR 2018, discount rate: 5%) comprises the costs of project documentation, implementation and maintenance costs.
Synergies and conflicts with policy objectives	Synergies with Rural Development Plan 2014-2020, Resolution on the strategic orientations of development of Slovenian agriculture and food industry by 2020 - "Securing you food for tomorrow" (Official Gazette of RS, no. 25/2011)[378], Regional Development Programme of Northern Primorska (Goriška development region) 2014-2020 plans within measure A1P2 (page 237)[379]; not yet confirmed Action plan for the development of irrigation in the RS until 2020[380], Conflicts with: /
Acceptance	High acceptance with agriculture sector, also with water sector
Suggested stakeholder involvement	Ministry responsible for environment is with “Conceptual plan” (slo: “projektna naloga” of terms of reference) already in process of public procurement for Reconstruction of barrier Vogrščček and its accompanying facilities. In conceptual plan, project and investment documentation for obtaining a building permit must be prepared (construction works carried by a contractor). Involved should be also Ministry responsible for agriculture, Ministry responsible for defense (Administration of the Republic of Slovenia for Civil Protection and Disaster Relief) and Municipalities (local community).

378 http://www.uradni-list.si/1/content?id=102992
379 RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
380 http://www.mkgp.gov.si/fileadmin/mkgp.gov.si/pageuploads/osnutki/2015/Nacrtnamakanjajuni2015.pdf

Preconditions for success	Funds available for implementing WMO. The main problem is unclarified ownership of the reservoir and its infrastructure between government and the private sector, which, in the past 20 years, has resulted in poor management, improper functioning, lack of operation and maintenance funding. Although formally the owner of the entire system Vogršček (reservoir and irrigation systems) is one (government), we can see that shared ownership between the Ministry responsible for agriculture (irrigation systems - MKGP) and Ministry responsible for the environment (reservoir - MOP) represent the main problem (disagreements) for proper functioning (maintenance)[381]. So the precondition for success would be improved legal framework concerning the ownership, management and financing for maintaining the system (not just reservoir). Reservoir needs to be seen as a part of the whole system.
Concrete examples where applied	In 2013 some refurbishment works (1st phase) took place on the reservoir Vogršček with the objective to ensure the safe operation of the dam.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Rural Development Plan 2014-2020	Funds available for construction of large irrigation systems (reservoir Vogršček is a part of a large irrigation system and reconstruction of extraction facility is a precondition to develop new irrigation systems from reservoir Vogršček)	
Water fund (Article 162 of Waters Act)	Finances the modernization of water reservoirs intended for irrigation of agricultural land, that are government water infrastructure.	WMO costs a lot of money – due to limited financial capacities reconstruction has been delayed.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure	Limited financial capacities	As owner of water reservoir already in process of public procurement for Reconstruction of barrier Vogršček
Ministry responsible for agriculture	Supportive towards measure		
Municipalities	Supportive towards measure		

381 Pintar M., 2011. Sistem Vogršček – izzivi nove ureditve, MVD 2011: http://mvd20.com/LETO2011/R19.pdf

WMO 11: Development of new irrigation systems

Overall description of the WMO

Short explanation	This option develops/implements new irrigation systems, derived from the existing water reservoir Vogrščček or from other planned water reservoirs (e.g. Koščivec, Vrnivec, Svinjščček, Pasji rep). This measure can prevent agricultural drought and consequently reduce the damage caused in the agriculture and consequently, also increase self-sufficiency in food. Also cleaner and more appropriate water for irrigation means reducing the risk of contamination and consequently healthier local food production. The establishment of proper irrigation systems, new technologically more efficient and equipped with proper agrometeorological support with sensors for optimal irrigation, targeting the type of crop and soil, and also reducing water consumption caused by inappropriate irrigation techniques.
Addressed challenges	Water availability during droughts (A)
Target locations and water uses	Location: Upper part of RB. Water uses: Agriculture
Benefits	Increased irrigated crop production and self-sufficiency in food
Potential negative impacts	More intensive agricultural production can lead to deterioration of water quality.
Timeline of implementation	Medium (5 to 20 years)
Feasibility	Minor barriers – involvement of different stakeholders must be assured to implement this option (farmers, landowners, spatial planning stakeholders), also relatively big financial burden.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 22,500,811 euros (EUR 2018, discount rate: 5%) comprises the costs of project documentation, implementation and maintenance costs of new irrigation systems with total area of 3,797 ha.
Synergies and conflicts with policy objectives	Development Programme of Northern Primorska (Gorizia development regions) 2014-2020, measure A1P2 (page 237)[382]; not yet confirmed Action plan for the development of irrigation in the RS until 2020[383], Rural Development Plan 2014-2020 Conflicts: Possible overexploitation of water resources – conflicts with Water Framework Directive - RBMP; Life+, Habitats Directive – PUN2000.
Acceptance	High acceptance with agriculture sector.
Suggested stakeholder involvement	Ministry responsible for agriculture with supporting services of Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units) and Farmland and Forest Fund of the Republic of Slovenia; an initiative must come from municipalities and farmers with interest of using water for irrigation. Also a cooperation of the Ministry responsible for environment needs to be assured as they issue permits.

[382] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
[383] http://www.mkgp.gov.si/fileadmin/mkgp.gov.si/pageuploads/osnutki/2015/Nacrtnamakanjajuni2015.pdf

Preconditions for success	The selected water source must have sufficient water quantities. Cooperation and agreement of at least 80 % of land owners who own land where irrigation systems are planned. There must be clear interest of farmers (cultivating land that would be irrigated) to use irrigation systems and to pay for its usage. Operator of irrigation systems needs to be determined! Funds available for implementing WMO.
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Rural Development Plan 2014-2020	Funds available for construction of large irrigation systems (Measure M4.3)[384]	VAT is not eligible cost.
Development Programme of Northern Primorska (Gorizia development regions) 2014-2020	Planning new irrigation systems (measure A1P2 (page 237)[385])	Before investing resources in the preparation of documentation for the construction of new irrigation systems it is reasonable to verify functionality and optimal utilization of existing irrigation infrastructure (eg. water reservoir Vogršček in the Vipava Valley).
Agricultural Land Act (Official Gazette of RS, Nos. 71/11 - official consolidated text, and 58/12)		The agreement of the owners of agricultural land who hold more than 80% of agricultural land in the area of planned irrigation system (Article 82.)

[384] http://www.program-podezelja.si/sl/prp-2014-2020/ukrepi-in-podukrepi-prp-2014-2020/m4-nalozbe-v-osnovna-sredstva/m4-3-podpora-za-nalozbe-v-infrastrukturo-povezano-z-razvojem-posodabljanjem-ali-prilagoditvijo-kmetijstva/operacija-izgradnja-velikih-namakalnih-sistemov

[385] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
Ministry responsible for the environment			SEA
Slovenian Environmental Agency *Ministry responsible for agriculture*	Supportive towards measure	Limited financial capacities	
Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS)	Supportive towards measure		Supporting farmers in the planning and implementation processes.
Regional development agency	Supportive towards measure.		
Municipalities		This is not the primary task of Municipalities	Can be initiators for future planning of irrigation systems and possibly help with management issues (as part of their public service).
Farmers	Supportive towards measure	Limited financial capacities	Likely need financial incentive.

WMO 12: Reconstruction of existing irrigation systems

Overall description of the WMO

Short explanation	This option aims to replace the current irrigation network from water reservoir Vogršček to arable land. The existing irrigation systems are outdated, inappropriately managed and this results in unsustainable use of water for irrigation (pipes are leaking - loss of water, the lack of pressure in the system, etc.). This measure can prevent agricultural drought and consequently reduce the damage caused in the agriculture and consequently, also increase self-sufficiency in food. Also cleaner and more appropriate water for irrigation means healthier local food production. The establishment of proper irrigation systems, new technologically more efficient and equipped with proper agrometeorological support or modernization of existing irrigation systems with sensors for optimal irrigation, targeting the type of crop and soil, and also reducing water consumption caused by inappropriate irrigation techniques (sprinklers vs drip irrigation).
Addressed challenges	Water availability during droughts (A)
Target locations and water uses	Location: Upper and lower part of RB. Water uses: Agriculture
Benefits	Increased irrigated crop production and self-sufficiency in food. Proper irrigation can reduce water consumption and pollution of groundwater caused by washouts of nutrients, fertilizers and plant protection products.
Potential negative impacts	Possible overexploitation of water resources (known as rebound effect (or take-back effect) that means the reduction in expected gains from new technologies that increase the efficiency of resource use). If irrigation properly in place farmers could choose to cultivate crops that need more water (are usually economically speaking, more profitable).
Timeline of implementation	Short (under 5 years)
Feasibility	Minor barriers – existing irrigation systems need to be reconstructed and this can represent a financial burden for some farmers already struggling with the loss of income due to market situation.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 2,864,605 euros (EUR 2018, discount rate: 5%) comprises the costs of the status analysis, project documentation, implementation and maintenance costs of existing irrigation systems with total area of 1,000 ha.
Synergies and conflicts with policy objectives	Development Programme of Northern Primorska (Gorizia development regions) 2014-2020, measure A1P2 (page 237)[386]; not yet confirmed Action plan for the development of irrigation in the RS until 2020[387], Rural Development Plan 2014-2020 Conflicts: /
Acceptance	High acceptance by the agriculture sector.
Suggested stakeholder	Ministry responsible for agriculture with supporting services of Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional

[386] RRP Severne Primorske, 2015. http://www.ra-rod.si/images/stories/dokumenti/RRP%20Goriske%202014-2020_koncni.pdf
[387] http://www.mkgp.gov.si/fileadmin/mkgp.gov.si/pageuploads/osnutki/2015/Nacrtnamakanjajuni2015.pdf

involvement	units) and Farmland and Forest Fund of the Republic of Slovenia; an initiative must come from municipalities and farmers with interest of using water for irrigation.
Preconditions for success	Funds available for implementing WMO. Establishment of proper system of financing the operation of irrigation systems (possible introduction of counters for water consumption). Commitment of farmers using irrigation systems and paying usage. Establishment of proper operator - active operator of irrigation system that has also expert knowledge on irrigation (requires formal legal arrangement).
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Rural Development Plan 2014-2020	Funds available for reconstruction of irrigation systems (Measure M4.3)[388]	VAT is not eligible cost.
CAP/European Agricultural Fund for Rural Development (EAFRD)[389]	1: efficient, responsible and sustainable use of water resources in agriculture: only indirect links to Significant Water management Issues (SWMIs); cooperation and irrigation/water savings possible (Art. 17 investments, linked to irrigation). Sub measure M1.2 - support for demonstration activities and information activities.	

[388] http://www.program-podezelja.si/sl/prp-2014-2020/ukrepi-in-podukrepi-prp-2014-2020/m4-nalozbe-v-osnovna-sredstva/m4-3-podpora-za-nalozbe-v-infrastrukturo-povezano-z-razvojem-posodabljanjem-ali-prilagoditvijo-kmetijstva/operacija-izgradnja-velikih-namakalnih-sistemov

[389] ICPDR, 2015: Annex 15: Financing the Joint Programme of Measures of draft The Danube River Basin District Management Plan – Update 2015 International Commission for the Protection of the Danube River / www.icpdr.org

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure		Can raise awareness among farmers
Ministry responsible for agriculture	Supportive towards measure	Limited financial capacities	
Municipalities		This is not the primary task of Municipalities.	Can raise awareness among farmers
Farmers	Supportive towards measure	Limited financial capacities. Farmers not well connected between each other although agricultural cooperative association (KZ Vipava) exist, incoherent organization of the existing irrigation fields.	Likely need financial initiative
Civil society (NGOs)	Supportive towards measure		Can raise awareness among farmers

WMO 13: Restoration of Vipava river and its tributaries

Overall description of the WMO

Short explanation	This option aims to restore the functionality of natural aquatic and also riparian ecosystems on Vipava river and its tributaries. Aim of this option is also to start implementation procedures for improvement of ecological status of Vipava River and all the other benefits that comes together with this option such as improvement of hydromorphological elements of river body quality.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole (excluding settlement areas). Water uses: Local population, Tourism, Agriculture, Water management.
Benefits	With restoration of regulated watercourses, the stability and functionality of the natural aquatic ecosystems is established, which enables dynamic stability and biodiversity and so increases the self-cleaning capability of the aquatic ecosystems. With retaining flood waves and prolonging the runoff, flood magnitudes can be reduced downstream. With natural self-cleansing capability, based essentially on the action of microorganisms and plants that can survive in polluted water or soil, and either absorb, break down or neutralize harmful waste substances, water quality is improved or preserved. With capacity of retaining water, this results in natural enrichment of groundwater (raisnig the level of ground water) and also results in natural humidification of the soil. Providing a suitable habitat for animal and plant species that are tied to occasional flooding and so maintaing a favourable status of protected and endangered plant and animal species (Natura 2000 management) and creating conditions for preserving biodiversity of aquatic, riparian and wetland ecosystems. If buffer zones or water margins along watercourses are established they can also slow down the wind and locally prevent wind erosion. Giving the Vipava River and its tributaries more needed space, natural river processes and link between water and terrestrial ecosystems can be restored. In the areas where agriculture prevails, improving habitat and biodiversity, and thus connectivity of ecosystems is important. Increased self-cleaning capacity of the watercourse eases the effects of chemicals (pesticides, insecticides) on aquatic and riparian ecosystems and the quality of water is preserved. Increased retention function of aquatic and riparian ecosystems results in natural humidification of the soil and raised groundwater level.).
Potential negative impacts	Restoration of riparian ecosystems and natural flow needs a lot of space at the expense of agricultural land. Furthermore, when restoring the natural water flow conditions, it can affect hydropower. Contradiction with the WMOs on reservoirs (#8, #9).
Timeline of implementation	Medium (5 to 20 years).
Feasibility	Minor barriers – low acceptance by farmers that cultivate land near watercourses.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 5,868,377 euros (EUR 2018, discount rate: 5%) comprises the costs of the analysis on potential locations of restoration, preparation of project documentation, implementation and maintenance costs of about 16 potential locations on the Vipava River (with a total of 11 km in length) and 7 potential locations on the tributaries (with a total of 11 km in length).

Synergies and conflicts with policy objectives	Synergies with Natura2000, Habitat Directive – PUN2000, WFD – RBMP. Possible conflicts with Natura2000 – some species (slo: "močvirska sklednica" or *Emys orbicularis*) need to have riverbank covered with grass and not trees, bushes (need to be trimmed) – here different maintenance techniques must be adopted (species specifics).
Acceptance	High acceptance by environmental sector (The Institute of the Republic of Slovenia for Nature Conservation). Low acceptance by farmers that cultivate land near watercourses.
Suggested stakeholder involvement	Ministry responsible for environment (support from Municipalities through inter-municipal WG but also from ministry responsible for agriculture and Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units)) with help of the supporting services, Slovenian Environmental Agency, The Institute of the Republic of Slovenia for Nature Conservation and Slovenian Forest Service. Local population – inhabitants with their knowledge and valuable experience need to be involved in planning of restoration.
Preconditions for success	Funds available for implementing WMO (buying land, implementation). Acceptance of farmers to relinquish their farm plots and land owners to sell their land near watercourses. Also spatial planning authorities must give consent for this.
Concrete examples where applied	Life project Ljubljanica Connects ("Ljubljanica povezuje"). Project Kučnica/ Kutscheniza (European Territorial Cooperation, the Operational Programme Slovenia–Austria 2007-2013). Publication on all restored watercourses: http://www.izvrs.si/wp-content/uploads/2013/10/PRIMERI-SONARAVNIH-UREDITEV.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
SI Natura2000 Management (LIFE11 NAT/SI/880)	Vipava Valley (SI3000226) – restoration of the river is envisaged.	There are known sections where the river continuity must not be enabled (small hydropower plant in Prvačina). This is due to the fact that there are Natura 2000 fish species (Barbus plebejus) whose living area is upstream of the hydropower plant dam (in Prvačina). The predatory fish species (Silurus glanis) live downstream of the dam where this Natura 2000 species (Barbus plebejus) are no longer present.
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	Article 4: Member States shall protect, enhance and restore all surface water bodies, for artificial and heavily modified water bodies with the aim of achieving good ecologic status/potential.	
River basin Management Plan (slo: "NUV II" implementation of the WFD) – in preparation	Measure DUDDS5.2 - Sustainable regulation of the watercourse and flood control reservoir (dry reservoirs).	
CAP/European Agricultural	3: implementation of the ecosystem-based approach when	

Name of policies *(examples)*	**Opportunities**	**Barriers**
Fund for Rural Development (EAFRD)	addressing challenges linked to climate change: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 18 "restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions" and Art. 24 "prevention and restoration of damage to forests from forest fires and natural disasters and catastrophic events). 4: restoration of natural water cycle and of fresh water ecosystems and ambient ecosystems: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 17 investments in non-productive physical assets, such as achieving biodiversity conservation status of species and habitat as well as enhancing the public amenity value of a Natura 2000 area or other high nature value systems).	
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.	
European Regional Development Fund (ERDF)	TO 5 (climate change adaptation, risk prevention): ecosystem-based approaches for hydromorphological alterations (reconnection of wetlands/floodplains), possibly nutrient pollution (diffuse pollution from agriculture). TO 6 (protecting the environment and promoting resource efficiency): organic pollution (UWWTP, industrial point sources), nutrient pollution (UWWTP, industrial point sources), hazardous substances pollution (UWWTP industrial point sources), hydromorphological alterations (reconnection of wetlands/floodplains).	
Cohesion Fund (CF)	*Climate change adaptation and risk prevention*:	Only EU Member States with a GNI per capita of less than 90% of

Name of policies *(examples)*	**Opportunities**	**Barriers**
	hydromorphological alterations (reconnection of wetlands/floodplains).	the EU-27 average.
Waters Act (Zakon o vodah (Uradni list RS, št. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14 in 56/15))	Article 14 - 15 m (40 m) width buffer stripes for Rivers of 1^{st} order of width and 5 m width buffer stripes for Rivers of 2^{nd} order. Article 16 – Local community can in order to facilitate the overall water use, decide that the status of natural public water good is established on the part of coastal land of inland waters.	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Help improving or maintaining good ecological status of Vipava river.	Limited financial capacities.	Directing funds from Water fund for implementation of this measure. Already involved in SEA procedures – obtaining permits for implementations of the WMO.
Ministry responsible for agriculture/ Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units)	Healthy (safe) locally produced food.		Can raise awareness among farmers on the benefits.
Slovenian Environmental Agency	Supportive towards measure	No financial/staff capacities. Prevailing mindest that only flood risk management need to be considered.	To help implement other objectives of water management.
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure	No financial/staff capacities	Ensuring expert support in the implementation.
Slovenian Forest Service	Supportive towards measure		Ensuring expert support in the implementation.
Municipalities	Supportive towards measure – possible creating a nature learning paths for sustainable tourism.		Can raise awareness among inhabitants on the benefits.
Households	Healthier living environment.		
Farmers		Willingness of farmers that cultivate land near watercourses and landowners to give/sell land for restoration. In past money was spent for regulating the Vipava River and its tributaries. Now it would be the opposite. Does not make sense.	To give/sell land for restoration.
Civil society (NGOs)	Supportive towards measure – possible creating a nature learning paths for eco-tourism.		Can raise awareness among inhabitants on the benefits.

WMO 14: Restoration of old meanders and oxbows of Vipava river and its tributaries

Overall description of the WMO

Short explanation	This option aims to restore functionality of abandoned (non-functional) natural aquatic ecosystems called meanders and oxbows on Vipava river and its tributaries. The stability and functionality of the natural aquatic ecosystems is established, which enables dynamic stability and biodiversity and so increases the self-cleaning capability of the aquatic ecosystems.
Addressed challenges	Water availability during droughts (A), Flood risk reduction (B), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole (focusing on locations of abandoned meanders that sometimes functioned on the Vipava River). Water uses: Local population, Tourism, Agriculture, Water management.
Benefits	The stability and functionality of the natural aquatic ecosystems is established, which enables dynamic stability and biodiversity and so increases the self-cleaning capability of the aquatic ecosystems. With retaining flood waves and prolonging the runoffs, floods can be reduced downstream. With natural self-cleansing capability, based essentially on the action of microorganisms and plants that can survive in polluted water or soil, and either absorb, break down or neutralize harmful waste substances, water quality is improved. With capacity of retaining water, this results in natural enrichment of groundwater (raising the level of ground water) and also results in natural humidification of the soil. Providing a suitable habitat for animal and plant species that are tied to occasional flooding and so maintain a favorable status of protected and endangered plant and animal species (Natura 2000 management) and creating conditions for preserving biodiversity of aquatic, riparian and wetland ecosystems.
Potential negative impacts	When restoring the natural water flow, it can affect hydropower. Contradiction with the WMOs on reservoirs (#8, #9).
Timeline of implementation	Medium (5 to 20 years).
Feasibility	Minor barriers – low acceptance by farmers that cultivate land near watercourses (still this will not affect their land – all potential areas are covered with forest and landowner is the government.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 1,276,262 euros (EUR 2018, discount rate: 5%) comprises the costs of the analysis on potential locations of restoration, preparation of project documentation, implementation and maintenance costs of about 9 potential locations on the Vipava River and its tributaries.
Synergies and conflicts with policy objectives	Synergies with Natura2000, Habitat Directive – PUN2000, WFD – RBMP. Possible conflicts with Natura2000 – some species (slo: “močvirska sklednica” or *Emys orbicularis*) need to have riverbank covered with grass and not trees, bushes (need to be trimmed) – here different maintenance techniques must be adopted (species specifics).
Acceptance	High acceptance by environmental sector (The Institute of the Republic of Slovenia for Nature Conservation).
Suggested stakeholder	Ministry responsible for environment (support from Municipalities through inter-municipal WG but also from ministry responsible for agriculture and Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units)) with help of the supporting services,

involvement	Slovenian Environmental Agency, The Institute of the Republic of Slovenia for Nature Conservation and Slovenian Forest Service. Local population – inhabitants with their knowledge and valuable experience need to be involved in planning of restoration.
Preconditions for success	Funds available for implementing WMO (implementing the WMO). Money for buying land is not needed as the potential areas for restoration are all in owned by the government.
Concrete examples where applied	Life project Ljubljanica Connects ("Ljubljanica povezuje"). Publication on all restored watercourses: http://www.izvrs.si/wp-content/uploads/2013/10/PRIMERI-SONARAVNIH-UREDITEV.pdf BioMura project (LIFE06NAT/SLO/00006) establishing of old canal distributaries

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
SI Natura2000 Management (LIFE11 NAT/SI/880)	WMO coherent with measure for Vipava Valley (SI3000226) - restoration	
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	Article 4: Member States shall protect, enhance and restore all bodies of surface water, for artificial and heavily modified bodies of water, with the aim of achieving good surface water status.	
River basin Management Plan (slo: "NUV II" implementation of the WFD) – in preparation	Measure DUDDS5.2 - Sustainable regulation of the watercourse and flood control reservoir (dry reservoirs).	
CAP/European Agricultural Fund for Rural Development (EAFRD)	3: implementation of the ecosystem-based approach when addressing challenges linked to climate change: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 18 "restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions" and Art. 24 "prevention and restoration of damage to forests from forest fires and natural disasters and catastrophic events). 4: restoration of natural water cycle and of fresh water ecosystems and ambient ecosystems: possibly	

Name of policies *(examples)*	**Opportunities**	**Barriers**
	hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 17 investments in non-productive physical assets, such as achieving biodiversity conservation status of species and habitat as well as enhancing the public amenity value of a Natura 2000 area or other high nature value systems).	
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.	
European Regional Development Fund (ERDF)	TO 5 (climate change adaptation, risk prevention): ecosystem-based approaches for hydromorphological alterations (reconnection of wetlands/floodplains), possibly nutrient pollution (diffuse pollution from agriculture). TO 6 (protecting the environment and promoting resource efficiency): organic pollution (UWWTP, industrial point sources), nutrient pollution (UWWTP, industrial point sources), hazardous substances pollution (UWWTP industrial point sources), hydromorphological alterations (reconnection of wetlands/floodplains).	
Cohesion Fund (CF)	*Climate change adaptation and risk prevention*: hydromorphological alterations (reconnection of wetlands/floodplains).	Only EU Member States with a GNI per capita of less than 90% of the EU-27 average.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Help improving or maintaining good ecological status of Vipava river.	Limited financial capacities.	Directing funds from Water fund for implementation of this measure. Already involved in SEA procedures – obtaining permits for implementations of the WMO. Here all land planned for restoration is owned by Government.
Ministry responsible for agriculture	Healthy (safe) locally produced food.		Can raise awareness among farmers on the benefits.
Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units)	Healthy (safe) locally produced food.		Can raise awareness among farmers on the benefits.
Slovenian Environmental Agency	Supportive towards measure	No financial capacities. Prevailing mindest that only flood risk management need to be considered.	To help implement other objectives of water management.
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure		Ensuring expert support in the implementation.
Slovenian Forest Service			Ensuring expert support in the implementation.
Municipalities	Supportive towards measure – possible creating a nature learning paths for eco-tourism.		
Farmers		Here all land planned for restoration is owned by Government and willingness of farmers is not a barrier.	
Civil society (NGOs) and local population	Supportive towards measure – possible creating a nature learning paths for sustainable tourism.		Involvement of inhabitants with their knowledge and valuable experience in restoration planning processes.

WMO 17: Reconstruction of stabilizing and transverse constructions from natural stone in the smaller tributaries of Vipava river

Overall description of the WMO

Short explanation	This option aims to reconstruct stabilizing and transverse constructions from natural stone in the smaller tributaries of the Vipava River. These barriers would be in function of slowing down the flow and retention of sediment and woody debris.
Addressed challenges	Flood risk reduction (B)
Target locations and water uses	Location: River Basin as a whole. Water uses: Water management.
Benefits	Reducing floods and flood damages downstream.
Potential negative impacts	Depending on the material and technical solution (height) - if constructions would be passable for water organisms, material as rocks not concrete is used, then no negative impacts.
Timeline of implementation	Short (up to 5 years).
Feasibility	No major barriers.
Robustness	No.
Flexibility	No.
Costs	The total discounted cost toward year 2030: 173,934 euros (EUR 2018, discount rate: 5%) comprises the costs of the analysis of all stabilizing and transverse constructions (weirs) on the smaller tributaries on steep slopes, preparation of the project, implementation and maintenance of potential 12 stabilizing and transverse constructions (weirs) on tributaries of the Vipava River.
Synergies and conflicts with policy objectives	Synergies with Floods Directive. Conflicts: / It depends. If torrents, where migratory fish do not live, river continuity is not obligatory and is not reasonable. Also somewhere this existing constructions will need to be reconstructed to achieve flood safety, for some that would not have this function, could be removed (WMO #13). At this point we do not know locations and best solutions.
Acceptance	High acceptance with water sector and municipalities.
Suggested stakeholder involvement	Ministry responsible for the environment (and its bodies like Slovenian Environmental Agency), support from support from municipalities (local communities), hydrologists, planners, possible in the scope of proposed inter-municipal working group.
Preconditions for success	Funds available for implementing WMO. Analysis on which barriers need reconstruction or are no longer needed and can be removed (as part of restoration option). Need to combine this measure with measures aiming at reducing floods.
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
Draft Spatial plan of the Municipality of Ajdovščina, June 2014[390]	Article 104: Arrangements on watercourses and torrents must be made primarily from natural materials. The natural dynamics of watercourses must be maintained, except for regulations needed for protection against floods and torrential waters.	
Ordinance on Municipal Spatial Plan of the Municipality of Vipava[391]	Article 116: Arrangements watercourses and torrents must be made primarily from natural materials.	
Floods directive 2007/60/EC	Achieving compliance with objective of Floods Directive – reducing flood risks.	
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy		Possible obstacle to river continuity (depending where the constructions would be placed).

[390] http://www.ajdovscina.si/javna_narocila_in_razpisi/druge_javne_objave/2014090214435154/
[391] http://www.uradni-list.si/1/content?id=116221#!/Odlok-o-Obcinskem-prostorskem-nacrtu-Obcine-Vipava

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
Ministry responsible for the environment	Supportive towards measure. To achieve compliance with Floods Directive.	Limited financial capacities.	Directing funds from Water fund for implementation of this measure.
Slovenian Environmental Agency	Supportive towards measure		Responsible for water (regulation) management. This option can contribute to other objectives of water management (flood safety).
The Fisheries Research Institute of Slovenia			Ensuring expert support in the implementation. Institute performs public service activities in the fields of Freshwater fisheries. For each intervention into the watercourse it is necessary to obtain requirements or guidelines of the Institute. Guidelines must be considered in project documentation. The Institute also carries out fish monitoring and holds information on fish species and communities within the area of intervention. These data are the basis for the preparation of the guidelines.
The Institute of the Republic of Slovenia for Nature Conservation			Ensuring expert support in the implementation phase.
Slovenian Forest Service			Ensuring expert support in the implementation phase.
Municipalities	Supportive towards measure as it improves flood safety.		Link between households and the ministry.
Households (inhabitants)	Supportive towards measure as it improves flood safety.		

WMO 19: Improving the system of payment for water used for irrigation

Overall description of the WMO

Short explanation	This option aims to improve the system of payment for water used for irrigation. Water availability would be reflected in the payments that need to be made to allow water being used for irrigation purposes. Two options are proposed: 1. To lower the limit of yearly consumption (from 5.000 m^3 to 2.500 m3) when farmers do not need to pay for actual water use. 2. To increase the level of water reimbursement fee for the use of water for irrigation of agricultural land to the value specified for the irrigation of non-agricultural land (in year 2013 that was 0.0015 €/m^3 for agricultural land compared to non-agricultural land 0.0919 €/m^3).
Addressed challenges	Water availability during droughts (A), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Local population, Agriculture, Water management.
Benefits	By reflecting water availability in pricing, this measure would result in reducing water consumption (from water reservoirs Vogršček, groundwater, surface water), and can also result in providing incentives for more efficient water use, all potentially resulting in reducing impact on aquatic ecosystems (more sufficient quantities of water mean better water quality and ecological status).
Potential negative impacts	Potential conflicts with users of water for irrigation (farmers, inhabitants).
Timeline of implementation	Short (up to 5 years).
Feasibility	Minor barriers – low acceptance of agricultural sector.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 83,895 euros (EUR 2018, discount rate: 5%) comprises the costs of the overall analysis of both proposed options, and the amendments of two regulations (Decree and Decision).
Synergies and conflicts with policy objectives	Synergies: WFD – RBMP. Conflicts: /.
Acceptance	Low acceptance by farmers. High acceptance by water sector and environmental sector.
Suggested stakeholder involvement	Ministry responsible for agriculture with supporting services of Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units), an initiative must come from ministry responsible for the environment and its supportive body Slovenian Environmental Agency.
Preconditions for success	Strong political support/back-up. Review of good practices of the system of payment for water used for irrigation around the world. Also analysis to definite exact figure on (1) changing the limit of yearly consumption (from 5.000 m3 to 2.500 m^3) when farmers do not need to pay for actual water use with assessed impacts of the option and (2) increasing the level of water reimbursement fee for the use of water for irrigation of agricultural land (in year 2013 that was 0.0015 €/m^3 for agricultural land compared to non-agricultural land 0.0919 €/m^3).
Concrete examples where applied	Not available.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Decree on the water fee[392]	Lowering the limit of yearly consumption (from 5.000 m3 to 2.500 m3) when farmers do not need to pay for actual water use.	Lacking analysis that will determine boundaries of yearly consumption giving expected result.
Decision determining the amount of water charge basis for the use of water, alluvial deposits and water areas[393]	Increasing the level of water reimbursement fee for the use of water for irrigation of agricultural land to the value specified for the irrigation of non-agricultural land (in year 2013 that was 0,0015 €/m3 for agricultural land compared to non-agricultural land 0,0919 €/m3).	Lacking analysis that will determine increase of water reimbursement fee that will still be accepted by water users and will give expected result.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
Ministry responsible for the environment	Supportive towards measure	No legal requirement to support WMO.	Need strong political support/back-up.
Ministry responsible for agriculture	Irrigation systems could from raised funds become self-sufficient and financially independent, the funds would be intended only for the operation and not to create benefit		
Slovenian Environmental Agency	Supportive towards measure		
Farmers		Not supportive towards measure as believed this will not solve the problems with water quality and quantity. Also financial burden.	Likely to need financial incentives.

[392] http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED2657
[393] http://www.pisrs.si/Pis.web/pregledPredpisa?id=SKLE9903

WMO 20: Preservation of existing and introduction of new shelterbelts

Overall description of the WMO

Short explanation	This option aims to protect the land against the effects of wind. Shelterbelts would reduce velocity of the strong winds (Bora), and would reduce damage in agriculture caused by this strong bora wind and also would be in function of reducing evaporation and the impact of summer winds on soils (drying, loss of water in soil). Also this vegetation belts represent a habitat for animal species that feed on insects (biodiversity, pest management) - lower consumption of plant protection products and related water pollution (sustainable agriculture). It is important to use native trees species - probably deciduous trees.
Addressed challenges	Water availability during droughts (A), Appropriate water quality (C)
Target locations and water uses	Location: Upper part of the RB. Water uses: Agriculture.
Benefits	Reducing wind damages, reducing evaporation and impact of summer winds on soil. Increasing habitat for animal species – can result in lower consumption of plant protection products and related water pollution (sustainable agriculture).
Potential negative impacts	None.
Timeline of implementation	Short (up to 5 years) – but to fully function, it needs more time so trees can grow…
Feasibility	Minor barriers due to low awareness of farmers, also not available funds for implementation of option.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 1,018,971 euros (EUR 2018, discount rate: 5%) comprises the costs of the preparation of proper policy regulation with the objective to regulate the system of financing the implementation and maintenance of shelterbelts, and its application together with implementation and maintenance of shelterbelts of about 40 km length (on 4 possible locations).
Synergies and conflicts with policy objectives	Synergies: WFD – RBMP, Natura2000 – habitats Directive – PUN2000. Common Agricultural Policy (CAP) – RDP 2014 – 2020. Conflicts: /
Acceptance	High acceptance by environmental sector (Slovenian Forest Service, The Institute of the Republic of Slovenia for Nature Conservation).
Suggested stakeholder involvement	Ministry responsible for agriculture and forestry together with Municipalities and Ministry advisory service Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units) and Farmland and Forest Fund of the Republic of Slovenia. Implementation and maintenance with the help of the experts –ZGS – Slovenian Forest Service. Farmers, local inhabitants.
Preconditions for success	Funds available for implementing and operating WMO. It is essential to determine the operator of shelterbelts. To raise awareness among local inhabitants (WMO #4) and farmers (WMO #3) of the positive effects of shelterbelts and involve them actively in their implementation.

Concrete examples where applied	In the frame of Republic Green plan (1970-1980), shelterbelts (wind barriers) were planted to minimize the impact of bora wind on agriculture. Most of them were illegally removal of already planted shelterbelts by farmers (lack of awareness), only few were left till today (Lokavec).

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
CAP/European Agricultural Fund for Rural Development (EAFRD)	3: implementation of the ecosystem-based approach when addressing challenges linked to climate change: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 18 "restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions" and Art. 24 "prevention and restoration of damage to forests from forest fires and natural disasters and catastrophic events). 4: restoration of natural water cycle and of fresh water ecosystems and ambient ecosystems: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 17 investments in non-productive physical assets, such as achieving biodiversity conservation status of species and habitat as well as enhancing the public amenity value of a Natura 2000 area or other high nature value systems).	
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure		Determination of the operator of shelterbelts.
Ministry responsible for agriculture	Supportive towards measure		Can help raise awareness amongst farmers.
Slovenian Environmental Agency	Supportive towards measure		
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure/ vegetation belts represent a habitat for animal species that feed on insects (biodiversity)		Can help raise awareness amongst farmers and local inhabitants. Ensuring expert support in the implementation.
Slovenian Forest Service	Supportive towards measure		Can help raise awareness amongst farmers and local inhabitants. Ensuring expert support in the implementation.
Municipalities	Supportive towards measure. WMO can help creating a rich cultural landscape that is a good basis for development of sustainable tourism.		Can help raise awareness amongst farmers and local inhabitants.
Farmers	Reduced impacts of Bora wind on crop production.	The land where shelterbelts are planned was already reserved within Republican Green Plan and excluded at the time of land readjustment and is treated as common good (slo: "javno dobro"), so willingness of farmers to give land for shelterbelts is not a barrier but willingness of farmers to take into account changed practices (removing young trees) can present a barrier due to lack of awareness of the importance of shelterbelts for agriculture.	The area was already reserved for planting green windbreaks (shelterbelts) within Republican Green Plan and the area has been already reserved and excluded at the time of land readjustment and is treated as common good (slo: "javno dobro").

WMO 21: Removal of invasive non-native species

Overall description of the WMO

Short explanation	Non-native plant and animal species have a direct impact on the biodiversity of aquatic environment, changing and threating the natural balance of aquatic ecosystems (their functional and structural features). With changing the composition of riparian and aquatic habitats, they degrade ecosystems and so have indirect impact on water quality. Introduction of fish in aquatic systems can affect trophic relationships and set off "trophic cascades" with resulting declines in native species and degradation of water quality[394] (e.g. Common Carp (Cyprinus carpio) feeds by searching through underwater vegetation. This feeding habit uproots plants which muddies the water. This makes it hard for other fish to see and destroys the food and cover for other fish. Also they compete with native species or are their predators, can be vectors of disease to native species). This can be also the case of plant species (e.g. Japanese knotweed threatens native plants and animals by forming dense thickets, blocking routes used by wildlife to disperse). More exactly there are problems with non-native fish species that were introduced by fishermen (fish farming) - for Vipava river it means a biological pressure - 9 non-native fish species were recorded in the project Analysis of biological pressures With measure identification, data collection and removal of invasive non-native species is planned. This measure would be addition to measure of restoration of watercourses in RB to maintain a favorable status of protected and endangered plant and animal species.
Addressed challenges	Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Water management, Nature conservation, Fishery
Benefits	Obtaining data on all invasive non-native species. Reducing number of invasive non-native species and biological pressures.
Potential negative impacts	None.
Timeline of implementation	Medium (5 to 20 years) – to 2030.
Feasibility	Minor barriers – low acceptance with fishery (posing restrictions with fish introduction). Limited success of removal of invasive fish species.
Robustness	Yes.
Flexibility	Yes. (Note: Depending on species – which species, their prevalence, etc.)
Costs	The total discounted cost toward year 2030: 175,921 euros (EUR 2018, discount rate: 5%) comprises the costs of the identification and data collection of invasive non-native species in Vipava RB, determination for which species, the area and the method of removal and disposal is possible, preparing work program of removal of invasive non-native species, choosing the location of the disposal of invasive non-native species, preparing and execution of monitoring programme, execution of removal of non-native species (priority: the Vipava River; duration of the removal approx. 5 years).
Synergies and conflicts with policy objectives	Synergies: with WFD-RBMP, Habitat Directive, Natura2000 – PUN2000, Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species

[394] http://www.fs.fed.us/rm/pubs_other/wo_gtr79-83/wo_gtr79-83_111_120.pdf (page 113)

	No conflicts.
Acceptance	Highly acceptable by environmental sector. Low acceptable by fishermen.
Suggested stakeholder involvement	Ministry responsible for environment with the support of Slovenian Environmental Agency and The Institute of the Republic of Slovenia for Nature Conservation, also cooperation of the Ministry responsible for agriculture and their supporting bodies (Fisheries department - fish species,), Agricultural Institute of Slovenia (KIS, for plant species)). Local inhabitants.
Preconditions for success	Knowing the ecology of all species so that removal is successful, still it is known that removal of these species (especially fish) has limited success.[395] Raising awareness among local people, also including them in the removal of invasive species. Local Slovenian Environmental Agency and The Institute of the Republic of Slovenia for Nature Conservation need to be more involved. Slovenia should adopt National action plan according to Regulation (EU) No 1143/2014.
Concrete examples where applied	Life project – removing Japanese knotweed on Ljubljansko barje: http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/life_ias.pdf

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy	Establishing monitoring systems for the purpose of estimating the values of the biological quality elements specified for each surface water category or for heavily modified and artificial bodies of surface water. In applying the procedure set out below to heavily modified or artificial water bodies, references to ecological status should be construed as references to ecological potential. Such systems may utilise particular species or groups of species which are representative of the quality element as a whole.	
Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species.	Sets out rules to prevent, minimise and mitigate the adverse impact on biodiversity of the introduction and spread within the Union, both intentional and unintentional, of invasive alien species.	Slovenia has no National action plan in place.
EU Biodiversity Strategy to 2020	Protecting species and their habitats, help us combat climate change and adapt to its impacts and contribute to meeting	

[395] http://www.environmentalscience.org/invasive-species

Name of policies *(examples)*	Opportunities	Barriers
	the goals of the EU's resource-efficient Europe initiative. One of 6 priority targets that aim to combat invasive alien species.	
Nature Conservation Act (Zakon o ohranjanju narave (Uradni list RS, št. 96/04 – uradno prečiščeno besedilo, 61/06 – ZDru-1, 8/10 – ZSKZ-B in 46/14))	Terminology/definition for non-native species can be adopted/used from receptive Europe-wide lists	Slovenian legislation does not use the terminology/definition of invasive non-native species[396]. A legal void is also in the protocol of removing invasive non-native plant or animal species that threaten native species, since implementing regulations envisaged by the Nature Conservation Act has not yet been adopted.
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.	
Life + (2014 – 2020)	LIFE Nature & Biodiversity (sub-programme for Environment) - Within the LIFE+ Nature and Biodiversity strand, specific funding is targeted at Biodiversity, a LIFE+ project category for innovative or demonstration projects that tackle wider biodiversity issues. These can range from the creation of green infrastructure, such as species corridors, to climate change adaptation measures and the removal of invasive species.	

[396] http://www.tujerodne-vrste.info/ukrepi/zakonodajni-mehanizmi/nacionalni-predpisi/

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Achieving objectives defined in national and EU legislation. To get information in-situ.	Limited financial capacities, understaffing.	Need strong political support.
Ministry responsible for agriculture		Local fishermen – lower income for local fishermen that introduce non-native fish species.	Can raise awareness among farmers and owners of fish farms.
Ministry responsible for health	Supportive towards measure		Can raise awareness among public and help organise the removal.
Slovenian Environmental Agency		Understaffing (no staff capacities).	Can raise awareness among public and help organise the removal.
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure		Can raise awareness among public and help organise the removal.
Municipalities	Supportive towards measure		Can raise awareness among public and help organise the removal.
Households *Farmers*		Willingness to participate.	Active removal (mostly plant species) Removal of plant species on the agricultural land.
Civil society (NGOs)	Supportive towards measure		Can raise awareness among public and help organise the removal.

WMO 22: Construction of municipal wastewater treatment plants and sewage systems

Overall description of the WMO

Short explanation	Problem of small and dispersed settlements and insufficient sewage systems and municipal wastewater treatment causing pollution (organic, pollution with nutrients and pathogens) of surface and ground water. All municipal wastewater treatment plants (WWTP), also can be implemented as biological WWTP, constructed wetlands for wastewater treatment, etc., depending on the analysis of most suitable treatment technology. Construction of small wastewater treatment plants Lozice, Črnice and other small WWTP in dispersed settlements. Also additional treatment of municipal wastewaters in the areas of bathing waters (in the case of the establishment of eco-bathing).
Addressed challenges	Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Local population, Water management.
Benefits	Reducing burdening waters with pollutants (organic, nutrients, pathogens) and so would result in better water quality (achieving objectives of WFD). Also result in good quality for bathing waters.
Potential negative impacts	None.
Timeline of implementation	Medium (5 to 20 years).
Feasibility	Minor barriers – funds…
Robustness	Yes.
Flexibility	No.
Costs	The total discounted cost toward year 2030: 55,461,147 euros (EUR 2018, discount rate: 5%) comprises the costs of the preparation of the project documentation and implementation with maintenance costs of sewage system for about 26,000 person equivalent and wastewater treatment plants for about 26,300 person equivalent.
Synergies and conflicts with policy objectives	Synergies: with WFD-RBMP, and National legislation regulating water quality (Waters Act and its statutory instruments) and wastewater treatment (Operational programme for the discharge and treatment of urban waste water, etc.) No conflicts.
Acceptance	High acceptance by local population, water sector.
Suggested stakeholder involvement	Municipalities and Operators of public service of collection and treatment of wastewater, local communities, in cooperation with Ministry responsible for the environment. Individuals (where public sewage system is not planned).
Preconditions for success	Funds available for implementing WMO. To raise awareness among inhabitants to replace inappropriate septic tanks (slo: “nepretočnih”) with suitable WWTP.
Concrete examples where applied	WWTP Vipava (central WWTP - trial operation). Still in construction WWTP Vrtojba.

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	**Opportunities**	**Barriers**
Council Directive 91/271/EEC	Determination of priority areas for the construction of sewerage systems and municipal wastewater treatment plants.	
Operational programme for the discharge and treatment of urban waste water	Determination of priority areas for the construction of sewerage systems and municipal wastewater treatment plants.	
European Regional Development Fund (ERDF)	TO 6 (protecting the environment and promoting resource efficiency): organic pollution (UWWTP, industrial point sources), nutrient pollution (UWWTP, industrial point sources), hazardous substances pollution (UWWTP industrial point sources), hydromorphological alterations (reconnection of wetlands/floodplains).	
Cohesion Fund (CF)	*Investment in the water and waste sectors, and the urban environment*: organic pollution (UWWTP, industrial point sources), nutrient pollution (UWWTP, industrial point sources, urban run-off), hazardous substances pollution (UWWTP, industrial point sources, urban run-off).	Only EU Member States with a GNI per capita of less than 90% of the EU-27 average.

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure	Limited financial capacities.	Setting priorities for agglomerations that urgently need sewage system and WWTP (in phase of preparation of new Operational programme).
Ministry responsible for health	Supportive towards measure		Can raise awareness among inhabitants.
The National Laboratory of Health, Environment and Food	Supportive towards measure		Can raise awareness among inhabitants.
Slovenian Environmental Agency			Can raise awareness among inhabitants.
The Institute of the Republic of Slovenia for Nature Conservation	Supportive towards measure		
Municipalities	Supportive towards measure	Limited financial capacities (there are EU funds available but VAT is not eligible cost). Also problems with acquisition of easements.	They are already involved in accordance with their financial capacity.
Households		Difficult to force people to replace inappropriate septic tanks (slo: “nepretočnih”) with suitable WWTP.	Likely need financial initiative.
Civil society (NGOs)			Can raise awareness among inhabitants.

WMO 23: The cultivation of crops that are resistant to climate changes (drought, pests and diseases)

Overall description of the WMO

Short explanation	To cultivate crops resistant to droughts, pests and diseases. Problem of agriculture is that it is not adapted to changes in climate. This measure can reduce water use (irrigation), water pollution (reducing the use of plant protection products) and increase self-sufficiency in food.
Addressed challenges	Water availability during droughts (A), Appropriate water quality (C)
Target locations and water uses	Location: River as a whole. Water uses: Agriculture.
Benefits	Increase self-sufficiency in food. Decrease of negative impact of droughts on agriculture. Reducing impact of unsustainable agricultural practices on water quality. Using old varieties of crops, also new ones, but not using genetically modified organisms.
Potential negative impacts	Possible decrease in profitability of crop production.
Timeline of implementation	Short (up to 5 years).
Feasibility	Minor barriers – some farmers and their advisors believe that better solution for them is irrigation crop production.
Robustness	Yes.
Flexibility	Yes.
Costs	The total discounted cost toward year 2030: 452,957 euros (EUR 2018, discount rate: 5%) comprises the costs of the analysis on the best selection of crop type regarding water requirements, growth phases (when and how long) and soil type, and formation of an experimental center (project documentation, implementation and maintenance) with replacement of maize with sorghum crops on 400 ha.
Synergies and conflicts with policy objectives	Synergies: CAP, WFD Conflicts: /
Acceptance	Low acceptance by farmers due to lower profitability.
Suggested stakeholder involvement	Ministries responsible for agriculture together with their professional services (Chamber of Agriculture and Forestry of Slovenia (CAFS) (Regional units)) and with researchers from agro-meteorological field (ARSO, UNI BF and KIS). Close cooperation with local farmers and agricultural cooperative needs to be guaranteed.
Preconditions for success	Funds available for implementing WMO - compensation for loss of income. Combination with agro-environmental and technological measures. Cross compliance must be assured. Important for this measure would be to make also market analysis - verify the interest of the market for such crops and farmers interest in growing new crops…here it would be preferable also to check the interest of private sector to commit on marketing such crops in their supply chains (to make clear commitments). Raising awareness of farmers.
Concrete examples where applied	Agricultural Experimental Centre Jable (http://www.spletna-stran.info/povezava-8438/Kmetijski-poskusni-center-Jable.html) and Gene bank of Crops (http://www.kis.si/Zacasna_resitev_genske_banke/).

Matching the WMO with the policy basis (Step 2.1)

Name of policies *(examples)*	Opportunities	Barriers
CAP/European Agricultural Fund for Rural Development (EAFRD)[397]	1: efficient, responsible and sustainable use of water resources in agriculture: only indirect links to Significant Water management Issues (SWMIs); cooperation and irrigation/water savings possible (Art. 17 investments, linked to irrigation). Sub measure M1.2 - support for demonstration activities and information activities. 2: ensuring that agricultural activities help/do not represent a constraint/to achieve GES and goals of the WFD: organic pollution (animal feeding/breeding lots), nutrient pollution (diffuse emissions from agriculture, animal feeding/breeding lots), hazardous substances pollution (diffuse sources from agriculture), hydromorphological alterations (reconnection of wetlands/floodplains). (Art. 28 agri-environment-climate payments and Art. 29 organic farming cover the complex issue of interlinked water, soil and biodiversity elements linked to agricultural diffuse sources; Art. 30 payments covered for areas under strict protection). 3: implementation of the ecosystem-based approach when addressing challenges linked to climate change: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 18 "restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions" and Art. 24 "prevention and restoration of damage to forests from forest fires and natural disasters and catastrophic events). 4: restoration of natural water cycle and of fresh water	

[397] ICPDR, 2015: Annex 15: Financing the Joint Programme of Measures of draft The Danube River Basin District Management Plan – Update 2015 International Commission for the Protection of the Danube River / www.icpdr.org

Name of policies *(examples)*	**Opportunities**	**Barriers**
	ecosystems and ambient ecosystems: possibly hydromorphological alterations (reconnection of wetlands/floodplains), organic/nutrient/hazardous substances pollution (through changes in land use intensity or forest cover: Art. 17 investments in non-productive physical assets, such as achieving biodiversity conservation status of species and habitat as well as enhancing the public amenity value of a Natura 2000 area or other high nature value systems).	
Rural development plan (2014-2020)	Possible source – within sub measure M1.2 - support for demonstration activities and information activities.	Eligible costs (M1.2) for organizing and carrying out only training.
The Interreg MED Programme 2014-2020	PRIORITY AXIS 3: MED RESOURCES Protecting and promoting Mediterranean natural and cultural resources - protection of natural and cultural heritage, biodiversity, the development of human activities in coherence with environmental change which represent enormous challenges to the MED area.	
Horizon 2020	Societal challenges / 9. Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bio economy/ 12. Climate action, environment, resource efficiency and raw materials / 13. Europe in a changing world – inclusive, innovative and reflective Societies	First WMOs in 2018 – not optimal period (programme ends in 2020)

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders (examples)	**Stakeholder attitude on WMO** Opportunities	Barriers	**Possible involvement**
Ministry responsible for the environment	Supportive towards measure	Limited financial capacities.	
Ministry responsible for agriculture	Supportive towards measure	Limited financial capacities.	
Agricultural Institute of Slovenia	Supportive towards measure, new jobs.		Ensuring expert support and staff in the implementation.
Municipalities	Supportive towards measure		Can raise awareness among farmers
Chamber of Agriculture and Forestry of Slovenia with Agricultural Advisory Service (KGZS)		Some reluctant to this options as they believe that irrigation is a better option	
Farmers	New jobs	Some reluctant to this options as they believe that irrigation is a better option	
Civil society (NGOs)	Supportive towards measure		Can raise awareness among farmers

4. Pedieos River Basin, Cyprus

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Foreword

Integrating climate change in water management is a priority in Europe, with key supporting pieces of legislation such as the Water Framework Directive (WFD, adopted in 2000), Floods Directive (adopted in 2007), EU Action on Water Scarcity and Droughts and EU Climate Change Adaptation Strategy (adopted in April 2013) (Quevauviller, 2014). Shifting priorities within Europe indicate that climate change is to be increasingly considered in the River Basin Management Plans (RBMPs) developed as part of the implementation of the Water Framework Directive (European Commission, 2012, 2009). The BeWater project, an EU FP7-funded project taking place from 2013 to 2017, responds to the above challenge by promoting dialogue and collaboration between science and society for sustainable water management and adaptation to the impacts of global change. In particular, the BeWater project worked together with four Mediterranean river basins to collaboratively develop river basin adaptation plans in each area. The European Commission's 7th Framework Programme funded the project, which involved 12 consortium members. Close cooperation between the four river basins, including Pedieos as well as Rmel, Tordera, Vipava, and the remaining project partners guided the process of writing the respective river basin adaptation plans. Over the course of the 3.5-year project, the following river basin adaptation plan for the Pedieos river basin has been developed. This basin was selected in view of the need for increased awareness of challenges facing its citizens and the environment due to global changes. The plan that has been developed is thus the result of intense team effort, targeted information gathering, wide stakeholder involvement, critical analysis, and thoughtful planning. The main emphasis of this river basin adaptation plan is on water resources management, as well as the potential economic impacts of global and climatic changes on those resources and the cost of implementing the suggested WMOs. The goal of the adaptation plan is to act as a catalyst for the development of further river basin adaptation plans in the Mediterranean region, as well as across Europe more broadly.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 612385

4.1 Introduction

4.1.1 Context

4.1.1.1 Location of the Pedieos river basin

The Pedieos river originates in the north-eastern hillslopes of the Troodos mountain complex (Figure 1.1), where it has its highest elevation at 1,400 m above sea level. The river basin covers approximately 120 km^2 at the green line in Nicosia, where it flows into the occupied areas of northern Cyprus. The basin has a population of approximately 192,000 inhabitants.

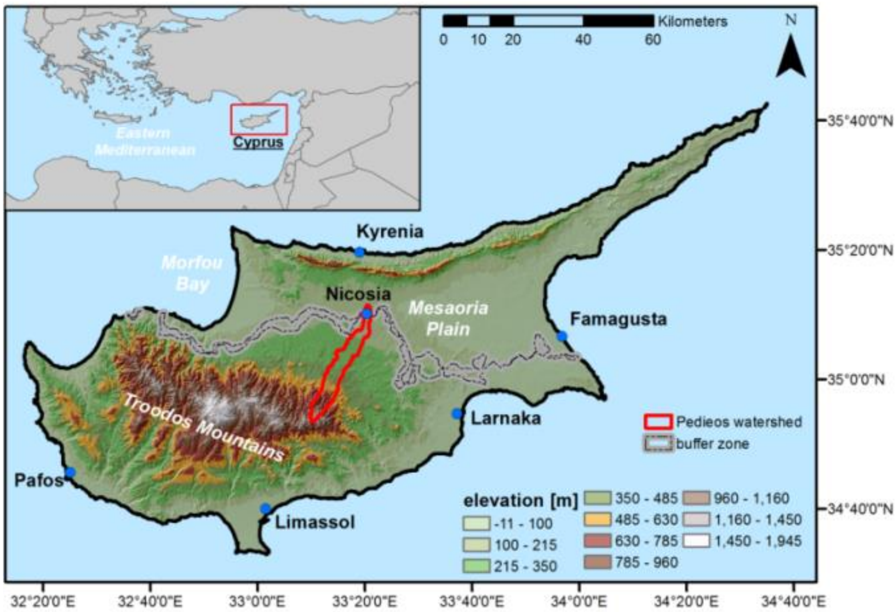

Figure 1.1: Location of the Pedieos River Basin in Cyprus.

At the bottom of the foothills, the Tamassos dam, which was completed in 2002, captures and stores the runoff of the 45-km^2 upstream river basin in a 2.8-million m^3 reservoir (see Figure 1.2). The dam provides flood protection, groundwater recharge through the release of water to the downstream alluvial aquifer, and water supply for nearby communities. Downstream from the dam, the river basin crosses about half a dozen rural communities, which grow rainfed and groundwater-irrigated crops. Barley, fresh vegetables and olives are the most common crops. Irrigation is the largest user of water in the rural areas of Pedieos consuming on average 4.5 Mm^3/year (82%). The island's capital Nicosia and its neighbouring municipalities of Strovolos and Lakatamia form the basin's downstream urban area.

The Pedieos river basin is a dynamic basin that currently faces significant water management challenges. Regional climate models project a drier and warmer Pedieos watershed in the near future that can aggravate the already high pressures on water supply and agriculture.

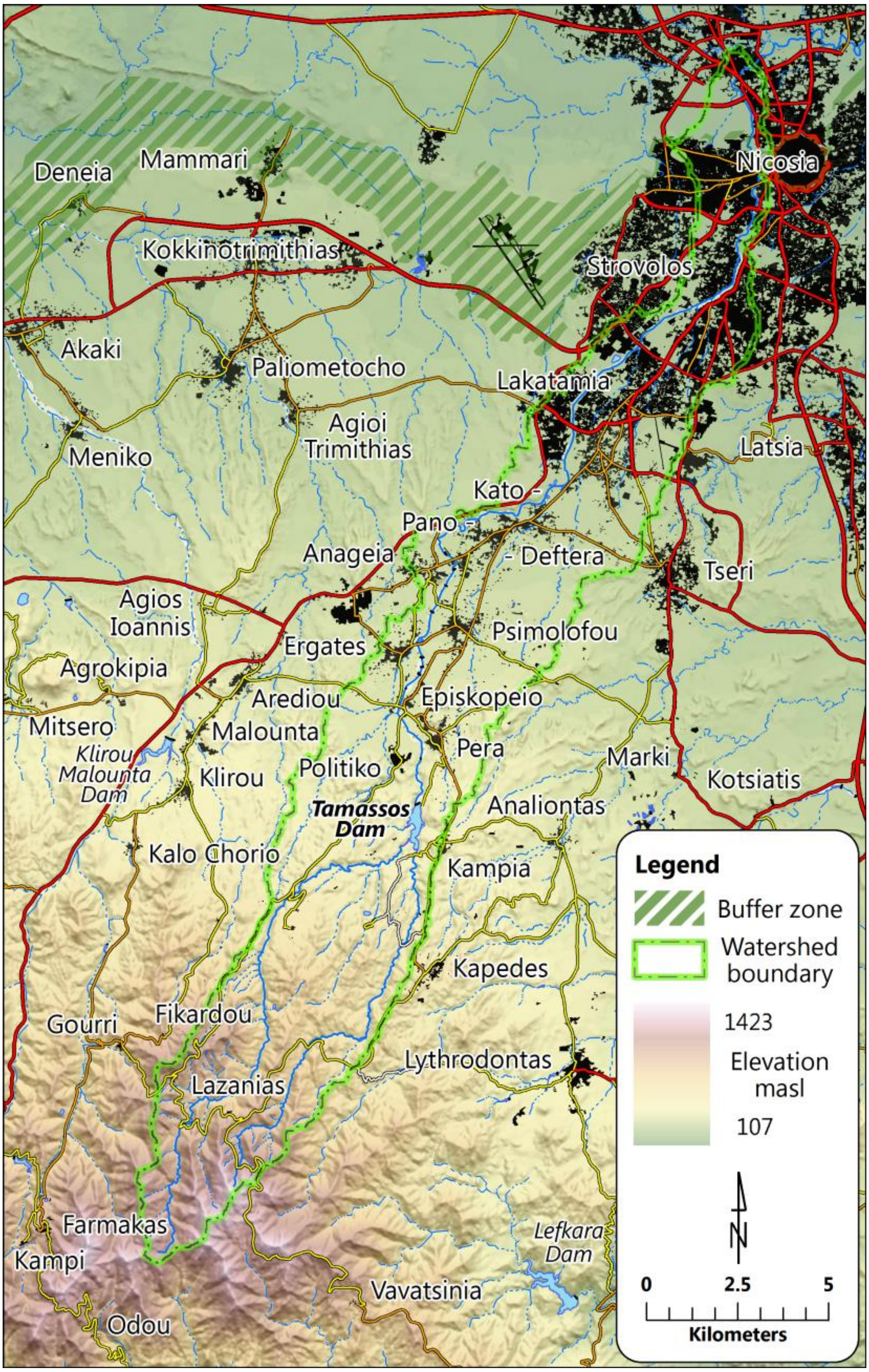

Figure 1.2: The Pedieos river basin; the build-up areas are shown in black, the downstream urban area is located in Lakatamia, Strovolos and Nicosia.

4.1.1.2 Reasons for developing the RBAP

The BeWater project aims to test innovative bottom-up approaches to integrate climate change in river basin management. A key objective of the project is to move away from expert-dominated adaptation planning and towards a process that will support the co-design of adaptation responses by stakeholders and experts. In other words, the RBAP aims to launch a transition from a technologically-focused river basin management approach to a stakeholder-driven planning and

management process that allows a pro-active response to emerging climatic changes and related pressures. Many initiatives across the world have started to integrate climate change in water management at multiple scales. However, few attempts have been made to integrate climate change in river basin management, as is proposed by the BeWater project.

4.1.2 Approach and objectives

Sustainable water management under climate change is an urgent challenge for the Euro-Mediterranean region. Future climate change projections estimate an increase in water scarcity and droughts in the region, causing substantial socioeconomic losses and environmental impacts. Within this context, efforts are needed to strengthen public participation and embed a sense of responsibility within the society concerning water management and adaptation towards these threats. The combination of improved awareness, mutual learning processes and shared responsibility of the civil society and stakeholders are keys to ensuring successful adaptation strategies and their implementation, leading to increased resilience of the social-ecological system of a river basin. BeWater recognizes the crucial role of participation and engagement of a wide group of stakeholders, including civil society, scientists, public administrators (policy makers and implementers, institutional administrations and local governments), water sector actors (e.g. service providers) and other related sectors (e.g. energy). This approach leads to a stakeholder-driven planning and management process that enables a proactive response to emerging climatic changes and related impacts. Therefore the BeWater framework establishes interrelations between the key actors through the project using different forms of participation.

The **specific objectives of the Pedieos RBAP** are:

(a) to raise awareness and motivate action in the river basin, based on a bottom-up approach and a multi-sectoral and multi-dimensional knowledge transfer between science and society;
(b) to support sustainable water use in the long-term;
(c) to analyse and assess adaptation options;
(d) to build adaptive capacity and resilience to climate change based on the engagement of a wide group of stakeholders;
(e) to strengthen capacities and networking and improving governance for climate change adaptation.

4.1.3 Overview of contents

After this introductory section, the structure of the RBAP is as follows. The next chapter provides the background to the river basin and outlines the framework for the development of the RBAP with specific emphasis put on stakeholder engagement. Chapter 3 presents the climate change impacts in the river basin and its dynamics, while Chapter 4 provides information on the water management options selected by the stakeholders.

4.2 The development of the river basin adaptation plan

4.2.1 Living in the Pedieos River Basin

The Pedieos River, similar to the majority of Cyprus rivers, is a non-perennial river, of ephemeral nature that only flows during the rainy winter months or after heavy rainfall events. The river originates in the north-eastern hillslopes of the Troodos mountain complex, where it has its highest elevation at 1,400 m above sea level. The river basin covers approximately 120 km^2 at the green line in Nicosia, where it flows into the occupied areas of northern Cyprus. There are ten communities in the upstream and midstream areas and five municipalities downstream. The basin has a population of approximately 192,000 inhabitants.

The steeply sloping forested upstream area hosts beautiful picnic sites and nature trails and forms an important Natura 2000 site (Department of Forestry, 2012). The fractured volcanic formations in the upstream area are mainly covered by conifers, with smaller areas of sclerophyllous and shrub woodlands and few plots of rainfed cereals, irrigated fruit trees, greenhouses and livestock farms.

At the bottom of the foothills, the Tamassos dam, which was completed in 2002, captures and stores the runoff of the 45-km^2 upstream river basin in a 2.8-million m^3 reservoir. The dam provides flood protection, groundwater recharge through the release of water to the downstream alluvial aquifer, and water supply for nearby communities.

Streamflow data just upstream from the dam, collected by the Cyprus Water Development Department, showed that the largest event in the past 40 years produced 3.1 million m^3 of water in one day! This event occurred on 9 January 1989 and resulted from 57 mm rain over the upstream catchment on the preceding day and 108 mm on the day itself. Considering that there is always water in the reservoir in winter time, an enormous volume of water would have flown through the spillway of the dam. Thus, it is important to manage the water body behind the dam in such a way that sufficient storage is available to protect the nearby communities against floods.

Downstream from the dam, the river basin crosses about half a dozen rural communities, which grow rainfed and groundwater-irrigated crops. Barley, fresh vegetables and olives are the most common crops. Irrigation is the largest user of water in the rural areas of Pedieos consuming on average 4.5 Mm^3/year (82%).

The river then flows into the urban agglomeration of the capital Nicosia and its adjacent municipalities. The Pedieos River in the urban areas of Nicosia is dry most of the year. However, during heavy rainfall events runoff from the surrounding paved areas flows to the river. A total of 38 floods were recorded in urban Nicosia, from 1960 to 2012, of which three were caused by flooding from the river (I.A.CO Ltd, 2011). Natural vegetation that grows in the dry river bed impedes the flow of the water. Garbage and branches that are dragged along by the flood get trapped at the low road crossings over the river, causing water to spill over the road. The Water Development Department has identified the urban area along the Pedieos as an area of potentially significant flood risk, for the European Flood Directive (2007/60/EC).

Along the river, a linear park with cycling path offers a quiet green corridor in the hectic urban environment of Nicosia. Many people visit the park in the early mornings and evenings during summer. Daily maximum temperatures in Nicosia average 37 degrees in July and August. A survey of the park visitors, conducted by intern students of the Cyprus Institute, showed that most people come for exercise or to enjoy nature (Poulou, 2014). The majority of the people indicated that they were happy with the services of the park. The park contributes to environmental awareness and creates an understanding of the functioning of ephemeral streams.

Historical sources indicate the Pedieos River was important for the foundation and growth of Nicosia (Charalambous et al., in review). The river used to replenish the groundwater reserves that served the historical town and its nearby agricultural communities. However, floods occurred in the past too. The most well-known historical flood of 1330 caused the death of 3000 people. Around

1570, the river was diverted northwards around the town. The reasons for this diversion, under debate by various authors, could have been the protection of the city against flood or the supply of water to the moat around the walls (Charalambous et al., in review).

At policy level, the Water Development Department of the Ministry of Agriculture, Rural Development and Environment is authorized to design and implement water policy and water management in Cyprus. The Republic of Cyprus has completely transposed the Water Framework Directive (WFD) to national legislation through the “Water Protection and Management Law of 2004” (WDD, 2004). The strategy of the Water Development Department focuses in a great degree on the protection of the quantity and quality of water resources in order to be able to meet water demand. The Floods Directive 2007/60/EC was harmonized in the Cypriot legislative framework with the Law 70(I) 2010 on the Flood Risk Assessment, Management and Preparedness. The Water Development Department in conformity with the EU guidelines has also elaborated a Drought Management Plan in 2010 (WDD, 2011b).

Several measures are implemented in the Pedieos River Basin (being identical at national, regional and river basin level) and contribute directly and/or indirectly towards the adaptation to climate change impacts on the water resources including:

(a) *water demand measures*: water allocation mechanisms, installation of water supply meters, irrigation water pricing; subsidies for water-saving measures, awareness campaigns (WDD, 2011a; 2011c; 2010)

(b) *water supply measures*: control groundwater exploitation; increase storage capacity; repair and improvement of water distribution networks; use of non-conventional water resources (WDD, 2011a; 2003)

(c) *water quality measures*: the Cyprus River Basin Management Plan includes the regulations and the basic measures that should be implemented in order to attain good ecological and chemical status of fresh and coastal waters by 2015 (WDD, 2011b)

(d) *measures for the protection from floods*: construction of drainage systems to collect stormwater, establishment of riverbed protection zones in several areas located next to rivers, construction of flood protection works such as bridges and retaining walls.

(e) *measures for the protection from droughts*: early warning system based on hydrological indicators, correlation of indicators with thresholds for different drought stages, alert levels to trigger action. According to the level of alert (mild, moderate, high, extremely high), the actions against drought include notification of responsible operators, notification of users for consumption reduction, raising awareness for sustainable water use, increase in desalinated water production, intensive controls of abstractions and leakages, limits to the abstractions from dams.

The Department of Agriculture of the Ministry of Agriculture, Rural Development and Environment is responsible for the implementation of the Common Agricultural Policy (CAP). The current Rural Development Programme (RDP) 2014-2020 provides several incentives to farmers to adapt to challenges stemming from climate change and adopt climate change mitigation and adaption actions. The measures that provide incentives to farmers for climate change mitigation include (DoA, 2014):

(a) Art. 14 *Knowledge transfer and information actions*: soil management; training activities on energy efficiency; reducing GHG emissions; climate change impacts and adaptation

(b) Art. 17 *Investments*: irrigation water use efficiency; green infrastructure; infrastructure for using renewable energy (biogas, solar dry fodder); manure storage facilities; energy-efficient equipment and buildings

(c) Art. 20 *Basic services and village renewal*: climate proofing of local development plans

(d) Art. 21 *Investments in forest area development and improvement of the viability of forests*: afforestation; investments
(e) Art. 28 *Agri-environment climate*: input intensity reduction; manure management; soil management practices; diversified crop rotations; climate-resilient crops
(f) Art. 29 *Organic farming:* reducing energy-intensive production inputs and N_2O emissions from soils
(g) Art. 42-44 *Leader*: Mitigation and adaptation as integral element of Local Development Strategies

4.2.2 RBAP development and stakeholder engagement

Stakeholder engagement has gained prominence in the water sector as a principle of good governance (OECD, 2015). The BeWater project is focused on fostering the dialogue between science and society with the ultimate objective of developing water adaptation plans for the four river basins. This effort included, beyond the participation of stakeholders at precise stages of the project, the setting up of mechanisms of sustained stakeholder engagement all throughout the lifetime of the project. The formulation of the river adaptation plan is the result of a public participation process. It is strongly based on the outcomes of the formulation and evaluation of the water management options as performed by the stakeholders, and the numerous necessary preparatory steps, which occurred in an itinerative manner.

As a first step for the development process of the plan, a comprehensive review of existing river basin (or local/regional) adaptation plans and strategies has been conducted (Davis et al., 2014). Over thirty global examples have been collected as the result of a search, supported by all case study partners as well as additional consortium members. The identification and description of best practice examples provided valuable input to the development and design of the Pedieos River Basin Adaptation Plan. The stakeholder engagement in BeWater comprised several stages of a participatory process where stakeholders actively participated and provided concrete input to the process of water management options formulation and evaluation, as well as adaptation strategies identification. It included: (a) two stakeholder engagement events, professionally designed and facilitated, (b) follow-up interviews to clarify stakeholder input during the workshops and obtain additional information, (c) an additional outdoor stakeholder event focused on gathering opinions on selected water management options from the Pedieos linear park users, (d) two meetings with expert stakeholders focused on the design and validation of a fuzzy cognitive map of the river basin. Finally, there were individual consultation interviews with stakeholders, in order to elicit additional information.

The adaptation plan draws upon significant input from the tasks carried out in the process of management options' formulation and evaluation, carried out during two stakeholder workshops (July 2014, July 2015 The overall objectives of the first stakeholder workshop were: (a) to inform stakeholders on the BeWater project, particularly its case studies, objectives and expected results; (b) to inform stakeholders on what is known about the river basin and what is projected to occur in the following years in the context of climate change (forecast towards 2030); (c) to map specific challenges and issues for the river basin; (d) to clarify objectives for the watershed; (e) to discuss water management options to tackle the identified challenges. The participating stakeholders (20) represented several thematic areas of activity (agriculture, infrastructure, water, environment, energy, forest management), and had various organizational affiliations (business and economy, government and public authorities, civil society, practitioners, media, youth and education). Participants identified a wide range of medium-to-long term challenges for the river basin including water availability, pollution of water resources, agriculture and biodiversity loss. The desired state expressed by participants included water sufficiency (both in terms of quantity and quality) for drinking and irrigation purposes, protection of environment and biodiversity through educational activities, legislation implementation and sustainable recreational facilities. The stakeholders proposed several preliminary options to address these challenges including: fire safety measures; sustainable farming and livestock practices; biodiversity conservation and enrichment with indigenous species from other areas; genetic material bank creation; awareness raising among

local societies; development of educational and leisure activities (i.e., by setting up thematic paths, agrotourism); cooperation between stakeholders; volunteerism; implementation of legislation; use of innovative irrigation systems to contain pollution; playgrounds, walking / cycling paths; rainwater collection system from houses and streets (SVDS); town planning zones to control housing development; preparation of hydrological studies; demolition of the dam; environmental education.

This information was further explored and complemented with 10 additional face-to-face interviews with policy officials to highlight additional river basin-relevant considerations, such as the current situation of adaptation in the region and their experience with public participation in the design of policies and potential conflicts that may appear.

The overall objectives of the second stakeholder workshop were: (a) to collect stakeholders' comments on the formulated water management options; (b) to have stakeholders evaluate the water management options through an on-the-spot multi-criteria analysis. The participating stakeholders (19) represented several thematic areas of activity, with the exemption of the agricultural sector which had a low level of representation. The challenges identified by stakeholders during the first Pedieos stakeholder workshop had been consolidated into three overarching challenges, namely, quantitative and qualitative status of groundwater, quantitative and qualitative status of surface water, and floods. Moreover, based on input collected from stakeholders during the first workshop, as well as from subsequent individual interviews, a number of 30 water management options (WMOs) aimed at tackling these challenges was formulated. In order to evaluate and rank the formulated water management options, a series of 15 criteria were proposed to the stakeholders to use in the multi-criteria analysis. Ten of these criteria were impact assessment factors from the cognitive map and five were characteristics (for more details see Verkerk et al., 2015). The stakeholders' preferences and comments on the selected criteria are presented in detail in Section 4.2. Stakeholders then provided input for the multi-criteria analysis. The relative importance of the criteria was determined by assigning points from 1 to 10 to the selected criteria, with 10 representing the greatest importance, while the value 0 was assigned if a criterion was not considered important. The outcome of the multi-criteria analysis is presented and discussed in the Section 4.2.

The objective of the outdoor public event along the Pedieos linear park bike/walking path, organized in October 2015, was to capture some more general opinions of the suggested water management options from a larger group of stakeholders. In particular, park visitors shared their opinions on 10 selected water management options targeting flooding in the downstream urban areas of the Pedieos River Basin. On average, all selected options were characterized by the visitors as "important" and "very important" for the sustainable management of the river basin. The "restoration and maintenance of riverbed" option received the highest preference value, while the "construction of flood protection works" was the least popular option.

4.2.3 Development of the Pedieos fuzzy cognitive map

To organize and synthesize all the information, Pedieos Case Study team compiled a narrative for the basin. The narrative described stakeholders' beliefs and expectations from the water management in the river basin and consisted of a written and a graphical component. The written component described the context, the status and the challenges of water management in the river basin, while the graphical component, i.e. a Fuzzy Cognitive Map, focused on the functioning of the basin and highlighted the relationships between main drivers, factors and challenges as perceived by stakeholders.

After various discussions among the Case Study team a conceptual map was constructed that represented the key climate change threads (drivers) and the physical systems and processes in the basin. A group of expert stakeholders with different environmental and water management expertise were invited by the Pedieos Case Study team in two meetings to exchange knowledge and opinions on the impact of climate change on Pedieos River Basin and to define and score all relations between the factors of the conceptual map. The stakeholders identified the connections between the factors and qualified the relationships as being positive or negative. Then, for each

identified relationship, they assigned a weight based on their beliefs on the current situation (between -1 for strong negative relationship to +1 for strong positive relationship). More specifically, the scale used for the weights was the following:

+1: strong positive effect
+0.5: medium positive effect
+0.2: low positive effect
0: no effect
-0.2: low negative effect
-0.5: medium negative effect
-1: strong negative effect

The stakeholders were encouraged to express their opinions and add more factors and connections to the system. No factors were added to the map. Once there was a consensus into the factors and the causal relationships, the weights of the relationships were encoded into the adjacency matrix and the factors into the state vector. The initial vector elements were set to 0.5.

After every multiplication, the values of the state vector were normalized by using the sigmoid threshold logistic function.

$$f(x) = \frac{1}{1+e^{-\lambda x}}$$

Where λ>0, is a parameter that determines its steepness. Here, λ was set to 1.

Thus, the impacts of climate change on the Pedieos river basin were determined based on stakeholders' views.

4.2.4 List of engagement activities

Table 2.1 presents the list of engagement activities held in Pedieos River Basin till November 2015.

Table 2.1: List of engagement activities in Pedieos River Basin

Engagement Activity	**Objectives**	**Target group**	**Date(s)**
First stakeholder workshop	– to inform stakeholders on the BeWater project, particularly its case studies, objectives and expected results – to inform stakeholders on what is known about the river basin and what is projected to occur in the following years in the context of climate change – to map specific challenges and issues for the river basin – to clarify objectives for the watershed – to discuss water management options to tackle the identified	20 stakeholders from several thematic areas of activity: – agriculture – infrastructure – water – environment – energy – forest management and various organizational affiliations: – business and economy, – government and public authorities – civil society – practitioners – media	2 July 2014

	challenges.	– youth – education	
Two meetings with expert stakeholders	– to better understand climate change impacts on Pedieos River Basin – to define the steady-state conditions of the fuzzy cognitive map based on stakeholders' views	12 expert stakeholders and CyI researchers with different expertise on: – water – agriculture – biology – climate – infrastructure – energy	24 March 2015 & 31 March 2015
Second stakeholder workshop	– to collect stakeholders' comments on the formulated water management options – to evaluate by stakeholders of the water management options through an on-the-spot multi-criteria analysis.	19 'key stakeholders' representing several thematic areas of activities: – agriculture – infrastructure – water – environment – energy – forest management and various organisational affiliations: – business and economy – government and public authorities – civil society – practitioners	1 July 2015
Outdoor public event along the Pedieos park bike/walking path	– to capture some more general opinions of the suggested water management options from a larger group of stakeholders	84 users of Pedieos linear park	23 October 2015

4.3 Climate change impacts

4.3.1 Current state and future climate change impacts

The Pedieos River Basin receives an average annual precipitation (1980-2010) ranging between 320 mm downstream to 670 mm upstream. Regional climate models indicate a drier and warmer Pedieos watershed in the near future (2020-2050) (Figures 3.1 & 3.2; Camera et al., 2013). In particular, it is projected that maximum and minimum temperatures may increase by an annual average of 1.5 ºC, indicating mainly hotter summers, while winter precipitation may decrease by an annual average of 7% (Hadjinicolaou et al., 2011). Changes in the number of hot days (Tmax ≥ 35 ºC) and tropical nights (Tmin ≥ 22.5 ºC) are also foreseen (Camera et al., 2013). The number of extreme precipitation events is also expected to increase in a warmer future (e.g., Russo and Sterl, 2012). No increases in precipitation extremes were found for Cyprus for three downscaled Regional Climate Models under the A1B scenario for 2020-2050, relative to 1980-2010 (Camera et al, in review). However, these 30-year periods may be too short to identify changes in precipitation extremes. These adverse changes can exert sizeable pressure on water supply and agriculture creating thus negative impacts on the local economy and the living standards of the residents.

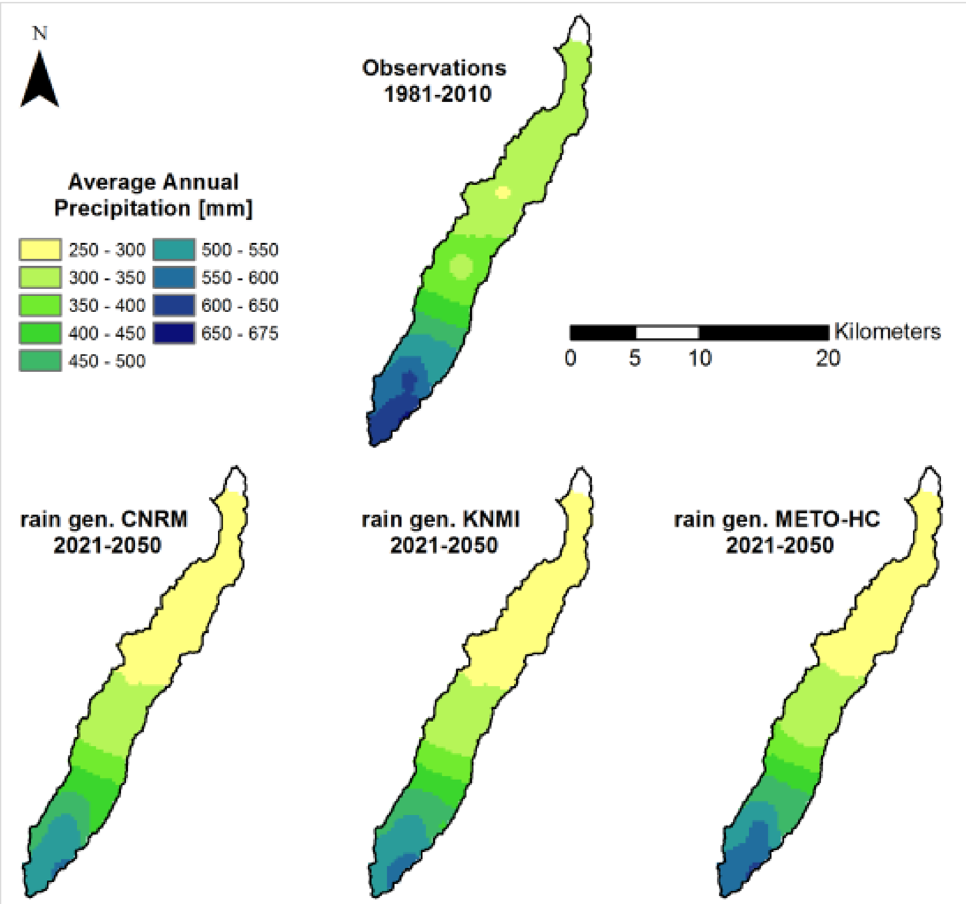

Figure 3.1: Precipitation projections for the period 2021-2050 indicate a drier Pedieos Watershed in the future. *Source: Camera et al., in review.*

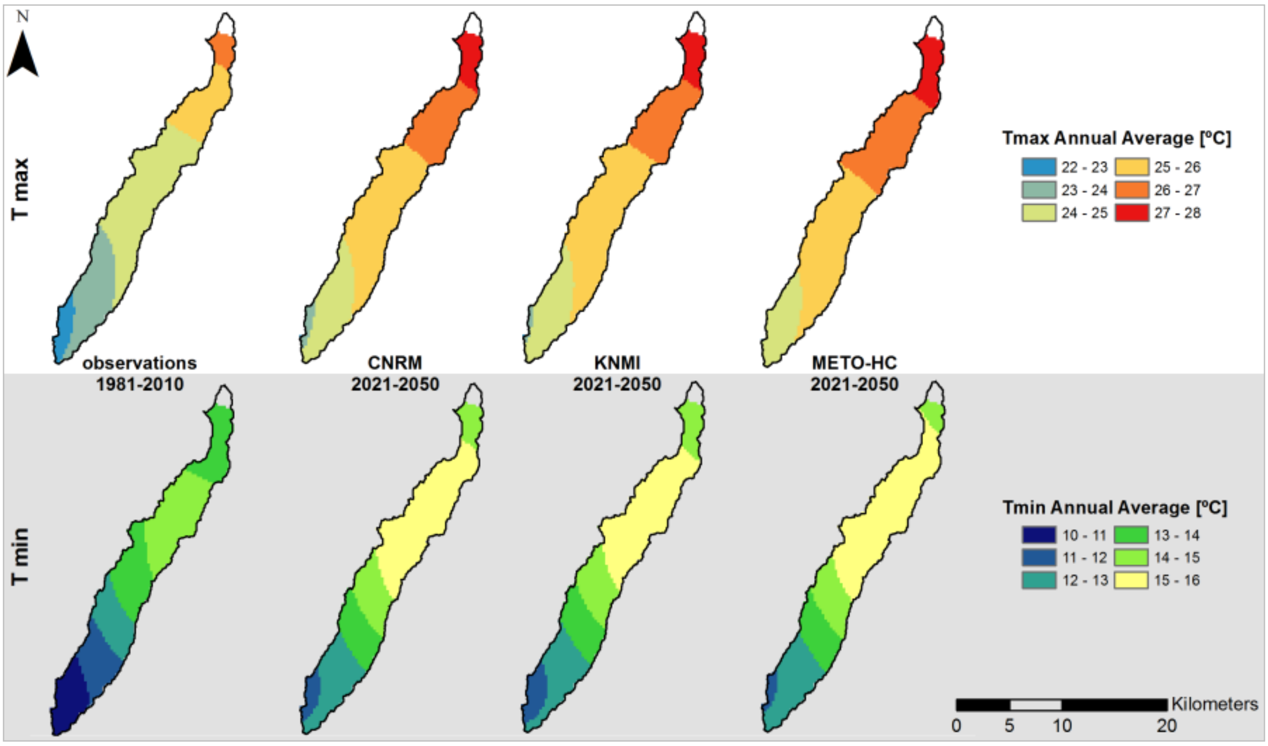

Figure 3.2: Average maximum and minimum temperature projections for the period 2021-2050 show a warmer future for Pedieos Watershed.
Source: Camera et al., 2013.

Population trends and the associated water demand are additional parameters that deserve attention. The population of both urban and rural communities of the Pedieos Basin follows an increasing trend over the past 30 years as shown in Figure 4. The population includes the rural communities Lazanias, Kampia, Politiko, Pera, Episkopio, Anageia, Ergates, Psimolofou, and Pano and Kato Deftera, which have their population centers in the basin. The urban Pedieos communities (municipalities) are Lakatameia with Anthopouli, Strovolos, Nicosia, Engomi and Agios Dometios. Some 94% of the total watershed population is located in urban communities, according to the 2011 Census (Cystat, 2014). Note that the total population of these communities and municipalities is shown. However, the administrative boundaries do not always coincide with the hydrological boundaries. Thus, part of the reported population lives outside the pictured boundaries of the watershed.

According to the UN (2013) medium variant projection, the urban population of Cyprus will continue to grow over the next 35 years, while the rural population will follow a diminishing trend over the period 2015-2050 (Figure 3.4). Based on the annual population rate of change of these projections, the gross domestic water demand for the two population categories was estimated (Figures 3.5 and 3.6). It was assumed that people in urban communities consume 215 l/d per capita and people in rural communities 180 l/d per capita, following the assumptions of WDD (2011). Currently, the annual domestic water demand in urban communities is 15 Mm^3/year and by 2050 is expected to increase by 28%. On the contrary, a 23% decrease by 2050 is expected in rural communities, from the current 0.85 Mm^3/year domestic water demand. It should be noted domestic water supply in urban communities relies on seawater desalination (supplied from outside the watershed), while groundwater and water from the Tamassos dam are the predominant water supply sources for rural communities.

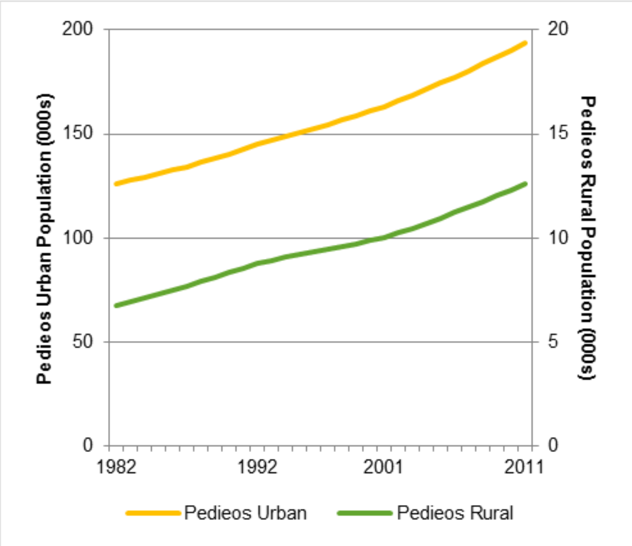

Figure 3.3: Urban and rural population in Pedieos watershed, 1982-2011. *Source: Cystat (2014)*

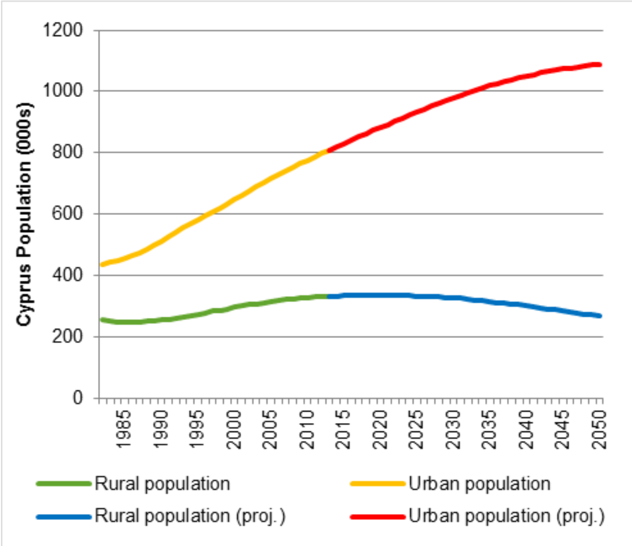

Figure 3.4: Past and projected total urban and rural population in Cyprus. *Source: UN (2013)*

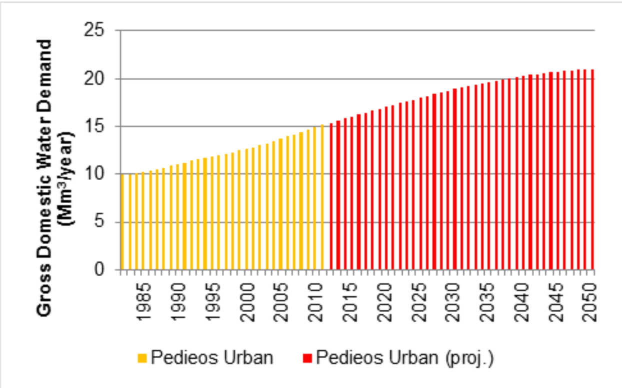

Figure 3.5: Estimated gross domestic water demand in the urban communities of Pedieos watershed (computed by authors, based on WDD, 2011; UN, 2013).

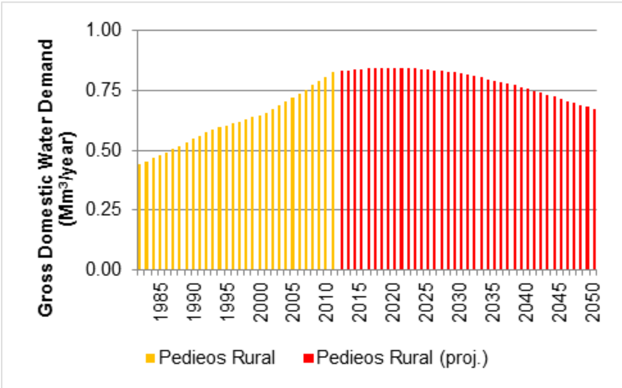

Figure 3.6: Estimated gross domestic water demand in the rural communities of Pedieos watershed (computed by authors, based on WDD, 2011; UN, 2013).

4.3.2 Main challenges and their interlinkages

The challenges identified by stakeholders during the first stakeholder workshop were analysed and consolidated into three overarching challenges that the river basin is facing, namely, quantitative and qualitative status of groundwater, quantitative and qualitative status of surface water and flooding from the river.

Challenge A: *Quantitative and qualitative status of groundwater*

A major challenge identified in the Pedieos River Basin is groundwater quantity and quality. The high temperatures and the increased variability of precipitation leads to an increased irrigation demand that will exacerbate the already high pressures on groundwater resources. A reduction in groundwater quantities will affect irrigated crop production and livestock farms, as well as some of the communities in the midstream area of the Basin that pump groundwater for domestic supply. Overpumping of groundwater lowers the water table and alters how water moves between the aquifers and the stream. Furthermore, overpumping of groundwater can also affect the groundwater quality. The completion of the Tamassos dam at the foothills of the forested Troodos mountains in 2004, has reduced the recharge of the downstream river aquifer. The results of monitoring activities for the European Water Framework Directive have been summarized in the Cyprus River Basin Management Plan and its Annexes (WDD, 2011). The Central and Western Mesaoria groundwater body, which includes the alluvial Pedieos Riverbed aquifer, has been

qualified as having a bad quantitative status for the European Water Framework Directive, with dropping groundwater levels (WDD, 2011; Annex 7, p.243). Similar findings were also reported by Zoumides et al. (2013), based on an analysis of irrigation water use.

Non-point source pollution from agriculture could affect groundwater quality, especially in the rural midstream area of river basin. Croplands are a primary nonpoint source of contamination to groundwater due to the applications of agricultural chemicals such as fertilizers, pesticides and manure. Excess irrigation water applications may also leach agricultural chemicals into groundwater. As a whole, the chemical status of the Central and Western Mesaoria groundwater body has been qualified as good, even though high concentrations of ammonium (NH4) have been found (WDD, 2011; Annex 7, p.243).

Urbanisation has increased the sealed areas in the downstream part of the river basin, which implies modification of the hydrological cycle. However, the situation is complex with both positive and negative effects on the quantitative and qualitative status of the groundwater resulting from reduced groundwater recharge from sealed areas, groundwater pumping for the irrigation of gardens, and leakages from water supply, sewage and drainage networks. The surface runoff from the urban areas of the watershed is drained into the Pedieos River and affects fluvial flooding, but could also incidentally cause increased groundwater recharge.

<u>Challenge B</u>: *Quantitative and qualitative status of surface water*

The adverse climatic conditions (increase of temperature & precipitation decrease) will result in diminished surface water supplies. These changes affect the services and the functions of the Tamassos dam water body, located at the border between the upstream and midstream area of the Basin.

The Tamassos dam provides water supply for the nearby rural communities, but has also created a new aquatic ecosystem and recreational area. Surface water flows downstream from the dam are controlled by the release of water from the dam for downstream groundwater recharge. During wet years water flows over the dam spillway and continuous downstream. A few small recharge checkdams and diversion structures have been constructed in the midstream area to increase groundwater recharge or divert surface water for irrigation. The reduction in surface water quantities will affect the riparian vegetation and biodiversity habitats of the streams as well as irrigated farming.

Similarly to groundwater qualitative status, during peak precipitation events, agro-chemicals from irrigated agriculture and livestock manure are carried away to the river.

Forest ecosystem services have a positive impact on water (groundwater and surface) quality. The ability of forests to generate porous and filtering soils helps to regulate soil erosion and reduce sediment load.

Uncontrolled urban development has led to a significant degradation of riverbed and riparian area. Solid and liquid waste dumping has detrimental effects on the quality of the surface water. Urban sprawl is also a significant factor regarding soil sealing in suburban areas of Pedieos River Basin. Soil sealing contributes negatively to water quality as the rainwater is polluted by concentrations of heavy metals in sealed areas, which when washed into the river degrade its water quality.

<u>Challenge C</u>: *Flooding from the river*

The urban area along the Pedieos River has been identified as an area of potentially significant flood risk. Although the Pedieos River in its downstream part is dry most of the year, heavy rainfall events may lead to significant floods, as indicated by the latest flood risk assessment (WDD, 2014). Natural vegetation across the riverbed impedes the flow of the water, while illegal dumping of garbage is often blocking waterways and causes localised floods and spill overs of water in the roads. The restoration and maintenance of the riverbed was emphasized by the stakeholders (Maes and Dude, 2014).

The forests in the upstream area of the RB help to regulate relatively minor floods although they are not able to prevent major floods. Crop fields in good state have also a positive contribution to flood prevention in the midstream parts of the river basin.

Tamassos dam provides significant flood protection to the midstream and downstream areas of the river basin. The dam modifies the volume of water flowing downstream and alters the natural rates at which rivers rise and fall during extreme runoff events.

The high urban sprawl intensifies soil sealing which increases the risk of flooding. The disturbed land loses its ability to hold soil in place that increases the rate and the volume of runoff. Finally, flooding is partly caused by problems in the rainwater drainage systems in the urban area. Sustainable urban drainage systems are necessary to capture and store surface water run-off and control its release into Pedieos River.

4.3.3 Basin dynamics

The fuzzy cognitive map of Pedieos River Basin is presented in Figure 3.7. Three main climate change threads, namely, precipitation decrease, increase in extreme precipitation events and temperature increase were identified by stakeholders and researchers. These threads affect either directly the aforementioned challenges in the basin (quantitative and qualitative status of groundwater, quantitative and qualitative status of surface water and flooding from the river) or indirectly through several (7) factors across the up-, mid- and downstream areas of the basin. These factors are: forest ecosystem services, riverbed and riparian area ecosystem services, livestock, rainfed and irrigated crop farming, rural communities' water demand and urban runoff. The definitions and the interrelationships between the factors of the basin are presented in detail in Verkerk et al. (2015).

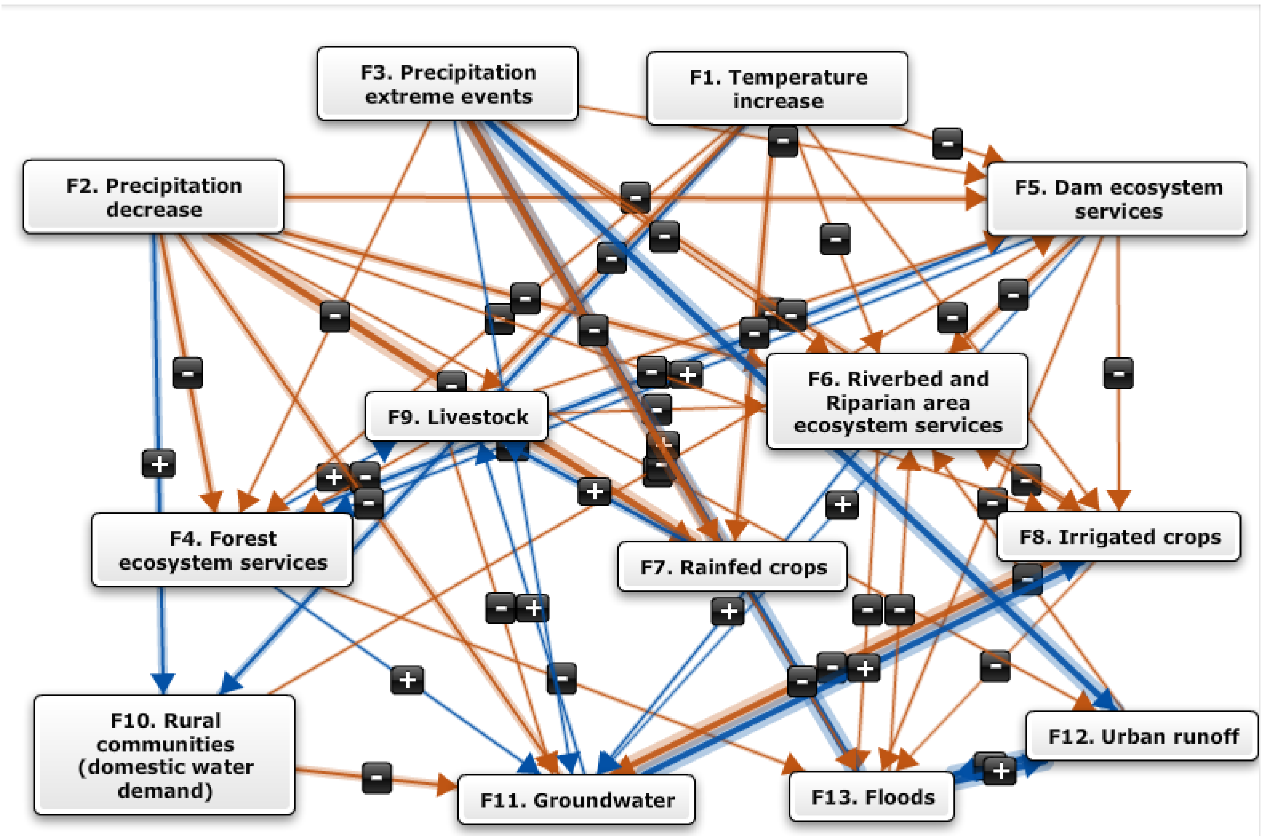

Figure 3.7: Cognitive map of the Pedieos river basin

Precipitation decrease and high temperatures create strong negative effects on ecosystem services provided by forests including the provision of clean water, maintenance of soil quality, wildlife habitat, recreation and a variety of forest products. Forests also help to regulate water flows during extreme rainfall events preventing to some degree flooding. In addition, drought increases forest fire risk since dry trees and shrubs provide fuel to fires, while trees become more vulnerable to pests and diseases.

Precipitation is the major driver for the ecosystem services and functions provided by Tamassos dam water body, such as biodiversity, recreation, water storage and supply. Low precipitation affects the capacity of the dam water body to provide sufficient water supply to the nearby rural communities and to release water for recharge of groundwater resources downstream. Furthermore, the major function of the dam is flood protection during heavy rainfall events.

The rural communities of Kampia, Psimolofou and Episkopio (and Kapedes just outside the basin) receive water from Tamassos (interview with Pera Community leader, March 2014). Anthoupolis, Deftera and Ergates receive water from the seawater desalination plants through the Nicosia Water Board (interview with Deftera Community Leaders, March 2014; Director of Nicosia Water Board, Cyprus Mail, 2013). However, some of the rural communities also pump groundwater for their domestic supply. The urban communities receive their water supply from the Nicosia Water Board. As mentioned above, the water is predominantly supplied from seawater desalination plants outside the basin, through the southern conveyor system.

The low precipitation and the high temperatures impact negatively on the ecosystem services provided by the riverbed and the riparian zone. The degradation of the above services creates negative impacts on the quantity and quality of groundwater resources. Groundwater resources are recharged through the riverbed, while ecosystem services of riparian zones, namely sediment filtering, water storage and release, bank stabilization and provision of habitat for biodiversity, affect positively water quality and water quantity. Furthermore, natural vegetation in the usually dry riverbed and across riparian area impedes the water flow reducing thus flood risk.

Local agriculture is the main user of the basin’s water resources and is significantly affected by climate conditions. Precipitation decrease exerts high pressures on the rainfed crops that rely on rainfall for water, while uncontrolled abstraction of groundwater resources for irrigation impact negatively on both the quantity and quality of groundwater resources. Higher production costs for groundwater-irrigated crops results in a further reduction of farm incomes. The performance and health of livestock is affected by the increase in temperature. This also increases the operational costs (energy and water for cooling) of intensive livestock units.

Although the Pedieos River is dry most of the year in its downstream part, extreme precipitation events increase urban runoff and lead to floods. The rapid urbanisation has increased drastically the sealed land in the suburban municipalities of Pedieos RB. The creation of impervious surfaces (e.g. roads, pavements etc.) results in the decrease of infiltration (groundwater recharge decrease) and an increase in surface runoff. The surface runoff flows through the sewer systems and drains to the Pedieos River, thereby increasing the flooding risk.

4.4 Water management options for the Pedieos River Basin

4.4.1 Identified water management options for the Pedieos River Basin

Based on input collected from stakeholders during the first Pedieos River Basin workshop (July 2014), as well as through face-to-face interviews with policy officials (September - October 2014) and a review of policy documents including the national strategy for adaptation to climate change and other international river basin adaptation plans and strategies, a number of 30 water management options (technical, nature-based, managerial) were formulated.

The water management options (WMO) are listed in the Table 4.1 and described in detail in Verkerk et al. (2015). The options address different challenges in the river basin, i.e., 25 options (83%) address Quantitative and qualitative status of groundwater (challenge A), 24 options (80%) address Quantitative and qualitative status of surface water (challenge B), and 14 options (47%) address Flooding from the river (challenge C). Several options address more than one challenge. To evaluate the options for the different challenges, the main challenge that each option addresses was identified.

Table 4.1: Overview of the identified water management options for the Pedieos River Basin

	Name of WMO	Main Challenge Addressed	All Challenges Addressed
1	Improved irrigation technologies	A	A-B
2	Borehole licences and water meters	A	A
3	Water pricing enforcement	A	A-B
4	Use of treated sewage water for irrigation and green infrastructure	A	A-B
5	Water desalination	A	A-B
6	Farm education	A	A-B
7	Improve plant genetic resources bank and use of drought resistant agricultural crops	A	A-B
8	Dynamic dam water management	A	A-B-C
9	Awareness campaign for local society	A	A-B
10	Agrotourism development	A	A-B-C
11	Domestic water saving equipment	B	A-B
12	Maintenance and repair of water distribution networks	B	A-B
13	Code of Good Agricultural Practices enforcement	B	A-B
14	Grazing control	B	A-B
15	Improve plant genetic resources bank and use of drought resistant forest species	B	A-B
16	Hydrological studies	B	A-B
17	Dam demolition	B	A-B-C
18	Integrated waste management	B	A-B
19	Construction of multi-purpose cycling/walking paths across the river	B	A-B
20	Volunteerism	B	A-B-C
21	Rainwater harvesting systems	C	A-B-C
22	Improve plant genetic resources bank and use of drought resistant plants in green infrastructures	C	A-B-C
23	Fire safety measures	C	A-B-C
24	Improving land zonation	C	A-B-C
25	Improve stakeholders' cooperation	C	A-B-C
26	Restoration and maintenance of riverbed	C	C
27	River runoff retention and groundwater recharge systems	C	C
28	Sustainable urban drainage systems	C	C
29	Construction of flood protection works	C	C
30	Cooperation for storm water drainage system	C	C

4.4.2 Policy and stakeholder basis of WMOs

Annex 1 provides a detailed description of water management options that could contribute to adaptation of water management in the river basin. It also presents the relevant policies and policy instruments that can support the implementation of the water management options as well as the relevant policy actors and stakeholders, and indicates the interest of stakeholders to implement the options and potential commitments/responsibilities.

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Annex 1 Detailed presentation of water management options

WMO1: Improved irrigation technologies

Overall description of the WMO

Short explanation	The installation of modern irrigation systems and technologies, namely irrigation scheduling decision support systems, including wireless sensor network, results in savings of irrigation water.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	The option aims to establish 100 irrigation blocks in the midstream areas of the river basin (downstream from Tamassos dam), where groundwater-irrigated crops prevail (e.g. vegetables).
Benefits	The adoption of irrigation scheduling decision support systems will result in the improvement of the quantitative and qualitative status of groundwater. Positive effects will be also created for irrigated agriculture.
Potential negative impacts	Increase of farm production cost
Timeline of implementation	The option can be functioning on very short term (<5 yrs). The expected lifetime of which irrigation scheduling decision support systems are operational without major rehabilitation is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor physical, technical or organisational barriers for the implementation of the option that can easily be overcome. Most significant obstacle is the capital cost of purchasing and setting up the wireless sensors.
Robustness	The option manages to maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The option can be complemented with other water management options (e.g. irrigation water pricing) to maximize its efficiency
Costs	The total implementation cost of the option towards 2030 is approximately 700.000€. This cost includes the establishment cost of irrigation blocks, the installation of wireless sensor network and the annual operational costs.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at the protection and management of groundwater resources, water pricing policies and agricultural policies aiming at strengthening the viability of farm holdings.
Acceptance	The acceptability of the option is not very high because local environmental actors support that the adoption of such technologies will lead to the expansion of irrigated agriculture resulting thus to the increase of water use.
Suggested stakeholder involvement	Ministry of Agriculture, Rural Development and Environment (MARDE); Department of Agriculture
Preconditions for success	Awareness raising amongst farmers for the benefits of the proposed technologies; Subsidies for the adoption of irrigation scheduling decision support systems through the rural development programme.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 612385

Concrete examples where applied	Very few farms are currently using irrigation scheduling decision support systems in the river basin.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Rural Development Policy 2014-2020	The Rural Development Programme 2014-2020 has identified water scarcity as a major challenge and supports investments in irrigation scheduling infrastructure to provide economic and environmental benefits	Non-adequate dissemination of information, knowledge and technical advice to farmers from agricultural extension services

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Agriculture	Supportive towards option	Lack of human (e.g. adequate personnel with technical knowledge) and financial resources to promote the adoption of irrigation scheduling decision support systems.	Awareness raising amongst farmers for the economic and environmental benefits of adopting the improved irrigation technologies
Farmers	Very willing to adopt irrigation scheduling decision support systems	The decision of farmers to invest in irrigation scheduling technologies is negatively affected by the chronic structural weaknesses of Cypriot agriculture including small farm size, ageing and less educated farm population and low farm investment levels	Need of financial incentives

WMO2: Borehole licences and water meters

Overall description of the WMO

Short explanation	Specific law requirements for granting license for borehole drilling and installation of water meters on groundwater pumps. This option aims at measuring and controlling groundwater abstraction and reduce its overexploitation
Addressed challenges	Quantitative and qualitative status of groundwater
Target locations and water uses	This option targets the whole river basin. The specific objective of the option is the installation of groundwater meters on 10,000 wells.
Benefits	The adoption of the option will result to the improvement of the quantitative and qualitative status of groundwater. Positive indirect effects will be created for irrigated agriculture and livestock.
Potential negative impacts	The production cost for farmers will increase as well as the water price for the communities' inhabitants.
Timeline of implementation	The option can be implemented in the short run (<5 yrs). The expected lifetime of which water meters are operational without major maintenance is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs)
Feasibility	There are serious barriers for the implementation of the option including the unwillingness of farmers to install water meters and the lack of political will to impose the legislative framework for groundwater abstraction.
Robustness	The option maintains its effectiveness under various climatic and socioeconomic conditions
Flexibility	The option can be complemented with other water management options (e.g. irrigation water pricing) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 2,5 million €. This cost includes transaction costs of policy implementation plus the installment of 10,000 water meters.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at the protection and management of groundwater resources and the pricing policies for efficient water management.
Acceptance	The acceptability of the option is low among local farmers since it increases the production costs. However, other social actors e.g., environmental NGOs are very positive about this option since it contributes to the protection of the groundwater resources.
Suggested stakeholder involvement	MARDE; Water Development Department; Department of Agriculture
Preconditions for success	Consultations between competent authorities and farmers; Improvement of farm training in order farmers better understand their requirements under cross-compliance schemes; Subsidies for the installment of water meters through the rural development programmes
Concrete examples where applied	The option is currently implemented for agricultural water use, but poorly enforced.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Groundwater abstraction control	Lack of political will to impose the already existing methodology

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards measures		Raise awareness amongst farmers
Farmers		Farmers do not like the use of water meters	Strict implementation of the legislative framework for the illegal abstraction of groundwater
Civil society (NGOs)	Civil society (and particularly environmental NGOS) recognise the need for actions to monitor and control groundwater abstraction	Lack of organisation and weak policy influence	Raise awareness amongst civil society actors

WMO3: Water pricing enforcement

Overall description of the WMO

Short explanation	The enforcement of a water pricing policy that ensures the full cost recovery of water services and takes into account the polluter pays principle provide adequate incentives for users to use water resources efficiently.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the whole river basin.
Benefits	The adoption of the option will result to the improvement of the quantitative and qualitative status of groundwater. Positive indirect effects will be created for irrigated agriculture.
Potential negative impacts	The production cost of farmers will increase.
Timeline of implementation	The option can be implemented in the short run (<5 yrs) since it is a matter of political will. The expected lifetime of the new water prices is medium (5-20 yrs), while the expected time since the policy is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	There are serious barriers for the implementation of the option including the lack of political will to impose additional costs to farmers. A precondition to efficient and equitable water pricing is the metering and monitoring of groundwater abstractions.
Robustness	Water pricing setting can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Water pricing setting can be easily adjusted to different climatic and socioeconomic conditions and can be complemented with other water management options (e.g. borehole licenses and water meters) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 376,000€. This cost includes transaction costs of policy implementation plus policy control costs.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation, e.g. the Water Framework Directive and the Rural Development Program 2014-2020 . Potential conflicts with agricultural policy objectives aiming to maintain and strengthen subsistence farming.
Acceptance	The acceptability of the option is low among local farmers since it increases the production costs. However, other social actors e.g., environmental NGOs are very positive about this option since it contributes to the protection of the groundwater and surface water resources.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Strict control of policy implementation; Consultations between competent authorities and farmers
Concrete examples where applied	The option is not implemented in the river basin.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Within the Water Framework Directive, Cyprus is required to set up a water pricing policy that ensures an adequate cost recovery of water services, taking into account the polluter pays principle	Lack of political will to impose higher water prices

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards the measure	Lack of political will to impose higher water prices	Need of strong political support for imposing the new pricing schemes; Raising awareness campaign
Farmers		Farmers are unwilling to pay higher prices for irrigation water	Need of strong political support for imposing the new pricing schemes
Civil society (NGOs)	Supportive towards the measure		Raising awareness campaign

WMO4: Use of treated sewage water for irrigation and green infrastructure

Overall description of the WMO

Short explanation	The use of non-conventional water resources such as treated sewage water increase water availability for agriculture and amenity use (green spaces) and can substantially alleviate the pressures on water resources which are very high in Cyprus.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the midstream and downstream areas of the river basin.
Benefits	The adoption of the option will result to the improvement of the quantitative and qualitative status of groundwater. Positive effects will be also created for irrigated agriculture and livestock.
Potential negative impacts	The long-term impacts of emerging contaminants such as pharmaceuticals that are present in the treated sewage water on soils, groundwater, ecosystems and human health are not known.
Timeline of implementation	The option can be functioning on short term (<5 yrs) since it refers to the construction of a treated sewage water supply (distribution) network. The expected lifetime of the irrigation network is medium (5-20 yrs), while the expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor physical and technical obstacles for the implementation of the option. These obstacles include the cost of constructing a treated sewage water supply (distribution) network and any potential unknown effects of treated sewage water on irrigated agriculture.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The use of treated sewage water for irrigation and green infrastructure can be complemented with other water management options (e.g. water pricing) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 14,5 million €. This cost includes the construction of the supply network (for 1,000 ha) and the annual operational costs (including the water price).
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation. Synergies also with agricultural policies that aim to alleviate water scarcity pressures on the agricultural sector. Potential conflicts with the already existing strict guidelines on quality standards regarding the use of treated sewage water for irrigation as well as measures for the protection of public health.
Acceptance	High acceptability of the option among local actors since it will contribute to the maintenance of the groundwater and surface water resources.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Awareness raising to farmers and citizens regarding the benefits and constraints of treated sewage water for irrigation.
Concrete examples where applied	The option is currently implemented in some of the green spaces of the downstream areas of the river basin.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	Department of Agriculture aims to promote the use of treated sewage water in irrigation.	Limited financial resources
Water Framework Directive	Water Development Department aims to further promote the use of treated sewage water. Wastewater collection and treatment infrastructure is being significantly expanded and/or upgraded. The lower water prices set for treated water compared to freshwater creates an incentive for farmers to turn to the use of recycled water.	Limited financial resources
Cyprus guidelines for urban treated effluents for irrigation	Department of Environment aims to further promote the use of treated sewage water for green spaces	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Agriculture	Supportive towards option	Limited financial resources	Awareness raising amongst farmers; Need of strong political support
MARDE; Water Development Department	Supportive towards option	Limited financial resources	Awareness raising amongst farmers and citizens; Need of strong political support
Farmers	Supportive towards option	Limited financial resources	Awareness raising amongst farmers
Civil society (NGOs)	Supportive towards option	Limited financial resources	Awareness raising amongst citizens

WMO5: Water desalination

Overall description of the WMO

Short explanation	Expansion of the distribution network to secure domestic water supply in rural communities
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the midstream and downstream areas of the river basin. In particular, it aims to expand the desalination up to Tamassos dam communities (Politiko, Pera, Episkopeio, Psimolofou, Anageia) covering extra 5,400 persons.
Benefits	The adoption of the option will result to the improvement of the quantitative and qualitative status of groundwater. Positive indirect effects will be also created for irrigated agriculture and livestock.
Potential negative impacts	Desalination is extremely energy intensive. Desalination plants are run on fossil fuels creating negative effect on climate change. Moreover, the brine of the desalination plants that is returned to the sea has a negative effect on marine biodiversity.
Timeline of implementation	The option can be functioning on short term (<5 yrs) since desalination plants are already in operation. The expected lifetime of the option is medium (5-20 yrs), while the expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	There are no physical, technical or organisational barriers for the implementation of the option.
Robustness	Very robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The use of water desalination can be easily adjusted to different climatic and socioeconomic conditions and can be complemented with other water management options (e.g. domestic water saving) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 4 million €. This cost includes the expansion of the water supply network and the annual operational costs.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation. Potential conflict with environmental policies since desalination is an energy intensive process the residue of which should be carefully treated.
Acceptance	Medium acceptability of the option among the midstream stakeholders because they don’t want an increase in the water price.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Adequate financial resources
Concrete examples where applied	The option is currently implemented in the downstream areas of the river basin, i.e. in the urban and sub-urban areas of Nicosia.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Development Strategy	Desalination is considered by the Republic of Cyprus as a secure option that ensures constant domestic water supply throughout the country	High cost
Municipal spatial planning	Communities require constant supply of domestic water	High cost

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards option	High cost	Need of informed planning and political will to expand the desalinated water supply network to Tamassos dam communities
Communities	Medium support towards option	High cost	Express the need for securing domestic water supply for midstream communities.

WMO6: Farm education

Overall description of the WMO

Short explanation	Climate change related farm education. Training local farmers on the rational use of water resources and agrochemical inputs in order to improve the resilience of agricultural ecosystems
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the upstream and midstream areas of the river basin
Benefits	The improvement of farm education will create significant positive effects to agriculture (both irrigated and rainfed) and livestock. The ecosystem services of the river and riparian zones (including sediment and nutrient filtering, water storage, bank stabilization and provision of habitat for biodiversity) will be improved as well as the quantitative and qualitative status of groundwater.
Potential negative impacts	-
Timeline of implementation	Farm education activities can be effectively functioning on short term (<5 yrs). The expected lifetime of the farm education programmes is medium (5-20 yrs), while the expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	No barriers for the implementation of the option.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Farm education is a rather flexible option and can be easily complemented with other water management options (e.g. improved irrigation technologies) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 205,000€. The proposed farm training activities are slightly more costly compared to current farm training courses since they are climate change related.
Synergies and conflicts with policy objectives	Significant synergies with: (a) agricultural policies aiming at the sustainability (economic, environmental, social) of agriculture; (b) policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors and mainly farmers.
Suggested stakeholder involvement	MARDE; Department of Agriculture
Preconditions for success	Awareness raising among farmers regarding the benefits of professional training.
Concrete examples where applied	Some local farmers are already participating in farm training schemes through rural development programmes and extension services.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Rural development policy 2014-2020	Rural development policy towards 2020 (CAP 'Health Check') extends its intervention domains in the fields of climate change, water management and biodiversity. Farmers are urged to be trained on issues such as the integrated and sustainable management of natural resources and the application of farm practices compatible with climate change challenges	Aging farmers are less motivated to change practices
Cyprus guidelines for urban treated effluents for irrigation	Training of farmers on the safe and efficient use of treated sewage water	Limited to farmers with access to treated sewage water

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Agriculture	Supportive to extend farm training courses to climate change challenges under rural development programme	Limited financial resources	Pressures to adopt the proposed farm training schemes under the next rural development programme
Farmers	Willing to participate to the proposed farm training schemes		Voluntary participation

WMO7: Improve plant genetic resources bank and use of drought resistant agricultural crops

Overall description of the WMO

Short explanation	Improvement of agriculture with drought resistant crops. The option aims to improve the systematisation and organisation of the plant genetic resources bank and the regeneration of seeds as well as the improvement of agriculture with drought resistant crops.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the whole river basin.
Benefits	The better systematisation and organisation of the plant genetic resources bank will create significant positive effects on rainfed agriculture and livestock.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the systematisation and organisation of the plant genetic resources bank is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option mainly due to the lack of personnel to organise and systematise the plant genetic resources bank. However, these barriers can be easily overcome.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. farm education) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including the equipment purchase and the annual operational costs, namely salaries of scientific and technical personnel of the seed bank): 73,000€
Synergies and conflicts with policy objectives	Significant synergies with cross-compliance requirements and policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Agricultural Research Institute
Preconditions for success	Awareness raising to farmers regarding the benefits of cultivating drought resistant agricultural crops.
Concrete examples where applied	The plant genetic resources bank is currently operating in the Agricultural Research Institute. However, the systematization and organisation of the seed bank needs to be improved as well as seeds' regeneration.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	The Agricultural Research Institute of Cyprus is involved in the conservation of genetic resources (including collection, conservation and utilisation of the genetic variability existing in local germplasm) and the genetic improvement of plants for adaptation to climate change by increasing their resistance to abiotic and biotic stresses and their adaptability to the warm and dry environment of Cyprus.	Limited financial resources; Lack of organisation

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Agricultural Research Institute	Supportive towards option	Lack of personnel; lack of financial resources	
Farmers	Supportive towards the option; farmers are willing to cultivate drought resistant crops, provided income is secured	Change to less water demanding or drought resistant crops requires investment	Raise awareness amongst farmers

WMO8: Dynamic dam water management

Overall description of the WMO

Short explanation	Dynamic management of the water in the reservoir to optimize environmental services, prevent flooding and improve groundwater resources
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction
Target locations and water uses	This option targets the midstream and downstream areas of the river basin (downstream from Tamassos dam).
Benefits	The dynamic dam water management will improve the quantitative and qualitative status of groundwater as well as the performance of irrigated agriculture and livestock. The provision of river and riparian zones' ecosystem services (including sediment and nutrient filtering, water storage and release, bank stabilisation, aquifer recharge, habitat for biodiversity) will also increase. Moreover, the risk of flooding from the Pedieos river and the surface runoff of rainwater will slightly decrease.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the proposed dam water management outcome is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option, which can be easily overcome. It mainly includes the cost of preparing a study based on which a dynamic management in the reservoir can be achieved.
Robustness	Quite robust option that can maintain its effectiveness under various climatic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. hydrological studies) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including the study preparation, equipment purchase and maintenance, salaries of technical personnel): 646,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Knowhow transfer regarding the benefits of the dynamic management of the water in the reservoir.
Concrete examples where applied	

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Water Development Department aims to promote the dynamic management of water in Cyprus dams	
Floods Directive	Water Development Department aims to promote the dynamic management of water in Cyprus dams	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Supportive towards option		
MARDE; Water Development Department	Supportive towards option		

WMO9: Awareness campaign for local society

Overall description of the WMO

Short explanation	It is a governmental initiative including seminars to educate local society and mainly younger generation about challenges related to water resources and climate change and the importance of water conservation. Campaigns may include lectures in schools, distribution of informative leaflets and other informative initiatives.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water.
Target locations and water uses	This option targets the whole river basin.
Benefits	Awareness raising and participation of local society will improve the quantitative and qualitative status of groundwater as well as the ecosystem services provided by the river and riparian zones (including sediment and nutrient filtering, water storage and release, bank stabilisation, aquifer recharge, habitat for biodiversity). Positive indirect effects will be also created in irrigated agriculture and livestock. Moreover, the risk of flooding from the Pedieos river and the surface runoff of rainwater will slightly decrease.
Potential negative impacts	-
Timeline of implementation	Awareness campaign can occur on short term (<5 yrs), while the expected lifetime of the knowledge acquired is considered medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	There are no barriers (physical, technical or organizational) for the implementation of the option.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The option is highly flexible under different climatic and socioeconomic scenarios and can be easily complemented with other water management options either grey or nature-based.
Costs	Total implementation cost of the option towards 2030 is approximately 248,000€. It includes the purchase of equipment and materials (e.g. leaflets) and the annual operational cost.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors and competent authorities.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	-
Concrete examples where applied	Awareness campaigns are taking place in the local schools of the river basin to develop a more conscious attitude towards water conservation. Dissemination activities and awareness campaigns take also place within the framework of Water Framework Directive.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Water Development Department aims to further expand awareness campaigns to local society within Water Framework Directive	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Very supportive towards option		
MARDE; Water Development Department	Very supportive towards option		
Households	Very supportive towards option		Active participation
Civil society (NGOs)	Very supportive towards option		

WMO10: Agrotourism development

Overall description of the WMO

Short explanation	Agrotourism could maintain agricultural land in good condition and increase environmental awareness. Four new agrotourism hotels will be constructed.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water; Flood risk reduction
Target locations and water uses	Agrotourism will be developed in the upstream and midstream areas of the river basin.
Benefits	The development of agrotourism will improve the quantitative and qualitative status of groundwater through the increase of environmental awareness. Moreover, the option will create positive impacts on agriculture and livestock through the increase of environmental awareness and the use of local agricultural products by the agrotourism hotels.
Potential negative impacts	-
Timeline of implementation	The option can be functioning on short term (<5 yrs), while the expected lifetime for which the option is operational without major rehabilitation is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	There are no barriers (physical, technical or organizational) for the implementation of the option.
Robustness	The option is robust to uncertainties and can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	If the implementation of the option in practice is inappropriate, it can be adjusted or reversed very slowly.
Costs	Total implementation cost of the option towards 2030: 2,356,556€.
Synergies and conflicts with policy objectives	Significant synergies with agricultural policies aiming at the viability of agriculture and the protection of environment.
Acceptance	The acceptability of the option is low among environmental actors (e.g. NGOs). Concerns arise with regards the risk of environmental degradation because of touristic infrastructure.
Suggested stakeholder involvement	MARDE; Department of Agriculture
Preconditions for success	Preparation of environmental studies
Concrete examples where applied	Very few agrotourism hotels in the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Rural development policy 2014-2020	Rural development programme 2014-2020 promotes the development of agrotourism as a means of employment diversification in rural areas. Agrotourism create significant backward and forward linkages within regional economies.	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Agriculture	Supportive towards option; aims to promote agrotourism expansion	Limited financial resources; need for private financing contribution	Awareness raising among farmers and rural inhabitants on the potential of agrotourism
Farmers	Supportive towards option	Requires motivation, commitment and financial resources	Awareness raising on the linkages of agriculture with tourism sector
Cyprus Tourism Organization	Supportive towards measure; Till now the promotion of tourism in Cyprus has primarily focused on the concept of 'sun and sea'; The Organization aims to promote alternative tourism including agrotourism		Awareness and marketing campaigns on agrotourism potential

WMO11: Domestic water saving equipment

Overall description of the WMO

Short explanation	Installation of water saving technologies and equipment for domestic water use and gardens
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the whole river basin. In particular, it aims at least 10% of river basin households (7,740) to adopt such water saving technologies and equipment
Benefits	The adoption of the option will decrease water demand of households for drinking and gardens' watering purposes. Thus, groundwater quantities will increase. The quantitative and qualitative status of surface water, related to the ecosystem services provided by the Tamassos dam reservoir (including water supply, provision of habitat for biodiversity and recreation) will also improve. Furthermore, land cultivated with irrigated crops (such as vegetables and fruit trees) and livestock (mainly intensive livestock farms with sheep, goats, chickens, cows) will be positively affected.
Potential negative impacts	-
Timeline of implementation	The option can be functioning on short term (<5 yrs). The expected lifetime of the relative equipment is around 10 years according to its technical specification. The expected time since the option is implemented until it starts to have the desired effect is very short (< 5 yrs).
Feasibility	Minor technical, physical or organizational barriers for the implementation of the option. Most significant obstacle is the cost of purchase of water saving technologies and equipment.
Robustness	Quite robust option to uncertainties since it manages to maintain its effectiveness under different climatic and socioeconomic development scenarios
Flexibility	Quite flexible option since it can be adapted to different climatic and socioeconomic development scenarios
Costs	Total implementation cost of the option towards 2030: 2,2 million €. This corresponds at a 10% of river basin households adoption rate
Synergies and conflicts with policy objectives	Potential synergies with housing and energy policies for promoting sustainable and environmentally friendly buildings
Acceptance	High acceptability of the option from the local actors
Suggested stakeholder involvement	Water development department promotes the adoption of water saving technologies and equipment.
Preconditions for success	Citizens should be further informed about the environmental (water saving) and economic benefits of adopting such technologies.
Concrete examples where applied	The option is currently implemented throughout the river basin for drinking and gardens' watering purposes.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Water Development Department aims at the reduction of drinking water consumption	Limited financial resources
Cyprus guidelines for drinking water	Mandatory installation of water saving technologies and equipment in new buildings	Lack of such legal framework

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	High interest for the promotion of water saving technologies	Citizens have to bear the cost	Society awareness raising and design subsidy schemes for adopting water saving equipment
Municipalities	High interest for the promotion of water saving technologies	Citizens have to bear the cost	Society awareness
Department of Town Planning and Housing	High demand for constructing sustainable and environmentally friendly buildings	Lack of relevant legislation	Explore the possibility of incorporating the mandatory character of the option into legislative action

WMO12: Maintenance and repair of water distribution networks

Overall description of the WMO

Short explanation	This option aims to enhance the maintenance and repair of the water distribution systems and related infrastructure thus minimizing leakages and water losses
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the whole river basin.
Benefits	The regular maintenance and repair of water distribution systems improves the qualitative and quantitative status of groundwater and surface water. The option contributes to the decrease of water demand of local households for drinking and garden's watering purposes, while it improves irrigated agriculture and livestock.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of water distribution systems repair is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option mainly due to limited financial resources.
Robustness	Currently, financial resources for maintaining and repairing the related infrastructure have been decreased resulting in a gradual loss of the effectiveness of the option. However, the option can still be characterized as robust to climatic and socioeconomic changing conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. hydrological studies, sustainable urban systems) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030, including capital and operational costs, based on average daily repairs of the existing network: 1,3 million €.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors and competent authorities.
Suggested stakeholder involvement	Water Board of Nicosia
Preconditions for success	The timely identification and repair of defective pipes is a crucial factor for the effective implementation of the option. Awareness raising for developing a more conscious attitude towards water conservation
Concrete examples where applied	The option is implemented throughout the river basin; around 5 repairs daily.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Water Development Department aims to minimize water leakages in the urban and rural domestic supply distribution networks. Nicosia Water Board is responsible for the maintenance and repair of the distribution network for domestic water within the urban and sub-urban areas of the river basin.	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
Water Board of Nicosia	Supportive towards option	Limited financial resources	Awareness raising to develop conscious attitude towards water conservation

WMO13: Code of Good Agricultural Practices enforcement

Overall description of the WMO

Short explanation	The strict implementation of the Code of Good Agricultural Practices reduces the leaching and surface runoff of agrochemicals and livestock waste from crop and livestock farming
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the upstream and midstream areas of river basin.
Benefits	The enforcement of the Code of Good Agricultural Practices significantly improves the qualitative and quantitative status of groundwater and surface water due to reduction of nitrate pollution from fertilizer use and livestock waste. The option strengthens the ecosystem services provided by the forest (ecological, sociocultural, scenic and landscape services and values) as well as the ecosystem services of the river and the riparian zone (including sediment and nutrient filtering, bank stabilization). Moreover, it slightly reduces flooding from the Pedieos river.
Potential negative impacts	Slight reduction in farm incomes due to additional labour requirements and lower yields.
Timeline of implementation	The enforcement of the Code of Good Agricultural Practices can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcomes is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is also very short (<5 yrs).
Feasibility	No barriers (physical, technical or organizational) for the implementation of the option.
Robustness	Robust option to uncertainties, which can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. farm education, improved irrigation technologies) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including transaction and policy control costs): 183,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming to improve the environmental performance of agriculture (e.g. cross-compliance requirements).
Acceptance	Medium acceptability of the option among local farmers because they consider the guidelines of the Code too strict that may endanger the viability of their farm holdings.
Suggested stakeholder involvement	MARDE; Department of Agriculture
Preconditions for success	The efficiency of the option depends on the systematic control of a representative sample of farm holdings.
Concrete examples where applied	It is implemented throughout the river basin.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	Department of Agriculture aims to improve the control system related to the guidelines of the Code. The enforcement of cross-compliance requirements is mandatory for all farmers receive farm subsidies.	Limited financial resources; ineffective existing administrative structures
Biodiversity policy	Department of Environment is very supportive towards the strict implementation of the Code of Good Agricultural Practices because it will strengthen biodiversity conservation	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Supportive towards option	Limited financial resources; ineffective existing administrative structures	More strict and regular controls in the field
MARDE; Department of Agriculture	Supportive towards option	Limited financial resources; ineffective existing administrative structures	More strict and regular controls in the field
Farmers	Willing to perform environmentally-friendly farm practices	Lack of information	Voluntarily participation

WMO14: Grazing control

Overall description of the WMO

Short explanation	The control of grazing by permits on the basis of the carrying capacity of the area reduces soil erosion and run-off.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the upstream and midstream areas of river basin.
Benefits	The grazing control significantly strengthens the ecosystem services provided by the forest (ecological, sociocultural, scenic and landscape services and values), while it improves the qualitative and quantitative status of groundwater and surface water. Furthermore, it is an effective measure for preventing soil erosion reducing thus run-off and the risk of flooding.
Potential negative impacts	-
Timeline of implementation	The control of grazing can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcomes is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is also very short (<5 yrs).
Feasibility	Minor obstacles mainly organizational that can easily be overcome.
Robustness	The option is quite robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. farm education, Code of Good Agricultural Practices) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including transaction and operational costs): 228,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming to protect forests (e.g. forest policy). Potential conflicts with agricultural policies aiming at the support of livestock raisers income.
Acceptance	Medium acceptability of the option among local livestock raisers because livestock is already declining in the region and the enforcement of strict requirements may endanger the viability of their holdings.
Suggested stakeholder involvement	MARDE; Department of Forests; Department of Environment
Preconditions for success	The efficiency of the option depends on the systematic and sufficient control of a representative sample of livestock holdings.
Concrete examples where applied	It is implemented throughout the river basin (Forest Law 1913; Statement of Forest Policy 1950, Statement of Forest Policy 2000-2010).

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Forestry policy	The control of grazing is one of the major objectives of forest policy in Cyprus.	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Supportive towards option	Limited financial resources	Awareness raising amongst all stakeholders on the option's benefits
MARDE; Department of Forests		Sceptical towards the option	Studies for the estimation of the carrying capacity of the upstream parts of the river basin
Livestock breeders		Sceptical towards the option	Awareness raising amongst livestock breeders

WMO15: Improve plant genetic resources bank and use of drought resistant forest species

Overall description of the WMO

Short explanation	Improvement of forests and ecosystems with drought resistant species. The option aims to improve the systematisation and organisation of the plant genetic resources bank and the regeneration of seeds and the improvement of forests and ecosystems with drought resistant species.
Addressed challenges	Quantitative and qualitative status of groundwater
Target locations and water uses	This option targets the upstream areas of river basin.
Benefits	The systematisation and organisation of the plant genetic resources bank significantly improves the ecosystem services provided by the forest (ecological, sociocultural, scenic and landscape services and values), while it improves the qualitative and quantitative status of groundwater and surface water. The option also improves livestock performance. Moreover, it reduces the flooding from the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcomes is long (> 20 yrs). The expected time since the option is implemented until it starts to have the desired affect is between 5 to 20 years.
Feasibility	Minor organizational obstacles (including limited personnel) that can easily be overcome.
Robustness	The option is quite robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. fire safety measures) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including the equipment purchase and the annual operational costs, namely salaries of scientific and technical personnel of the seed bank): 131,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming to protect forests (e.g. forest policy).
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Department of Forests; Department of Environment
Preconditions for success	Optimal systematisation and organisation of the plant genetic resources bank and the regeneration of seeds.
Concrete examples where applied	

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Forestry policy	Forest policy promotes drought resistant forest species that can be easily adapted to the warm and dry environment of Cyprus and the climate change challenges.	
Biodiversity policy	Department of Environment is positive to promote drought forest resistant species due to their positive impact on biodiversity conservation	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
MARDE; Department of Environment	Supportive towards option	Lack of personnel	
MARDE; Department of Forests	Supportive towards option	Lack of personnel	

WMO16: Hydrological studies

Overall description of the WMO

Short explanation	This option aims to develop hydrological studies including risk assessment to combat desertification and improve water management
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	This option targets the whole river basin.
Benefits	The preparation of hydrological studies will identify and analyse the factors that improve: (a) the qualitative and quantitative status of groundwater, (b) the ecosystem services of the river and the riparian zone (including sediment and nutrient filtering, bank stabilization), (c) the performance of irrigated agriculture and livestock, (d) the reduction of urban runoff and flooding from the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The preparation of hydrological studies can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcomes of the option is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (< 5 yrs).
Feasibility	No major obstacles (physical, technical, organizational) for the implementation of the option.
Robustness	The option is quite robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is rather flexible under different climatic scenarios and can be easily complemented with the majority of the selected water management options.
Costs	Total cost of preparing 3 hydrological studies towards 2030: 479,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming to water resources conservation and flood protection.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Adequate financial resources
Concrete examples where applied	Hydrological studies have been conducted in the river basin in the past.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	The preparation of hydrological studies is necessary to meet the requirements of the Water Framework Directive	Limited financial resources due to the current economic crisis
Biodiversity policy	The Department of Environment recognises the positive contribution of hydrological studies to biodiversity conservation	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Supportive towards option	Limited financial resources	
MARDE; Water Development Department	Supportive towards option	Limited financial resources	Simplification of bureaucratic procedures for tenders' submission

WMO17: Dam demolition

Overall description of the WMO

Short explanation	The removal of Tamassos dam can contribute to the restoration of the watershed and the upgrade of river ecosystems
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction
Target locations and water uses	The option targets the upstream and midstream areas of the river basin.
Benefits	This radical water management option significantly improves the ecosystem services of the river and the riparian zone (including sediment and nutrient filtering, bank stabilization) as well as irrigated agriculture.
Potential negative impacts	The removal of dam negatively impacts on the qualitative and quantitative status of groundwater and surface water, while it increases the urban runoff and the flooding from the Pedieos river.
Timeline of implementation	The dam removal can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcome of the option is medium (5-20 yrs). The expected time from dam removal until it starts to have the desired affect is short (< 5 yrs).
Feasibility	Serious physical, technical and organizational obstacles that would be very difficult to overcome within the time horizon of the project.
Robustness	It is difficult to assess the effectiveness of the option under different climatic and socioeconomic conditions.
Flexibility	The option is not flexible under different climatic and socioeconomic scenarios. However, it can be complemented with other water management options to trade-off the negative impacts.
Costs	Total cost of dam demolition (including studies and restoration works) towards 2030: 1,5 million €.
Synergies and conflicts with policy objectives	Potential synergies with environmental policies aiming at river ecosystem services protection. However, significant conflicts with flood protection policies.
Acceptance	Low acceptability of the option among local actors and competent authorities due to the high negative impacts.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Conduct of hydrological studies (including ex ante evaluation and risk assessment)
Concrete examples where applied	Neither applied in Pedieos river basin nor in Cyprus

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy		Serious technical and political barriers for the implementation of the option

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Doubts about the efficiency of dams on water conservation and flood protection	Serious technical and political barriers for the implementation of the option	Explore the technical and physical feasibility of the option

WMO18: Integrated waste management

Overall description of the WMO

Short explanation	The option promotes the strict enforcement of regulations regarding solid waste dumping at or near river. Moreover, it provides incentives for waste reuse and recycling.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	The option targets the whole river basin.
Benefits	The integrated waste management improves the qualitative and quantitative status of groundwater as well as the performance of irrigated agriculture and livestock. Moreover, solid waste at or near the river may block water flow thus increasing the risk of flooding.
Potential negative impacts	-
Timeline of implementation	The implementation of an integrated waste management can be effectively functioning on short term (<5 yrs), while the expected lifetime of the outcomes of the option is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (< 5 yrs).
Feasibility	Minor obstacles (physical, technical, organizational) for the implementation of the option that can easily be overcome. The major obstacle is the high construction cost.
Robustness	The option is quite robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is rather flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. awareness campaign for local society, volunteerism).
Costs	Total cost of the option (including construction cost, i.e., garbage collection, garbage disposal, recycling, yard waste composting, and annual operating costs) towards 2030: 3,8 million €.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming environmental protection and water resources conservation.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Department of Environment
Preconditions for success	Strict regulations for permits and regular inspections of waste treatment facilities and collectors
Concrete examples where applied	The option is applied at the urban areas of the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Environmental Policy	The Department of Environment aims to apply an environmentally rational management of waste in Cyprus.	High cost of integrated waste management; low income from integrated waste management

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Environment	Supported towards option	Limited financial resources	Willing to promote an environmentally rational waste management

WMO19: Construction of multi-purpose cycling/walking paths across the river

Overall description of the WMO

Short explanation	This option includes the expansion of walking and cycling paths up to Tamassos dam area. Walking and cycling paths can raise environmental awareness and discourage people dumping in the riverbed.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water
Target locations and water uses	The option targets the whole river basin.
Benefits	The expansion of walking/cycling paths will increase environmental awareness and discourage people from waste dumping in the riverbed, thus contributing to the improvement of the quantitative and qualitative status of groundwater. The implementation of the option includes the maintenance and improvement of infrastructure across the river, which can potentially reduce urban runoff and flooding from Pedieos river.
Potential negative impacts	-
Timeline of implementation	The construction of multipurpose cycling /walking paths across the river can be effectively functioning on short term (<5 yrs), while the expected lifetime of the desired outcomes of the option is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (< 5 yrs).
Feasibility	Minor obstacles (physical, technical, organizational) for the implementation of the option that can easily be overcome.
Robustness	The option is quite robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is rather flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. awareness campaign for local society, volunteerism).
Costs	The total cost of expanding the cycling and walking path across the river towards Tamassos dam (14.6 km) (including operational costs) towards 2030 is approximately 8,2 million €
Synergies and conflicts with policy objectives	Significant synergies with policies promoting environmental protection and physical activity.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	Department of Town Planning and Housing
Preconditions for success	Financial resources commitment for the expansion of cycling/walking paths up to Tamassos dam
Concrete examples where applied	Multi-purpose cycling/walking paths (10 km) have been constructed in the urban areas of the Pedieos river basin (including Lakatamia, Strovolos and Nicosia).

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Policies of the Department of the Town Planning and Housing	The expansion of walking/bicycling paths up to Tamassos dam areas has been already designed by the Department of Town Planning and Housing	Lack of financial resources due to economic crisis

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
Department of Town Planning and Housing	Very supportive towards option	Lack of financial resources	Construction of the walking/bicycling paths

WMO20: Volunteerism

Overall description of the WMO

Short explanation	Strengthening volunteerism movement improves awareness raising for the importance of water conservation and helps to restore and clean river bed. This WMO is a private initiative.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction
Target locations and water uses	The option targets the whole river basin.
Benefits	The volunteerism movement strengthening contributes to the restoration and cleaning of the riverbed, therefore improving the quantitative and qualitative status of groundwater as well as the ecosystem services of the river and the riparian zone (including sediment and nutrient filtering, bank stabilization). The restoration of the riverbed also reduces urban runoff and flooding from Pedieos river.
Potential negative impacts	-
Timeline of implementation	Strengthening of volunteerism movement can be effectively functioning on short term (<5 yrs), while the expected lifetime of the desired outcomes of the option is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (< 5 yrs).
Feasibility	No major obstacles (physical, technical, organizational) for the implementation of the option.
Robustness	The option is very robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is very flexible under different climatic scenarios and can be easily complemented with the majority of the proposed water management options.
Costs	Total cost of the option towards 2030: 36,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies promoting environmental protection and water resources conservation.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	Environmental NGOs (e.g. Let's Do It Cyprus)
Preconditions for success	Willingness of local society to support such movements.
Concrete examples where applied	Environmental NGOs have participated in Pedieos river bed cleaning activities

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
-		

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
Civil society (NGOs)	Supportive towards option		Organisation of awareness events and river bed cleaning activities

WMO21: Rainwater harvesting systems

Overall description of the WMO

Short explanation	Installation of rainwater harvesting systems to supplement water supply at both household (e.g. collect surface runoff from roofs and paved areas in storage tanks; use of stored water for irrigation of gardens) and farm (e.g. collect surface runoff from roofs of farm buildings and greenhouses; use of stored water for irrigation of agricultural crops) level.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction
Target locations and water uses	The option targets the whole river basin.
Benefits	The installation of rainwater harvesting systems contributes to the improvement of the quantitative and qualitative status of groundwater. Positive indirect effects are also created in irrigated agriculture and livestock, while its implementation reduces flooding of the Pedieos river.
Potential negative impacts	-
Timeline of implementation	Installation of rainwater harvesting systems can be effectively functioning on short term (<5 yrs), while the expected lifetime of the desired outcomes of the option is medium (5-20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (< 5 yrs).
Feasibility	Minor obstacles (physical, technical, organizational) for the implementation of the option that can easily be overcome.
Robustness	The option is robust to uncertainties and can maintain its effectiveness under different climatic and socioeconomic conditions.
Flexibility	The option is flexible under different climatic scenarios and can be easily complemented with other water management options (e.g. river runoff retention and groundwater recharge systems; improved irrigation technologies)
Costs	The cost of the option towards 2030 (including plastic water storage tanks and pipes, operational costs) is approximately 26,4 million €.
Synergies and conflicts with policy objectives	Significant synergies with policies promoting water resources conservation and farm viability.
Acceptance	Medium acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	Awareness raising campaigns to local society and farmers regarding the benefits of the rainwater harvesting systems
Concrete examples where applied	Small-scale application of the option throughout the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	Department of Agriculture aims to promote the installation of rainwater harvesting systems at farm holdings. Efforts will be made these systems to be subsidized under the rural development programme.	
Water Framework Directive	Water Development Department promotes the installation of rainwater harvesting systems	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Agriculture			Awareness campaign to farmers regarding the benefits of rainwater harvesting
MARDE; Water Development Department	Supportive towards option		Awareness campaign to local society and farmers regarding the benefits of rainwater harvesting
Farmers	Willing to collect surface runoff and use it for irrigation of agricultural crops	High cost of installation	Voluntary participation

WMO22: Improve plant genetic resources bank and use of drought resistant plants in green infrastructures

Overall description of the WMO

Short explanation	Improvement of green infrastructures with drought resistant plants. Parks, gardens and green areas along roads can be grown with plants that maintain a protective land cover and need little or no irrigation. The option aims to improve the systematisation and organisation of the plant genetic resources bank.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction.
Target locations and water uses	This option targets the midstream and downstream areas of the river basin.
Benefits	The better systematisation and organisation of the plant genetic resources bank will create significant positive effects on the provision of the river and riparian zone ecosystem services (including sediment and nutrient filtering, bank stabilization) as well as the quantitative and qualitative status of groundwater.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the systematisation and organisation of the plant genetic resources bank is long (> 20 yrs). The expected time since the option is implemented until it starts to have the desired affect is very short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option mainly due to the lack of personnel to organise and systematise the plant genetic resources bank. However, these barriers can be easily overcome.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The option is rather flexible under different climatic scenarios.
Costs	Total implementation cost of the option towards 2030 (including the equipment purchase and the annual operational costs, namely salaries of scientific and technical personnel of the plant genetic resources bank): 363,000€.
Synergies and conflicts with policy objectives	Significant synergies with policies aiming at water resource conservation.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Agricultural Research Institute
Preconditions for success	Awareness raising to local society and competent authorities (e.g. municipalities) for the benefits of adopting the option.
Concrete examples where applied	The plant genetic resources bank is currently operating in the Agricultural Research Institute. However, the systematization and organisation of the plant genetic resources bank needs to be improved.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	The Agricultural Research Institute of Cyprus is involved in the conservation of genetic resources (including collection, conservation and utilisation of the genetic variability existing in local germplasm) and the genetic improvement of plants for adaptation to climate change by increasing their resistance to abiotic and biotic stresses and their adaptability to the warm and dry environment of Cyprus.	Limited financial resources; Lack of organisation
Municipal spatial planning	Competent authorities, i.e. municipalities, promote native plants that are drought tolerant and low maintenance for green infrastructures	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
Municipalities	Supportive towards option		Adoption of the option
MARDE; Agricultural Research Institute	Supportive towards option	Lack of personnel	Organisation and systematization of plant genetic resources bank

WMO23: Fire safety measures

Overall description of the WMO

Short explanation	The protection of forests from fires contributes to the reduction of soil erosion and protection against floods. It is a prevention measure including wood protection constructions, construction of a reservoir, maintenance of firebreaks and maintenance of forest roads.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction.
Target locations and water uses	This option targets the upstream areas of the river basin.
Benefits	Fire safety measures improve the forest ecosystem services (including ecological, sociocultural, scenic and landscape services and values) as well as the qualitative and quantitative status of groundwater and surface water. The implementation of the option helps to maintain the ecosystem services provided by the river and the riparian zone (including sediment and nutrient filtering, bank stabilization), while it improves the performance of livestock. Moreover, fire safety constructions reduce the surface runoff and the flooding of the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the fire safety measures outcome is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	No major obstacles (physical, technical or organizational) for the implementation of the option.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	The option is rather flexible under different climatic scenarios and can be complemented with other water management options (e.g. grazing control) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including wood protection constructions, reservoir constructions, maintenance of firebreaks and forest roads): 486,000€.
Synergies and conflicts with policy objectives	Significant synergies with forest policies.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Department of Forests
Preconditions for success	Adequate financial resources
Concrete examples where applied	Fire safety measures have been applied in the upstream areas of the river basin.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Forestry policy	Department of Forests aims to construct new fire safety measures and maintain the existing one	Lack of financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Department of Forests	Supportive towards option	Lack of financial resources	Planning of fire safety measures at spatial level

WMO24: Improving land zonation

Overall description of the WMO

Short explanation	Establishment of protection zones across river basin to control housing development. Land zonation maps and laws need to be improved, widely disseminated and properly enforced.
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction.
Target locations and water uses	This option targets the whole river basin.
Benefits	The improvement of land zonation laws and plans contributes to the increase of the ecosystem services provided by the river and the riparian zone (including sediment and nutrient filtering, bank stabilization) as well as the qualitative and quantitative status of groundwater and surface water. The implementation of the option also improves the performance of the irrigated agriculture and livestock, while it reduces the surface runoff and the flooding from the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the land zonation improvement outcome is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome.
Robustness	Very robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with other water management options (e.g. restoration and maintenance of riverbed) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including the preparation of a study and policy recommendations as well as the operational costs): 496,000€.
Synergies and conflicts with policy objectives	Significant synergies with groundwater conservation and riverbed protection policies.
Acceptance	Medium acceptability of the option among local actors due to the high housing demand.
Suggested stakeholder involvement	Department of Town Planning and Housing
Preconditions for success	Land protection zones across rivers have been already established by laws indicating that no housing development is allowed. However, these laws have not been properly applied due to a lack of effective control.
Concrete examples where applied	Land zonation laws and plans have already been established but they are not properly enforced

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Policies of the Department of the Town Planning and Housing	Department of Town Planning and Housing aims to properly enforce land zonation laws and plans	Increasing housing demand

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
Department of Town Planning and Housing	Supportive towards option		Strict enforcement of land zonation laws and plans

WMO25: Improve stakeholders' cooperation

Overall description of the WMO

Short explanation	Cooperation between stakeholders and competent authorities is key element for effective water resources management. Lack of such cooperation may lead to conflicts that aggravate existing problems
Addressed challenges	Quantitative and qualitative status of groundwater and surface water and flood risk reduction.
Target locations and water uses	This option targets the whole river basin.
Benefits	The improvement of stakeholders' cooperation improves the qualitative and quantitative status of groundwater as well as the ecosystem services provided by the river and the riparian zone (including sediment and nutrient filtering, bank stabilization). The implementation of the option also improves the performance of the irrigated agriculture and livestock, while it reduces the surface runoff and the flooding from the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of stakeholders' cooperation improvement is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome.
Robustness	Very robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with other water management options (e.g. volunteerism) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 50,000€.
Synergies and conflicts with policy objectives	Significant synergies with water resources management policies.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department; Department of Agriculture
Preconditions for success	The organization of regular consultation events is necessary for the improvement of cooperation between stakeholders and authorities.
Concrete examples where applied	Water Development Department is currently organizing awareness and dissemination events within Water Framework Directive.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
National Agricultural Strategy	Common Agricultural Policy promotes a transparent, well-targeted and coherent stakeholder consultation	As yet stakeholder engagement was done through communication and awareness events
Water Framework Directive	A transparent, well-targeted and coherent stakeholder consultation is currently promoted within Water Framework Directive	As yet stakeholder engagement was done through communication and awareness events
Municipal spatial planning	Municipalities and communities aim to promote a transparent, well-targeted and coherent stakeholder consultation	Limited experience in organizing such activities

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	**Stakeholder attitude on WMO**		**Possible involvement**
	Opportunities	Barriers	
MARDE; Department of Agriculture	Supportive towards option		Organisation of consultation processes where the input from stakeholders is taken in the formulation of policies into account
MARDE; Water Development Department	Supportive towards option		Organisation of consultation processes where the input from stakeholders is taken in the formulation of policies into account

WMO26: Restoration and maintenance of riverbed

Overall description of the WMO

Short explanation	The cleaning and maintenance of the riverbed and the embankment of the riparian zone, including the removal of illegal constructions, allows undisturbed river flow and reduces flooding.
Addressed challenges	Flood risk reduction.
Target locations and water uses	This option targets the whole river basin.
Benefits	The cleaning and the maintenance of the riverbed reduce the surface runoff and the flooding from the Pedieos river. The implementation of the option improves the qualitative and quantitative status of groundwater.
Potential negative impacts	-
Timeline of implementation	The option can be effectively functioning on short term (<5 yrs), while the expected lifetime of the riverbed's cleaning and maintenance is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome. They mainly relate to the cost of implementing the option.
Robustness	Very robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with other water management options (e.g. improving land zonation, volunteerism) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 545,000€.
Synergies and conflicts with policy objectives	Significant synergies with flood protection policies.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department; Volunteer movements
Preconditions for success	Public awareness and participation to foster a sense of individual responsibility and proactive environmental attitude.
Concrete examples where applied	Pedieos riverbed has been cleaned and maintained by Water Development Department actions and NGOs volunteer events.

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	One of the major priorities of the Water Development Department is the regular cleaning and maintenance of all riverbeds in Cyprus	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards option	Limited financial resources and personnel available	Organisation of regular clean up and maintenance events of Pedieos riverbed
Civil society (NGOs)	Supportive towards option		Voluntary participation in clean up and maintenance events of Pedieos riverbed

WMO27: River runoff retention and groundwater recharge systems

Overall description of the WMO

Short explanation	The constructions of river runoff retention systems including detention basins, retention ponds and check dams prevents flooding and improves groundwater recharge and water quality
Addressed challenges	Flood risk reduction.
Target locations and water uses	This option targets the midstream and downstream areas of the river basin.
Benefits	The construction of river runoff retention and groundwater recharge systems decreases the urban runoff and the flooding from the Pedieos river, while it increases the quantitative and qualitative status of groundwater.
Potential negative impacts	-
Timeline of implementation	The construction of river runoff retention and groundwater recharge systems can be effectively functioning on short term (<5 yrs), while the expected lifetime of the option is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome. They mainly include the high cost of constructing these runoff retention systems.
Robustness	Very robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with other water management options (e.g. restoration and maintenance of riverbed, sustainable urban drainage systems) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030 (including 20 detention basins & retention ponds plus 20 check dams): 748,000€.
Synergies and conflicts with policy objectives	Significant synergies with flood protection and water resources conservation policies.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	MARDE; Water Development Department
Preconditions for success	-
Concrete examples where applied	The option has been implemented in several parts of the midstream and downstream areas of the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	River runoff retention systems are of high importance within Water Framework Directive	
Floods Directive	River runoff retention systems are of high importance within Floods Directive	
Municipal spatial planning	Municipalities aim to promote the construction of river runoff retention systems	Lack of financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards option		To further promote a targeted construction of river runoff retention and groundwater recharge systems
Municipalities	Supportive towards option		To further promote a targeted construction of river runoff retention and groundwater recharge systems

WMO28: Sustainable urban drainage systems

Overall description of the WMO

Short explanation	Systems including green roofs and green ditches that capture surface water run-off through local collection, storage, recharge, re-use or release into Pedieos River with low environmental impact
Addressed challenges	Flood risk reduction.
Target locations and water uses	This option targets the midstream and downstream areas of the river basin.
Benefits	The development of sustainable urban drainage systems improve the ecosystem services provided by the river and the riparian zone (including sediment and nutrient filtering, bank stabilization). The implementation of the option also reduces the urban runoff and the flooding from the Pedieos river.
Potential negative impacts	-
Timeline of implementation	The development of sustainable urban drainage systems can be effectively functioning on short term (<5 yrs), while the expected lifetime of the option is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome. These obstacles mainly relate to the high implementation cost of the option.
Robustness	Quite robust option that can maintain its effectiveness under various climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with other water management options (e.g. river runoff retention and groundwater recharge systems) to maximize its efficiency
Costs	Total implementation cost of the option towards 2030: 8,6 million €.
Synergies and conflicts with policy objectives	Significant synergies with flood protection policies.
Acceptance	High acceptability of the option among local actors.
Suggested stakeholder involvement	Water Development Department; Individual citizens
Preconditions for success	Awareness raising to local society regarding the benefits of sustainable urban systems
Concrete examples where applied	Small-scale sustainable urban drainage systems have been implemented in the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Municipal spatial planning	Municipalities promote the installation of sustainable urban drainage systems	Limited financial resources
Floods Directive	Water Development Department promotes the installation of sustainable urban drainage systems. For example, stormwater retention ponds have been already installed in Limassol and Paralimni.	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards option	Limited financial resources	Further implementation of the option in the river basin
Civil society (NGOs)	Supportive towards option	High construction cost	Voluntary participation

WMO29: Construction of flood protection works

Overall description of the WMO

Short explanation	Technical flood protection through the construction of anti-flooding works such as terraces, rectangular culverts and hydraulically designed bridges.
Addressed challenges	Flood risk reduction.
Target locations and water uses	This option targets the downstream areas of the river basin.
Benefits	The construction of flood protection works significantly decreases urban runoff and the flood from the Pedieos river.
Potential negative impacts	Constructions harm the natural condition and the ecosystem services of the river and the riparian zone (including sediment and nutrient filtering, bank stabilization).
Timeline of implementation	The construction of flood protection works can be effectively functioning on short term (<5 yrs), while the expected lifetime of the option is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (physical, technical or organizational) for the implementation of the option that can easily be overcome. These obstacles mainly include the high cost of implementing the option.
Robustness	This option cannot be characterized as robust since it cannot maintain its effectiveness under changing climatic and socioeconomic conditions.
Flexibility	Similarly, this option is not flexible under different climatic and socioeconomic scenarios.
Costs	Total implementation cost of the option towards 2030: 3,3 million €.
Synergies and conflicts with policy objectives	Significant synergies with flood protection policies.
Acceptance	Medium acceptability of the option among local actors.
Suggested stakeholder involvement	Water Development Department
Preconditions for success	Targeted installation of anti-flooding works
Concrete examples where applied	The option has been implemented throughout the river basin

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Water Framework Directive	Water Development Department promotes the construction of flood protection works including bridges, terraces and retaining walls.	Flood protection works do not consist an integrated approach to flood management; Low flexibility of the option
Municipal spatial planning	Municipalities and communities promote the construction of small flood protection works	Limited financial resources

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Supportive towards option	Low flexibility of the option; limited financial resources	Targeted installation of flood protection works
Municipalities	Supportive towards option	Limited financial resources	Targeted installation of flood protection works

WMO30: Cooperation for storm water drainage system

Overall description of the WMO

Short explanation	Cooperation between municipalities for the design of storm water drainage systems at the downstream watershed level. This is a soft measure.
Addressed challenges	Flood risk reduction.
Target locations and water uses	This option targets the downstream watershed areas.
Benefits	The improvement of cooperation between municipalities significantly reduces urban runoff and the flooding from the Pedieos river, while it improves the ecosystem services provided by the river and the riparian zone (including sediment and nutrient filtering, bank stabilization).
Potential negative impacts	-
Timeline of implementation	The improvement of cooperation for storm water drainage systems can be effectively functioning on short term (<5 yrs), while the expected lifetime of cooperation strengthening is medium (5-10 yrs). The expected time since the option is implemented until it starts to have the desired affect is short (<5 yrs).
Feasibility	Minor obstacles (mainly organizational) for the implementation of the option that can easily be overcome.
Robustness	Very robust option since it can maintain its effectiveness under changing climatic and socioeconomic conditions.
Flexibility	Flexible option under different climatic scenarios that can be complemented with the majority of water management options addressing flood protection issues.
Costs	The total implementation cost of the option towards 2030 is approximately 384,000€.
Synergies and conflicts with policy objectives	Significant synergies with flood protection policies.
Acceptance	High acceptability of the option among municipalities.
Suggested stakeholder involvement	River basin municipalities
Preconditions for success	The creation of a coordinating center between municipalities for the design and evaluation of storm water drainage systems
Concrete examples where applied	There is cooperation between river basin’s municipalities but it is not effective

Matching the WMO with the policy basis (Step 2.1)

Name of policies	Opportunities	Barriers
Municipal spatial planning	Municipalities aim to strengthen cooperation amongst their competent authorities	
Floods Directive	Floods Directive encourages cooperation between municipalities within sub-basins.	

Identifying stakeholder willingness and possible commitments for implementing the WMO (Step 2.1)

Relevant stakeholders	Stakeholder attitude on WMO		Possible involvement
	Opportunities	Barriers	
MARDE; Water Development Department	Water Development Department promotes cooperation between river basin's municipalities		Water Development Department may operate as a coordinating center between municipalities
Municipalities	Supportive towards option		Organise regular meeting between municipal competent authorities

5. Rmel River Basin, Tunisia

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Foreword

Sustainable water management under climate change is an urgent challenge for the Euro-Mediterranean region. Future climate change projections estimate an increase in water scarcity and droughts in the region, causing substantial socio-economic losses and environmental impacts.

In this context, efforts are needed to strengthen public participation and embed a sense of responsibility within the society concerning water management and adaptation towards these threats. The combination of improved awareness, mutual learning processes and shared responsibility of the civil society and stakeholders are key to ensuring successful adaptation strategies and their implementation, leading to increased resilience of the social-ecological system of a river basin.

BeWater is an EU-funded scientific project (FP7) that intends to address the above challenges by promoting dialogue and collaboration between science and society. The project stands for a process of building resilience based on the engagement of a wide group of stakeholders, with the goal of achieving a sustainable and adaptive management at river basin scale. From 2013-2017, the BeWater project worked together with four Mediterranean river basins to collaboratively develop river basin adaptation plans in each area. The European Commission's 7th Framework Programme funded the project, which involved 12 consortium members. Close cooperation between the four river basins, including the Rmel (Tunisia) as well as Pedios (Cyprus), Tordera (Spain) and Vipava (Slovenia), and the remaining project partners guided the process of writing the respective river basin adaptation plans.

Over the course of the 3.5-year project, the following river basin adaptation plan for the Rmel river basin has been developed. This basin was selected due to the need for increased awareness of challenges facing its citizens and the environment due to global changes. The plan that has been developed is thus the result of intense team effort, targeted information gathering, wide stakeholder involvement, critical analysis, and thoughtful planning.

The main emphasis of this river basin adaptation plan is on the selection of water management options that will improve sustainable water management in the Rmel river basin in the short and long term future. The goal of the adaptation plan is to act as a catalyst for the development of further river basin adaptation plans in the Mediterranean region, as well as across Europe more broadly.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 612385

5.1 Introduction

5.1.1 Context

The watershed of wadi Rmel is located on the eastern coast of Tunisia, about 80 km south of Tunis. It provides a transition between different regions: the north of the Tunisian dorsal, the Sahel and the Cap Bon. This basin extends essentially on the Zriba delegation of the governorate of Zaghouan and a substantial part of the same governorate with a total area of approximately 87,000 ha. The total population in the basin is estimated at 135,438 inhabitants, according to the latest (2014) figures.

The basin is part of the average semi-arid bioclimatic stage with only the West Zone in the highest semi-arid. The limits in the South West are located in the subhumid (Figure 1).

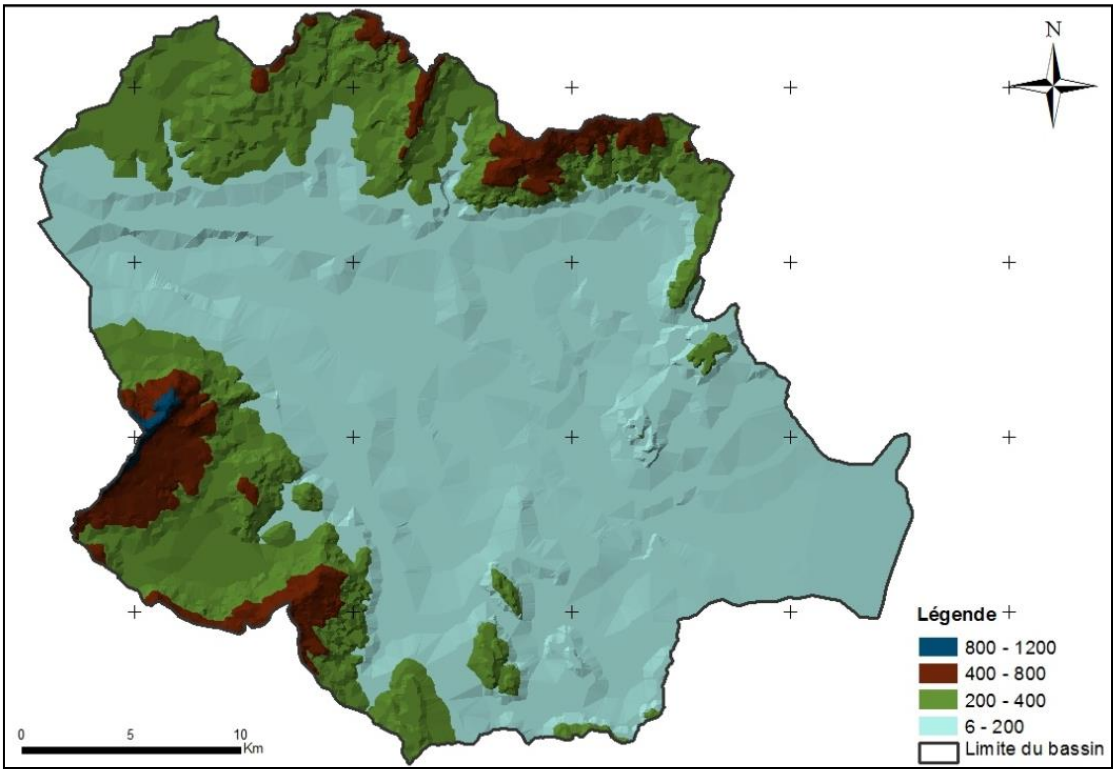

Figure 1. Topographic map for Rmel river basin

Global changes (e.g., climate, population, land use, economic development) pose major challenges in the Rmel river basin. In fact, water resources in this watershed, as in most parts of Tunisia, are limited, unevenly distributed and annually variable. In light of future climate conditions, the growing demand for water by various sectors (agriculture, drinking water, industry and tourism) will exert acute pressure on these resources in the next years and will therefore bring a confrontation between resource supplies and needs. Consequently, the management of water resources remains a prominent issue whose resolution requires the roll-out of management plans not only on a large-scale (national level) but also on a small scale (watershed level).

The development of an adaptive management plan for a watershed requires a good knowledge of the general context (e.g., existing resources, the main problems and issues) and a strong mobilization of stakeholders at both national and local levels. The involvement of the local population (e.g., public actors, farmers, civil society and associations) is fundamental as it allows a better understanding of the current needs and constraints as well as an acceptance of commonly agreed solutions. In addition, a participatory approach leads to rising awareness among local actors on the challenges related to integrated water management and displays the need to adapt to global changes. It promotes a deeper sense of ownership of the water management.

5.1.2 Approach and objectives

The Rmel River Basin Adaptation Plan was developed through an iterative process of mutual learning, participatory techniques and a bottom-up approach to ensure that stakeholders play an active role in developing appropriate strategies for the management of river basins. Several groups of stakeholders were invited to express their interest and views to manage water resources at Rmel river basin. They took part in two workshops, as well as several dissemination events and interviews. Relevant discussions were conducted every time to describe the current situation and the main issues regarding water resources. Therefore, specific local knowledge, several suggestions and different water management options that would be considered at the Rmel watershed scale emerged. The participatory workshops led to the identification of six water challenges and nineteen options. Among the mentioned options, we highlight those related to water erosion, forest fire, the overexploitation of natural resources and the introduction of agricultural best practices.

The Rmel river basin adaptation plan is a pilot case developed within a research project (Bewater). One of the underpinning objectives was to develop a novel approach to engage with society on matters related to sustainable water management and adaptation to global change. This document presents the synthesis of the initiative and key recommendations. As such, the plan is voluntary and should be seen as a source of inspiration and ideas for the future management of the Rmel river basin and beyond.

The objectives of the river basin adaptation plan, and the process that led to it, are:

- To raise public awareness of the importance of sustainable water management, with particular focus on the expected climate change impacts at river basin scale;
- To actively engage with local communities to discuss current water uses, related problems, and potential solutions;
- To present in a synthetic way a range of options and key recommendations which can increase the capacity of the Rmel river basin to adapt to the impact of global changes on water resources.

5.1.3 Overview of contents

This document presents the outcome of the two first Bewater participatory process in developing a river basin adaptation plan for the Rmel river basin.

The document presents the following:

- The process of developing the river basin adaptation plan
- An overview of the current and future conditions of the Rmel river basin
- The identified challenges and the list of selected Water Management Options

In addition, the annex presents more information on each water management option. The current document is a draft, compiling the up-to-date information produced through the Bewater project.

Future research and participatory activities are planned in particular regarding the more detailed development of WMOs, their bundling against challenges and pathways for implementation.

5.2 The development of the river basin adaptation plan

5.2.1 Living in the Rmel River Basin

The Rmel river basin is spread over 17 local territorial units called “*secteurs*” (Figure 2) and covers administratively four governorates (70% in Zaghouan, 19% in Sousse, 8% in Nabeul and 3% in Benarous). Several delegations act in the Rmel river basin: four in Zaghouan (Zriba, Zaghouan Saouaf and Bir Mchergua), one delegation of Sousse (Bouficha), a delegation of Nabeul (Hammamet) and one of Ben Arous (Mornag). The total population was estimated in 2012 at about 135, 438inhabitants, with about 46% living in urban areas and 54% in rural areas. Agriculture is the largest sector in the area, but the area also welcome forestry, agro-tourism and industrial activities. The rural population is constantly looking for casual off-farm employment opportunities or emigration to the neighboring governorates.

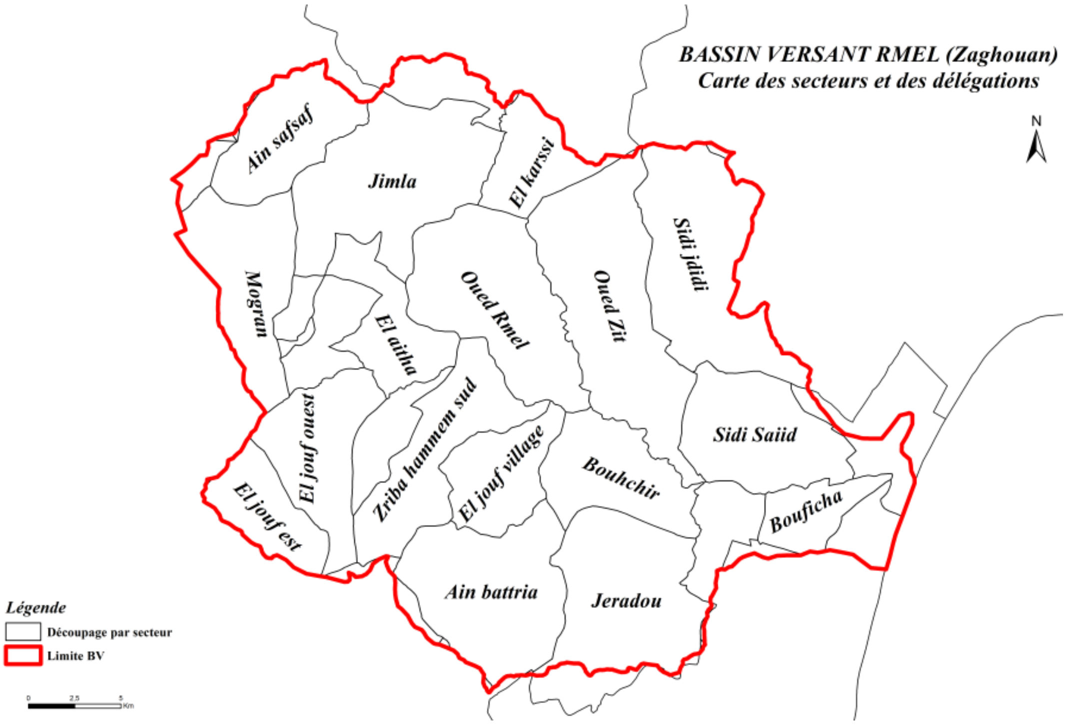

Figure 2.Map of local territorial units in the Rmel river basin

The distribution of the population in the basin is closely related to water resources. Indeed, valleys or so called wadis, small lakes and groundwater (aquifers and springs) are among the factors encouraging sedentary populations in the basin. In addition the Rmel river basin has a strong cultural heritage around water resources (see textbox below).

Textbox 1. Cultural heritage in the Rmel river basin: The Temple of Water

A historic feature of Zaghouan Governorate, which is the most important part of the basin under study, is the roman monument "The temple of water", located behind the city of Zaghouan and right under the mountain of Jebel Zaghouan. It was built near the water source known since antiquity. In addition to the water temple, there is an aqueduct connecting Zaghouan to Carthage, allowing the water supply to the Terms of Antoninus and a source for the temple.

The Rmel river basin and its citizens nevertheless face great challenges in relation to sustainable water management. Important gaps with regards to drinking water supply and wastewater

treatment remain, while demand for further economic opportunities and development is high. The unemployment rate at the governorate level was evaluated in 1999 at 25%, against 15.8% nationally. However, more recent estimates for 2012 put unemployment at 8.9% in the governorate of Zaghouan. Future economic development is likely to result in growing water demand. With limited available resources and increased aridity with climate change, the rising pressures on water resources is a challenge for the near future.

The Tunisian Government has established an extensive national legal framework, reflecting, on the one hand, an awareness of the problems related to the management of natural resources, and, on the other hand, its commitment to improve the rational and sustainable use of water for future generations. This legal framework is composed by provisions contained in codes such as the water code, the forestry code, the investment incentives code, as well as a wealth of laws, regulations, and ministerial orders. However challenges remain, in particular regarding levels of enforcement, which are closely linked with the lack of financial resources to support implementation and effective governance to support collaboration across the large range of actors relevant for sustainable river basin management (see text box 2).

The “Water Code”, now being revised, is the major legislative instrument for water management in Tunisia since 1975. This code is the legal baseline organizing the ownership and exploitation of water in Tunisia. In addition, every five years, the Tunisian Government sets its “Development Strategy” which includes a core component on water. Management is based primarily on a system of financial incentives for the promotion of facilities and water-saving technologies. The government offers subsidies for farmers to promote the rationalization of water in agriculture. In addition, the “Development Strategy” promotes the decentralization of the state and the participation of users in water management. The authorities display an interest in the conservation and water policy domain; authorizations or concessions affecting water, water resources, drinking and agricultural water, as well as the fight against water pollution.

In Tunisia, rural development is considered in the context of five-year socio-economic development plans. The Ministry of Agriculture and Water Resources is the body responsible for water resources mobilization and development, to ensure access to drinking water for the urban and rural population and supply water to the agriculture, industry and tourism sectors. Technical bureaus within the Regional Offices for Agricultural Development (ROAD) enforce all programs and projects at the regional level. These are the government’s main agricultural development institutions in each governorate. The districts are represented in the delegations by representatives. Often under Integrated Rural Development Programs (IRDP), the representatives are supported by a management unit (PMU). It is divided into the departments for water resources, forests, land resources and agricultural engineering. In addition, the CRDA works closely with Agricultural Development Groups (GDA) which bring together owners and users to jointly manage natural resources.

Textbox 2: Water management in Tunisia: historical development and current challenges

Early on, the risk of water scarcity has prompted the political class to take decisions and to set specific strategies in this sector. The first strategy of water resources management that Tunisia undertook after independence was considered as a technical investment phase (1960-1980). It was marked by the construction of large hydraulic structures that mobilized more than 50 per cent of total agricultural investment. These projects stored, allocated, transferred, treated and distributed water resources. These choices were based on the logic of better resource allocation between different regions in order to accelerate the country's development. This infrastructure was intended to increase agricultural production in the northern region, ensure the supply of drinking water, promote the tourism industry in the Sahel, and supply large cultivated areas with irrigation. However, the legal and structural component that accompanied these programs resulted in a policy which encouraged intensification of agriculture and natural resource use.

Since 2000, a period of adjustment has been occurred, characterized by the launch of several studies (e.g., Water 2000 - water sector strategy) for the rational and sustainable exploitation of water resources. This policy aims to promote a number of “modern” water management approaches such as water demand management, better water pricing, encouraging water saving, reinforcement of collective management, and promotion of small and medium hydraulic infrastructure.

Nevertheless, several challenges regarding water management in Tunisia remain, in particular in rural river basins such as the Rmel. Investments in large hydraulic projects did not always result in widespread benefits and the emergence of a resilient rural economy. Rural society is suffering from unemployment and underemployment, rural exodus with the loss of know-how in traditional irrigation practices, the accentuation of regional imbalances favouring urban development and the industrial and touristic sectors, and the emergence and a deepening, chronic food deficit. Small hydraulic structures, which have the potential to benefit small farm holders, are mobilizing less than 10 per cent of total agricultural investment. In parallel, decentralization and local water governance remain to be fully established and appropriated by the government and society. Water associations have had mixed success, with issues regarding enforcement, empowerment, commitment and inclusion of marginalized farmers.

5.2.2 RBAP development and stakeholder engagement

5.2.2.1 The first stakeholder workshop

The first BeWater workshop in the Rmel river basin took place in Zaghouan on 24 June 2014, and was hosted by the river basin partner, the National Research Institute for Rural Engineering, Water and Forestry (INRGREF). It aimed at gathering a representative and knowledgeable group of stakeholders in the basin, in order to discuss the current water use problems.

The attending stakeholders were first introduced to the BeWater Project and were further briefed on the current situation of the river basin and the forecasts and projections towards 2030. Subsequently, through various interactions in groups and in plenary, they identified specific issues and challenges in the medium-long term for the Rmel river basin. They then created a vision for the river basin for 2030. Furthermore, they also reflected on options, understood as measures or sets of measures, aimed at achieving that desired state in the river basin by 2030. These options ranged from being technical, nature-based, soft (managerial, legal, policy, awareness, etc.), to any other type considered relevant. Finally, the participants were also asked to indicate the issues, desired state and options on a geographic map of their river section. This map was then presented to the other groups, allowing all participants to have a good overview of the outcomes of the workshop.

5.2.2.2 The second stakeholder workshop

The second BeWater stakeholders' workshop was held in Yasmine Hammamet (Tunisia) on June 4th 2015, and was attended by 24 stakeholders and the research team. The main objectives of this workshop were to bring the Rmel basin stakeholders together in order to discuss the progress registered since the first stakeholder workshop (2014) and to collect their opinions and evaluations of the the water management options (WMOs).

The 6 main challenges identified during the first workshop (water quantity, agriculture, water quality, forest resources, awareness campaign, human resources and creation of jobs) were heavily discussed. The participants selected and ranked the most important criteria for characterising the WMOs through a multi-criteria analysis (MCA). The preliminary results of MCA for each challenge, the average weighing of different criteria for the participants, the results of impact assessment and the characterization of options were then discussed. Participants evaluated whether these results fit their expectations and prior debates. The workshop concluded with an outline of the workshop outcomes and how they would feed into the "next steps" of the project. This enabled participants to form a comprehensive and enriched idea about the project, by exchanging reactions and raising highly interesting and relevant questions.

5.2.3 List of engagement and dissemination activities

The Rmel River Basin Adaptation Plan was accompanied by an extensive awareness-raising programme targeted at the broader society in the Rmel and beyond.

Table 1: List of engagement and dissemination activities

Dissemination/engagement activity	Content	Target group	Dates
First Rmel river basin workshop in Zaghouan	-Introduction to the BeWater project. -Discussion of the current water use problems in the Rmel river basin. -Identification of the issues and challenges in the medium-long term for the Rmel river basin. -Reflection on the water management options.	Public authority, Academia, civil society, Education and youth, Agriculture, water, forest management, environment, tourism	24 June 2014
The Rmel awareness campaign	-Raising awareness on the BeWater project. -Discussion of banners that tackle several subjects (e.g. a better adaptive water management in the Rmel river basin, global change and related challenges in the Mediterranean, Adaptive Water Management in the Mediterranean, climate changes impacts in the Rmel river basin and ways to adapt) -Discussion on the first draft of water management options and the fuzzy cognitive map	Public authority, Academia, civil society, Education and youth, Agriculture, water, forest management	16 December 2015
Second Rmel river basin workshop in Hammamet	-Introduction to the BeWater project. -Discussion of specific aspects of the basin highlighted during the first stakeholder workshop (water management options and main challenges). -Ranking of the most important criteria for characterizing the WMOs. -Evaluation of the water management options. -Discussion on the preliminary results of the MCA for each challenge.	Public authority, Academia, civil society, Education and youth, Agriculture, water, forest management.	4 June 2015
Third Rmel river basin workshop in Tunis	-Introduction to the BeWater project. -Evaluation and validation of the water management options. -Discussion on the preliminary results of cost-effectiveness for the water management options.	Public authority, Academia, civil society, Education and youth, Agriculture, water, forest management, environment, tourism	7 October 2015
Meeting with individual stakeholders within different Offices (central and regional)	-Discussion on the water management options and the fuzzy cognitive map.	Public authority, agriculture, water, forest management, environment, industry	October/November 2015

5.3 The Rmel River Basin

5.3.1 Current and future state of the river basin

5.3.1.1 State of the Land

The Rmel watershed is characterized by a relatively rugged land, especially in the mountains of south-west and the north-east, and by medium to steep slopes. Slopes are between 0 and 10% over most of the basin, the steepest slopes are encountered mainly in southwestern and north-east side. The basin is characterized by a large variety of soils (Figure 3), such as the raw mineral soils, rendzinas, vertisols, isohumic, and fersiallic soils. Three main formations however dominate: slightly evolved intake soils, brown calcareous soils, and complex soil units.

The basin is covered by forest formations ranging from degraded scrubland to dense forest. Bushes or scrubland areas as well as forest relics of Aleppo pine occupy deposit slopes, forming the catchment. In the hills connecting the mountain, low lands lopes and agro cereal. Plains and piedmonts are under a heavy human pressure. They are systematically cultivated, mainly cereals, which speeds up the process of soil erosion and consequently land degradation.

At the site of the dam of the oued Rmel and its depression zone, the vegetation cover of the area is generally dominated by herbaceous crops, grazing areas, tree crops and forest plantations. The predominant vegetation in this zone is generally formed by formations of Olea europea and Pistacia lentiscus, Eucalyptus spp, Tetraclinis articulata, Pinnus halepensis, and Quercus ilex. Regarding animal communities, they are usually dominated by waterbird species.

The Oued Rmel watershed is a rich region in wildlife, as reflected in the variety of species such as boar, jackal, fox, wild cat, and partridge. It is important to stress some species of birds such as hawks that are sedentary, while others are migratory as the booted eagle or dove. The wealth of wildlife has declined but remains important and deserves to be developed as it may be the basis of a great contribution to launch the green tourism in the area: near Tunis, Hammamet, Sousse, in an attractive environment where the forest and hill dams are highly valued landscapes.

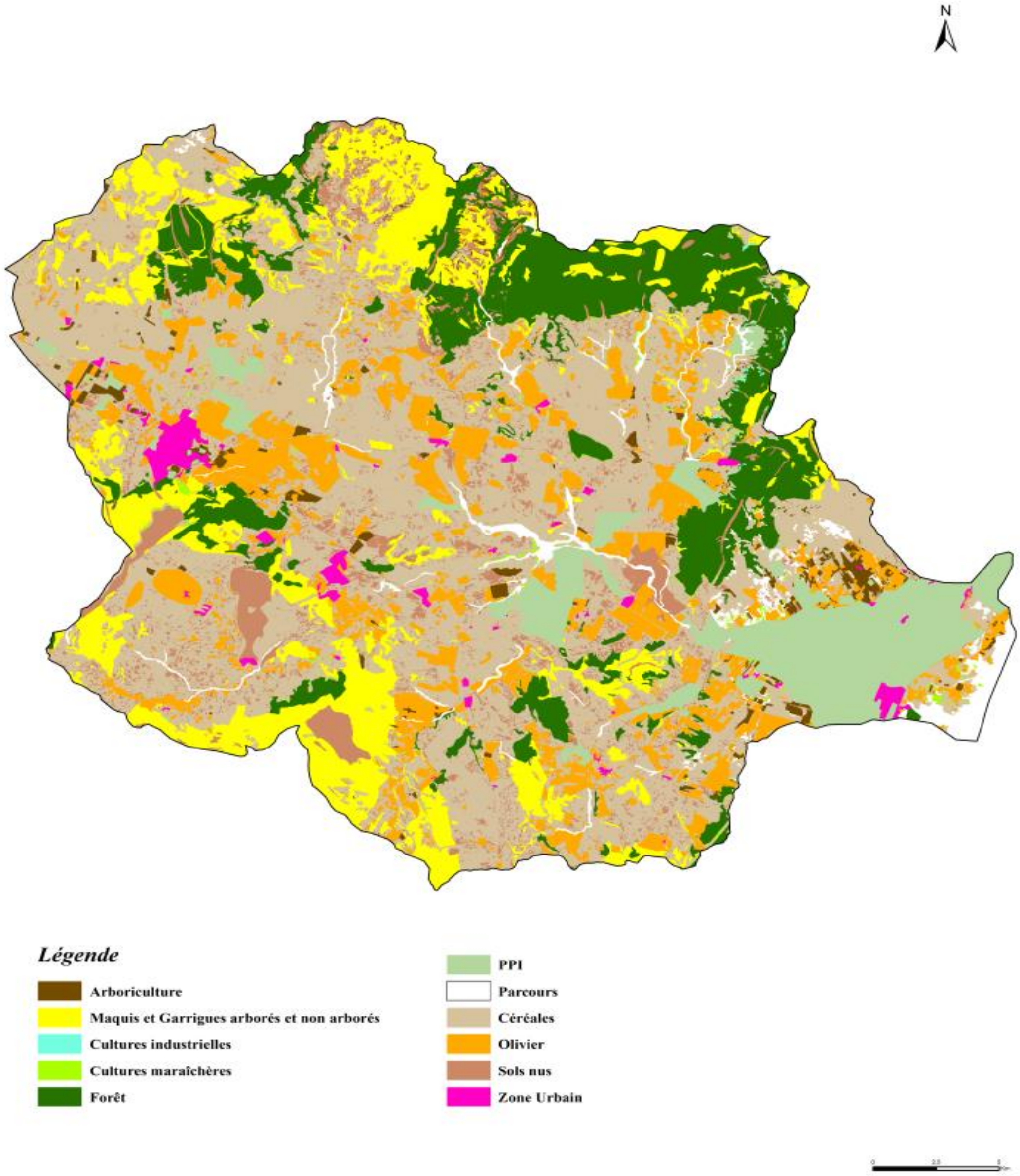

Figure 3. Soil cover at Rmel river basin

5.3.1.2 State of Water Resources

The Rmel watershed is subject to a double influence climate, Mediterranean and continental, with an average temperature of 18.5°C. As a result, precipitation is very irregular, both intra-annually (with long dry summers) and inter-annually (with frequent multi-annual and decadal droughts). Average rainfall range for example from 350 mm to 600 mm. In addition, the basin has two deep groundwater bodies with a capacity of 8.38 million m^3.

Rainfall variability represents one of the biggest challenges regarding water resource development in the Rmel river basin. A dam with an initial capacity of 22 million m^3 was constructed in 1998 about 9 km from the city of Bouficha. Water is intended mainly for the irrigation of 5900 ha of cropland in Bouficha and about 500 ha in Zaghouan. Additional infrastructure has been developed to exploit water resources. These are: 13 used natural sources, 104 boreholes, 370 shallow wells, and 22 small lakes. Groundwater use and drilling is primarily intended for irrigation and drinking water supply, and provide a “security” valve during dry years. Small lakes are intended either for irrigation, for groundwater recharge, or for the protection of the Rmel dam against siltation (Figure 4).

In Tunisian semi-arid areas, the overall annual amount of precipitation is rather low and characterized by high annual and seasonal irregularity. The summer rain is generally of the convective type and breaks out as storms on the relief. During these short, sudden, and violent storms heavy runoff is typical. The floods that originate in the mountains spread onto the coastal plains in the eastern part, where they represent either a source of life for the farmers or a catastrophe that destroys their assets. The wadis are quite wide and shallow. They are known to be unpredictable. Almost everywhere during rainstorms they carry large quantities of water and sediments, blocking traffic for hours, and threatening the lives and property of the people along their usually dry banks.

Water resources management is based on surface and groundwater water use, cereal crop agriculture, tree farming, and cattle grazing. The problem of storing a near-annual volume of rainwater that falls in only 5 months is a known issue to sustain agricultural activities within the different geomorphological units.

Reliefs and the steepest slopes are reserved for cattle. The valleys are the areas of cereal crops or trees that do not require irrigation. The latter include olive, almond, and many cacti types in the driest regions. The glaze (artificial mound sloped) and cone of dejection foothills are covered with cereals and orchards competing routes and steppe alfa (Stipa tenacissima). The floodplains are the areas of where irrigated crops are sown.

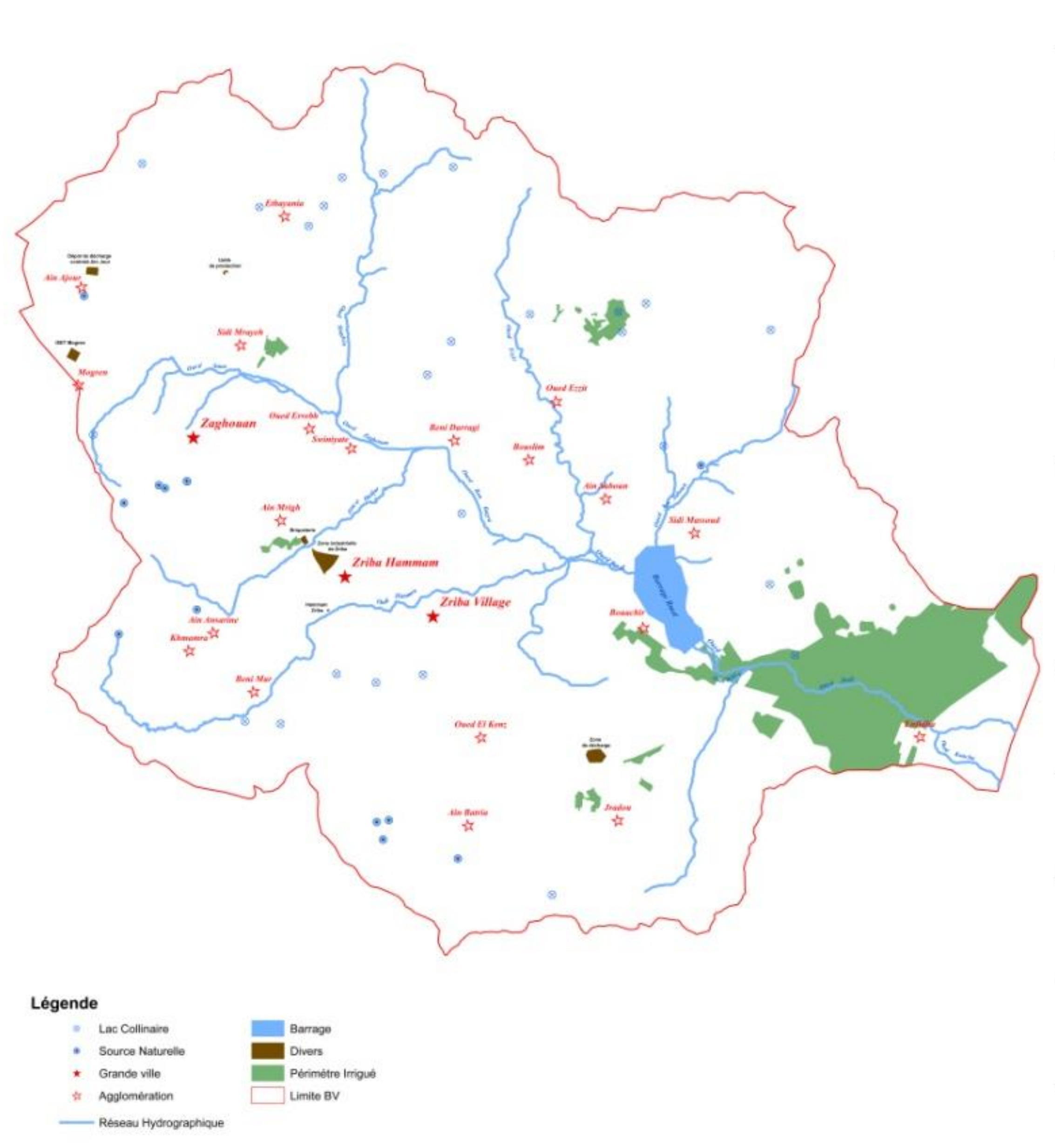

Figure 4. Observation network and Hydraulic Infrastructure at Rmel river basin

5.3.1.3 People and socio-economic activities

Households, drinking water supply and wastewater treatment

The provision of drinking and irrigation water is estimated to be satisfactory for 20% of existing networks (called « *groupement de développement agricole professionnel* »), medium for 55% of existing networks and weak for the remaining 25%. Despite several programmes providing technical support and training, several challenges remain. This include for example low level of capacity by administrative council members who participate voluntarily to the management of the network, the complexity of existing networks with repeated expansion and the multiplication of individual connection (including illegal connections), the lack of maintenance to prevent the deterioration of the equipment, low cost-recovery of maintenance and operational costs, delays for reparations, and limited women participation. In mountainous regions, drinking water provision is manual or through cisterns that are transported within 3km of the water source. However, households are increasingly seeking connection to a drinking water network. Since 2007, new rehabilitation projects aim to provide households access to the drinking water network.

Agriculture and irrigation

Agriculture represents approximately 8% of gross domestic product in Tunisia, about a tenth of total exports. In the Rmel river basin, agriculture is still the largest economic sector for employment with 31.9% (as opposed to 20% for Tunisia as a whole), closely followed by the manufacturing sector with 28%. Agricultural employment has gained momentum with an increase of 9.2% employment between 1999 and 2010. In rural areas, agriculture accounts for 34% the main source of employment and it provides jobs to almost all rural women (World Bank, 2012).

Traditional self- subsistence agriculture is important in the Rmel river basin. It includes annual cropping of cereals and vegetables and a diversified extensive livestock dominated by goats and sheep. Field crops (wheat, barley) are the grown in the area, followed by vegetables and arboriculture. Cereal crops are important source for the basin with annual average production of 25 tonnes/ha. The yields reach 50 tonnes/ha under irrigation context. This importance is the result of improved payoff of this activity following the increase of sales prices registered in recent years. Livestock farming is mainly based on grazing of range land and scrub forests, fallows and stubbles. Forage resources are insufficient and do not cover the needs of the herds (cattle).

A study conducted by the Department of farmland conservation and management at Sbaihia sub-basin (a representative hill lake in the Rmel river basin), shows that 40% of agricultural land in the basin belong to large farmers or non-resident owners, who practice cereal agriculture. 30% of land belongs to local families relying on low-yielding cereal crops, extensive production and especially off-farm income (migration, construction workers). The financing of agricultural private investments in the governorate of Zaghouan is largely provided by self-financing and bank loans, which represent 92% of the total. These investments were in the order of 23 million dinars in the year 2012. Agricultural activity is supervised by agricultural technicians assigned to especially agricultural extension, animal production, irrigation and crop production. Agricultural extension is provided by local cells of the extension.

Farmers are often organised into cooperatives which aims to secure the provisioning of material and consumables, develop infrastructure (e.g. irrigation) improve production, and facilitate product commercialisation. Cooperatives are non-for-profit organisations with the sole aim to increase profits of members by reducing costs.

Industrial activities

The Rmel river basin holds an industrial zone with an area of 44 ha. It is located in the delegation of Zriba and contains 38 companies with a total workforce of 4,500 employees. This area is causing a water pollution problem due to direct dumping of waste in waterways. The development of the competitiveness of the industry: This objective fits within the logic of the liberalization of economy and its integration into the global economy. It is therefore globalization that has made competitiveness a key objective of which the application to agricultural products is likely to cause not only a real redeployment of productive choices and resource allocation systems at micro-economic but also new directions in agricultural policies.

In addition to agriculture and industrial activities, the Rmel river basin consists of 20% of forests that are used mainly for firewood, the extraction of oil, and the production of alep seeds. Given the mountainous landscape, several areas of the watershed have been considered for agro-tourism projects.

5.3.1.4 Future challenges: impacts of global change in the Rmel river basin

Water demand in Tunisia is estimated at 2,689 Mm^3 in 2010 and projected to reach 2,770 Mm^3 by the year 2030. Main water uses are irrigation, tourism, industry and drinking water (Figure 5). The demand for irrigation presents 77% of the total potential in 2030, making agriculture by far the largest water consumer. Drinking water demand was estimated at 381 Mm^3 in 2010 and is projected to reach 491 by the year 2030 views of population growth (inhabitants will be reach 12 million by 2030). For industry, is projected to almost double between 2010 and 2030 going from 136 Mm^3 to 203 Mm^3. Concerning tourism sector, water demand was estimated at 19 Mm^3 in 2010 and is projected to reach 41 Mm^3 by the year 2030. Overall, the trend of mobilization of water resources shows that groundwater and surface water will be totally mobilized in 2025. Therefore, it will be necessary, from 2020, to have recourse to unconventional water resources to respond the demand of different sectors.

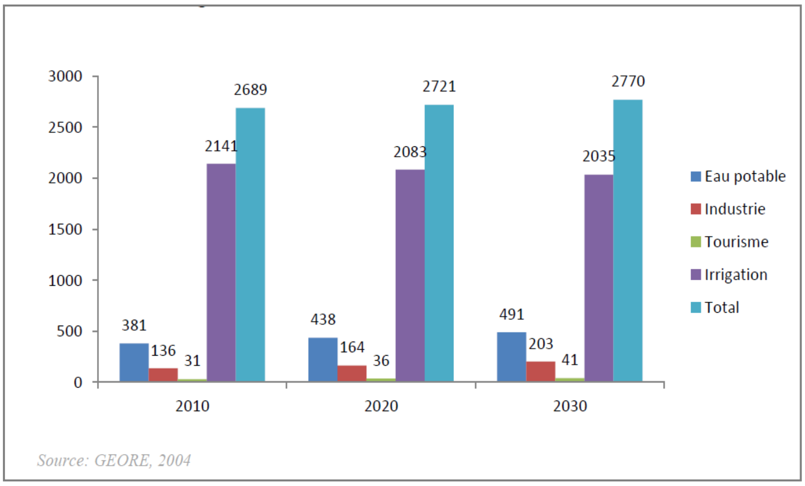

Figure 5. Future demand for water resources in Tunisia

The impacts of climate change on water resources are multiple (see texbox 3). Groundwater resources, primarily in groundwater of high salinity, coastal aquifers and not-renewable aquifers are forecasted to decrease by 28% in 2030. Sea level rise will put additional pressure on coastal groundwater through saline intrusion. The decrease in surface water will be about 5% in the same horizon. The exploitable water will decrease slightly. The decrease in summer precipitation will increase the lack of soil moisture.

Textbox 3. Impacts of climate change in Tunisia

Climate projections for Tunisia have been made with the HadCM3 model (general circulation model coupled atmosphere-ocean) to quantify and evaluate the increase in temperature and the likely decrease of rainfall. The study examined changes in precipitation variability and extremes for the horizons 2030-2050, as compared to the reference period 1961-1990. The projected impacts of climate changes include:

- Increased frequency and intensity of extreme dry years.
- Drier and wetter periods should vary greatly from one season to another.
- Moderated decreasing of rainfall
- Temperature increases (range +1,1ºC in 2030 to +2,1ºC in 2050)

The main resources directly affected by these climate changes are water resources, ecosystems and agro-systems.

Agriculture will be impacted in multiple ways. In the occurrence of a succession of dry years, lower production of olive and cereal area in the centre and south is likely tob e observed as well as reduced cattle in the north but especially in the centre and south. In case of favourable rainfall years, the security performance of the dry oil production and yields of rainfed arboriculture will

increase by 20%. In case of flooding, irrigated cereal, production will be affected. In the South, climate change may render the situation of oasis (microclimate) more critical.

There will be an increased risk of large fires in the North of Tunisia. Rising temperatures and sea levels (50 cm by 2100) is likely to increase coastal erosion and will cause the advance of the sea to the mainland coastal areas, posing threats to the integrity of coastal wetlands. All sebkhas with an area of 730 ha will turn into lagoons. The Gulf of Hammamet with an area of about 1400 ha will turn into lagoon.

5.3.2 Main challenges and their interlinkages

Building on the information collected during the first workshop and additional interviews that were conducted in the Rmel river basin, six main challenges are identified.

5.3.2.1 Water quantity

In the study area, the rainfall regime is characterized by irregularity and high intensity that cause soil degradation. Also, unconventional human activities (overgrazing, bad agricultural practices…), accelerate erosion. The limited water and soil conservation techniques all over the catchment and their conditions are causing reduction of the dam storage capacity. Certain areas remain disserving drinking water. Losses in the drinking water supply network and low flows affect the quantity of water especially during peak hours. Responding to the needs of the local population, proper water management is apriority in our basin.

This challenge is related to water and soil conservation techniques, soil degradation, flooding, surface water and ground water, irrigated cropland, soil water reserve, water demand, water availability in reservoirs.

5.3.2.2 Water Quality

This region consists of 33 enterprises that release their waste liquids (waste of olive presses, lime) in the river Oued Rmel. These waste liquids have a high influence on the water quality in the basin. Wastewater treatment and control of contamination of the river is necessary to preserve the water quality in the basin.

This challenge is related to water quality, industry and tourism, surface water and ground water, water demand.

5.3.2.3 Agriculture

The current situation of the irrigated sector is characterized by several levels of exploitation and an overall modest increase resulting from various constraints, mainly related social and land pressures. Agriculture sector can face water shortage during summer time. In fact, the surface water at the Rmel dam is limited and can’t supply all downstream irrigated perimeters. The majority of farmers is very aged and is trapped in ancient techniques and old agricultural customs; moreover, they are struggling with land conflicts. Good management of irrigated perimeters, support of farmers and improving operational and management requirements constitute a challenge to improve agriculture that represents the main occupation of the basin.

This challenge is related to population livelihood and settlements, irrigated cropland, rainfed cropland, job creation, water quality.

5.3.2.4 Forestry and biodiversity management

The forest is both a valuable protective mantle for soil and an incomparable set of sites and landscapes but it is particularly threatened. The over-exploitation of the forest and the intensive agro-pastoral practices have led to severe degradation of forest resources. Consequently, it

becomes crucial to highlight the economic, social, and ecological importance of forests. Future strategies need to develop and ensure the protection of this precious and fragile heritage.

This challenge is related to forest fire, forest resources, soil degradation, pasture and cattle raising, population and settlements.

5.3.2.5 Awareness of civil society

The lack of awareness of civil society about the importance of natural resources is due to the lack of coordination between the authorities and civil society, as well as the fact that local people were kept out of decision making processes(not only in the basin, but in the whole region). Therefore, awareness, training and integration of civil society in studies and the coordination between society and science are necessary for the success of the project.

This challenge is related to population and settlement, forest resources, surface water and ground water, soil degradation, pasture and cattle raising, irrigated cropland, industry and tourism.

5.3.2.6 Human resource and employment

The analysis of socio-economic issues has identified constraints that concern the future beneficiaries: the main constraints mentioned by young people are, namely, guidance difficulty towards vocational training, lack of generating income projects, unemployment, migration, and lack of specialized manpower. A better exploitation of existing human resources in the basin and the creation of jobs in the agricultural sector are a relevant challenge for the development of the area.

This challenge is related to job creation, industry and tourism, population and settlements, irrigated cropland, rainfed cropland.

5.3.3 Uncertainty and knowledge gaps

Based on the results of group discussions during the various workshops, the main uncertainties and weaknesses are mainly:

- The estimations of climate change impacts on water resources availability and the hydrological extreme events (drought, inundations);
- The level of vulnerability of society and water resources at river basin scale;
- The adaptation options to be considered while managing water at watershed level for future climate conditions;
- New kind and design for hydro-agricultural devices in the context of climate change;
- Analysis and modeling tools needed for academia to conduct studies on climate change.

The current institutional context is displaying serious limits. We particularly mention the followings:

- The legal framework needs to be updated. Therefore there is a need for a major review of existing codes (e.g., forestry code, water code, water and soil conservation code and the investment incentives code);
- Remediation of the land tenure situation: Land rights and property rights need clarifications. Moreover, there is need for increased and improved investments;
- Participation of the farmers on the decision making: the preferences of the farmers on the resources management, the set of planning and the development of a legal framework are crucial from now on;
- The ability and capacity of people to get together and organize
- Decentralization: administrative, financial and technical autonomy is to be strengthen besides the central power.

Efforts should be made to raise environmental awareness and behavior among all citizens, including the sustainable use of water. The government can incite a reorientation of the existing institutions. Financial support as well as awareness development can be used to enlighten and educate landowners and land users, and hence let them become more directly involved. Such a commitment can lead to the conception and spreading of interventions that could be understood and streamlined by the local population. The above suggestions come in accordance with the new constitution of the country set during 2014 (article 13 & 44).

Research needs to adopt transdisciplinary methods to work together with society in the development of solutions and innovations for sustainable agriculture and sustainable water use. Society including farmers, local economy, and communities need to strengthen the market of sustainable agriculture. Transparency in production, communicating the negative impacts of practices as well as promoting irrigation through sustainable systems could cause mind shifts among the community toward more conscious consumption as well as open up new business opportunities for farmers and the local economy competing the global market. Policy needs to provide the adequate legal framework to enable education institutions, research, farmers, and community to make use of their capabilities in becoming agents for change toward sustainable water management.

5.4 Water management options

The first list of water management options have been identified during the first stakeholder workshop. This was complemented through additional interviews carried out in the basin to reach a number of 19 options. The latter options were presented discussed and evaluated subsequently by stakeholders during several meetings that took place at regional and central offices including the second workshop of June 4 2015.

Each water management option was defined as options that can be implemented to tackle one or several challenges. These options can include technological and engineering solutions ('grey' actions), ecosystem-based approaches that use the multiple services of nature ('green' actions) and managerial, legal and policy approaches that alter human behavior and styles of governance ('soft' actions).

Taking into account the main challenges, the water management options were divided into six groups.

5.4.1 Water management options tackling challenge 1 (water quantity)

This group contains three water management options:

- **Option 1:Promote a new water and soil conservation technique**. This option aims to promote new water and soil conservation techniques to collect runoff water. These techniques are placed on agricultural lands (upstream) and are based on technological and engineering solutions (waterway development techniques and watershed development techniques).
- **Option 2: Consolidation of existing water and soil conservation techniques**. This option aims to improve the function of existing soil and water conservation techniques based on ecological solutions. It is based on the strengthening of these techniques by plantations. The implication of Rural Development firms (mutual companies of agricultural services) and the setting for incentive context become crucial.
- **Option 3: Creation and rehabilitation of hydraulic infrastructure.** This option aims to improve hydraulic structures to meet the demands of the population (rehabilitation and upgrading of existing networks, construction cisterns and lifting stations, etc.) while maintaining the balance between demand and distribution.

5.4.2 Water management options tackling challenge 2 (water quality)

This group contains three water management options:

- **Option 4: Application of taxes to protect water quality.** This option aims to launch taxes to protect the quality of water resources against the threat that comes from industrial areas, which discharge their waste directly into the wadis. Taxation is necessary for agriculture and for drinking water. The enforcement of the existing laws becomes a duty.
- **Option 9: Improvement of the treatment of wastewater.** This option aims to improve the quality of non-conventional water (treated wastewater + desalinated brackish water) to make it available for crop irrigation.
- **Option 10: Water discharge control.** This option will promote the control of pollutant releases by improving the application of the regulations and recovering waste.

5.4.3 Water management options tackling challenge 3 (agriculture)

This group gathers four options:

- **Option 5: Develop agricultural cooperatives.** Agricultural cooperatives are companies freely organized by farmers to ensure supply of their operations, improve production conditions and facilitate the flow of products. These companies organized under the principle cooperative do not pursue profit. Their exclusive mission is to promote the development of their members' holdings (cost reduction, improved irrigation systems and facilitating the agricultural flow products).
- **Option 6: Development and sustainable use of agricultural land resilient to climate change.** This option targets a proper use of farmland to improve production and reduce the amount of consumed water.
- **Option 7: Development of new financial instruments.** This option will develop of a grant system adapted to the regional context to encourage farmers to improve their production.
- **Option 8: Use of water irrigation technologies.** This option encourage farmers to use water-saving techniques. Based on calculations of the plant water needs, these techniques make it possible to reduce water losses as much as possible towards a better management of water in irrigated land.

5.4.4 Water management options tackling challenge 4 (forest resources):

This group contains four options:

- **Option 11: Reduction of society pressure on forests.** Forest will be protected by implementing prevention and control options in order to reduce overgrazing. Users will be involved and integrated in the management and protection of forests and private forest owners will be compensated for the resulting costs or the losses in production.
- **Option 12: Protection against forest fire.** The protection of forests against fires will be achieved by implementing appropriate techniques and providing the required equipment, as well as by involving users in forest management to make them aware of the importance of conserving these resources to improving their income.
- **Option 13: Introduction of new agro forestry species and enrichment of existing forest).** Good management of forest resources by introducing new species for agroforestry purposes as well as enriching and preserving existing species in order to preserve and develop the forest.
- **Option 14:Promoting a better governance of forest resources.** This option aims to protect forest resources by giving more importance to the application of adapted harvesting practices and to the sustainable use of these resources by local communities. This option requires the support of the government through regulations and laws.

5.4.5 .Water management options tackling challenge 5 (awareness of civil society):

This group gathers two options:

- **Option 15: Awareness campaign and courses on the management of natural resources.** This option aims to raise awareness and improve the degree of information of the civil society concerning the importance of natural resources and the necessity to protect

them for better management and exploitation. These actions must be initiated at the school and be continued for relevant results.

- **Option 16:Involve stakeholders in all steps of decision making.** This option aims to improve the decision-making process with the civil society. The civil society will participate in different types of projects at various stages, but primarily in the decision phases.

5.4.6 Water management options tackling challenge 6 (human resource and employment):

This group contains three options:

- **Option 17: Promote projects that generate more income.** This option aims to improve livelihoods through job creation and encouragement of the launch of income-generating projects.
- **Option 18: Encourage investments.** Facilitate funding by encouraging investment in various fields (agriculture, industry and tourism), taking into account the profiles of the area.
- **Option 19: Developing skills for young people**. This option aims to organize training sessions to facilitate the integration of young people into working life and thus a generation of skilled technicians for proper use of different techniques.

The annexes provide further information on each WMOs. Future research activities will aim to refine the information on each WMO as well as creating bundles of options and implementation pathways for their future uptake by society.

Annex 1 Presentation of water management options

For the Rmel River Basin the matching with policies and the identification of the stakeholder willingness are integrated in the WMO-factsheets. These factsheets will be translated into English in the final RBAP.

WMO1 : Promouvoir les nouvelles techniques de conservation de l'eau et des sols (combined with WMO2)

Description	L'objectif de cette option est de promouvoir de nouvelles techniques de conservation des eaux et du sol pour la collecte des eaux de ruissellement. Ces techniques sont généralement placées sur les terres agricoles amont en pente et en se basant sur des solutions techniques comme les techniques d'aménagement des voies (ex. lacs collinaires, ouvrage de recharge d'eau, seuil en pierres sèche), les techniques d'aménagement des versants (ex. banquettes mécaniques, banquettes manuelles, cordons en pierres sèches) et les techniques douces (ex. labour en courbes de niveaux, bandes enherbées). Ces techniques nécessitent par la suite des travaux d'entretins, de réhabilitation et de consolidation pour garantir leur efficacité ainsi que leur durée de vie.
Enjeux ciblés	Cette option participera directement à la gestion quantitative du bassin et en particulier à réduire le risque de sècheresse et d'inondation. Indirectement, l'option participera à améliorer la qualité de l'eau et à promouvoir une agriculture plus soutenable.
Localisation dans le bassin et utilisations de l'eau ciblées	Une étude de priorisation a été effectuée en se basant sur une analyse multicritère et en tenant compte des critères de sensibilité à l'érosion des sols, de protection des ressources en eau, des aménagements existants, de mise en valeur agricole et socioéconomiques. Les sous bassins choisis sont ceux qui ont obtenus les poids les plus élevés. Les sous bassins choisis sont ceux de l'oued sbayhia, de l'oued Jouf et d'Ain batteria.
Bénéfices	Cette option offre plusieurs bénéfices dont : maximisation de l'utilisation des eaux de ruissellement sur les parcelles agricoles ; maintenance de la fertilité et la productivité des terres agricoles ; diminution du transport solide au niveau du barrage Rmel ; rapprochement des points d'eau aux opérateurs ; création d'emploi et investissements associés.
Impacts négatifs possibles	Cette option implique plusieurs risques, dont : réduction de la superficie des terres agricoles ; contrainte sur le pâturage directe des animaux durant la réalisation des travaux.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Les options de conservation des eaux et du sol ont été l'objet de politiques depuis plusieurs années. Il existe donc une bonne compréhension technique. Leur mise en œuvre demande un renforcement des actions de sensibilisation et de formation auprès des opérateurs. Ces actions peuvent aider à dépasser les problèmes dus au manque de transparence sur le foncier et l'absence de registre à jour des propriétés.
Robustesse	Les techniques de conservation des eaux et du sol contribueront à réduire les risques de désertification quel que soit les impacts des changements globaux futurs. Cependant, il se peut qu'une augmentation de la disponibilité d'eau dans le court terme via les lacs collinaires augmente la dépendance des activités économiques à l'eau et à leur vulnérabilité à la sècheresse.
Flexibilité	La plupart des techniques de conservation des eaux et du sol requièrent peu d'investissements initiaux et sont faciles à modifier (ex. labour, bande enherbée). Certaines options cependant, comme les techniques d'aménagement des voies, peuvent demander un investissement plus important et résulter en une infrastructure difficile à modifier dans le futur (ex. seuil, lacs).
Coûts	En se basant sur des coûts sur une période de 15 ans, le coût nécessaire pour ces deux options est de 5 milliard DT dont 3 milliard DT est pour promouvoir de nouvelles techniques de conservation des eaux et du sol et 2 milliard DT pour la consolidation des techniques de conservation des eaux et du sol existantes.

Synergies et conflits avec objectifs des politiques actuelles	Cette option est principalement soutenue actuellement par le Code de Conservation des Eaux et du Sol qui interdit l'utilisation de tout outil ou technique pouvant entraîner la destruction de la structure du sol dans les zones menacées d'érosion hydrique ou éolienne. Le Code interdit aussi toute action pouvant endommager les ouvrages de conservation des eaux et du sol déclarés d'utilité publique ou exécutés conformément aux dispositions du code des eaux et existant sur leurs terres. Le Code finance et indemnise les propriétaires qui réalisent des travaux de conservation dans le but d'assurer la durabilité de la productivité des terres agricoles. L'option est aussi synergique avec les objectifs de la Stratégie de Conservation des Eaux et du Sol dont un des objectifs est la conservation et l'utilisation rationnelles des ressources naturelles. Le code d'investissement donne lieu à des primes spécifiques en cas de la réalisation de travaux de conservation des eaux et du sol. L'option est aussi renforcée par le 11ème plan de la Politique de Développement Agricole (2007-2011) qui requiert comme condition minimum l'application du Code de Conservation des Eaux et du Sol. L'option se confronte cependant à une politique nationale en agriculture globalement productiviste, ce qui peut entrainer des pratiques agricoles intensives. Il manque aussi des mécanismes de financement appropriés à une gestion plus large des ressources naturelles. Finalement, le Banque Africaine de développement finance entre 2016 et 2021 plusieurs actions cohérentes avec cette option.
Acceptabilité	Les acteurs clefs de cette option sont les agriculteurs et la société civile (acteurs non-institutionnels) et le Ministère de l'Agriculture (instances publiques). Cette option est globalement peu intrusive et aura des impacts bénéfiques directs sur l'opérateur (ex. agriculteur). Elle promeut la protection de l'environnement ce qui sera perçu positivement par les groupes environnementaux. De plus, elle est activement supportée par le Ministère de l'Agriculture via la législation et règlementation en place. Certaines barrières existent cependant. Certains bénéfices de cette option sont peu quantifiables ou difficilement ressentis (ex. amélioration de la fertilité) alors qu'une perte de terrain productive s'effectuera. En même temps, cette option s'applique de manière volontaire sur demande des opérateurs (qui recevront une compensation financière). Actuellement, un manque d'intérêt et de participation de la part des agriculteurs existent. La mise en place d'associations afin de contrer le problème du morcellement se confronte aussi à des procédures administratives longues.
Implications des acteurs	Il faudra renforcer la sensibilisation et l'implication des agriculteurs et des populations locales dans la conception et la réalisation de toutes les actions proposées. L'option peut se reposer en partie sur la Stratégie Nationale de Conservation des Eaux et du Sol qui met l'accent sur la vulgarisation et la sensibilisation des problèmes d'érosion et des réponses appropriées.
Pré-conditions	- Sensibilisation des opérateurs - Compensation financière pour perte de terrain agricole - Implication des opérateurs dans tous les programmes et les projets réalisés dans leurs terres - Une approche collaborative entre propriétaires afin de contrer les problèmes de morcellement du foncier)
Exemples	A développer en 2016

WMO2: Renforcer les techniques existantes de conservation de l'eau et des sols (combined with WMO1)

Description	L'objectif de cette option est de promouvoir de nouvelles techniques de conservation des eaux et du sol pour la collecte des eaux de ruissellement. Ces techniques sont généralement placées sur les terres agricoles amont en pente et en se basant sur des solutions techniques comme les techniques d'aménagement des voies (ex. lacs collinaires, ouvrage de recharge d'eau, seuil en pierres sèche), les techniques d'aménagement des versants (ex. banquettes mécaniques, banquettes manuelles, cordons en pierres sèches) et les techniques douces (ex. labour en courbes de niveaux, bandes enherbées). Ces techniques nécessitent par la suite des travaux d'entretins, de réhabilitation et de consolidation pour garantir leur efficacité ainsi que leur durée de vie.
Enjeux ciblés	Cette option participera directement à la gestion quantitative du bassin et en particulier à réduire le risque de sècheresse et d'inondation. Indirectement, l'option participera à améliorer la qualité de l'eau et à promouvoir une agriculture plus soutenable.
Localisation dans le bassin et utilisations de l'eau ciblées	Une étude de priorisation a été effectuée en se basant sur une analyse multicritère et en tenant compte des critères de sensibilité à l'érosion des sols, de protection des ressources en eau, des aménagements existants, de mise en valeur agricole et socioéconomiques. Les sous bassins choisis sont ceux qui ont obtenus les poids les plus élevés. Les sous bassins choisis sont ceux de l'oued sbayhia, de l'oued Jouf et d'Ain batteria.
Bénéfices	Cette option offre plusieurs bénéfices dont : maximisation de l'utilisation des eaux de ruissellement sur les parcelles agricoles ; maintenance de la fertilité et la productivité des terres agricoles ; diminution du transport solide au niveau du barrage Rmel ; rapprochement des points d'eau aux opérateurs ; création d'emploi et investissements associés.
Impacts négatifs possibles	Cette option implique plusieurs risques, dont : réduction de la superficie des terres agricoles ; contrainte sur le pâturage directe des animaux durant la réalisation des travaux.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Les options de conservation des eaux et du sol ont été l'objet de politiques depuis plusieurs années. Il existe donc une bonne compréhension technique. Leur mise en œuvre demande un renforcement des actions de sensibilisation et de formation auprès des opérateurs. Ces actions peuvent aider à dépasser les problèmes dus au manque de transparence sur le foncier et l'absence de registre à jour des propriétés.
Robustesse	Les techniques de conservation des eaux et du sol contribueront à réduire les risques de désertification quel que soit les impacts des changements globaux futurs. Cependant, il se peut qu'une augmentation de la disponibilité d'eau dans le court terme via les lacs collinaires augmente la dépendance des activités économiques à l'eau et à leur vulnérabilité à la sècheresse.
Flexibilité	La plupart des techniques de conservation des eaux et du sol requièrent peu d'investissements initiaux et sont faciles à modifier (ex. labour, bande enherbée). Certaines options cependant, comme les techniques d'aménagement des voies, peuvent demander un investissement plus important et résulter en une infrastructure difficile à modifier dans le futur (ex. seuil, lacs).
Coûts	En se basant sur des coûts sur une période de 15 ans, le coût nécessaire pour ces deux options est de 5 milliard DT dont 3 milliard DT est pour promouvoir de nouvelles techniques de conservation des eaux et du sol et 2 milliard DT pour la consolidation des techniques de conservation des eaux et du sol existantes.
Synergies et conflits avec objectifs des politiques actuelles	Cette option est principalement soutenue actuellement par le Code de Conservation des Eaux et du Sol qui interdit l'utilisation de tout outil ou technique pouvant entraîner la destruction de la structure du sol dans les zones menacées d'érosion hydrique ou éolienne. Le Code interdit aussi toute action pouvant endommager les ouvrages de conservation des eaux et du sol déclarés d'utilité publique ou exécutés conformément aux dispositions du code des eaux et existant sur leurs terres. Le Code finance et indemnise les propriétaires qui réalisent des travaux de conservation dans le but d'assurer la durabilité de la productivité des terres agricoles. L'option est aussi synergique avec les objectifs de la Stratégie de Conservation des Eaux et du Sol dont un des objectifs est la conservation et l'utilisation rationnelles des ressources naturelles. Le code d'investissement donne lieu à des primes spécifiques en cas de la réalisation de travaux de conservation des eaux et du sol.

	L'option est aussi renforcée par le 11ème plan de la Politique de Développement Agricole (2007-2011) qui requiert comme condition minimum l'application du Code de Conservation des Eaux et du Sol. L'option se confronte cependant à une politique nationale en agriculture globalement productiviste, ce qui peut entrainer des pratiques agricoles intensives. Il manque aussi des mécanismes de financement appropriés à une gestion plus large des ressources naturelles. Finalement, le Banque Africaine de développement finance entre 2016 et 2021 plusieurs actions cohérentes avec cette option.
Acceptabilité	Les acteurs clefs de cette option sont les agriculteurs et la société civile (acteurs non-institutionnels) et le Ministère de l'Agriculture (instances publiques). Cette option est globalement peu intrusive et aura des impacts bénéfiques directs sur l'opérateur (ex. agriculteur). Elle promeut la protection de l'environnement ce qui sera perçu positivement par les groupes environnementaux. De plus, elle est activement supportée par le Ministère de l'Agriculture via la législation et règlementation en place. Certaines barrières existent cependant. Certains bénéfices de cette option sont peu quantifiables ou difficilement ressentis (ex. amélioration de la fertilité) alors qu'une perte de terrain productive s'effectuera. En même temps, cette option s'applique de manière volontaire sur demande des opérateurs (qui recevront une compensation financière). Actuellement, un manque d'intérêt et de participation de la part des agriculteurs existent. La mise en place d'associations afin de contrer le problème du morcellement se confronte aussi à des procédures administratives longues.
Implications des acteurs	Il faudra renforcer la sensibilisation et l'implication des agriculteurs et des populations locales dans la conception et la réalisation de toutes les actions proposées. L'option peut se reposer en partie sur la Stratégie Nationale de Conservation des Eaux et du Sol qui met l'accent sur la vulgarisation et la sensibilisation des problèmes d'érosion et des réponses appropriées.
Pré-conditions	- Sensibilisation des opérateurs - Compensation financière pour perte de terrain agricole - Implication des opérateurs dans tous les programmes et les projets réalisés dans leurs terres - Une approche collaborative entre propriétaires afin de contrer les problèmes de morcellement du foncier)
Exemples	A développer en 2016

WM03: Créer et réhabiliter les infrastructures hydrauliques existantes

Description	L'objectif de cette option est d'améliorer les structures hydrauliques afin de subvenir au besoin de la population tout en contrôlant la demande. L'option consiste principalement à encourager la réhabilitation et la modernisation des réseaux d'eau potable et d'irrigation existants, la construction de citernes afin d'augmenter le nombre d'heures d'accès à l'eau, la création de puits de recharge artificielle des eaux souterraines, la création de puits peu profonds dans des zones ayant un bilan hydrologique excédentaire et amélioration des conditions de pompage, la création de stations de refoulement afin de couvrir la demande en eau de populations rurales, et l'électrification de points d'eau existants créés dans des zones couvertes par l'eau souterraine d'oued Rmel.
Enjeux ciblés	Cette option permettra la gestion quantitative des eaux par la réduction des pertes et des fuites d'eau au niveau des conduites de distribution et d'adduction que ce soit pour l'agriculture que l'eau potable.
Localisation dans le bassin et utilisations de l'eau ciblées	Toutes les zones du bassin sont concernées par cette option.
Bénéfices	Cette option offre plusieurs bénéfices dont un meilleur service aux usagers, une réduction des pertes d'eau, et une réduction de la pression sur les ressources en eau.
Impacts négatifs possibles	Une meilleure infrastructure peut engendrer une utilisation plus intensive des ressources si l'objectif principal n'est pas de rationaliser la demande via une réduction des pertes et une utilisation plus efficace de la ressource.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	La dispersion élevée des habitants et les contraintes d'accès aux sites montagneux limitent la réalisation des projets à des coûts raisonnables.
Robustesse	Les économises en eau, la réduction de la demande et la rationalisation de la distribution en eau potable aidera à contrer les impacts des changements futurs quel que soit leur futur développement.
Flexibilité	Cette option requière un financement important et des capacités techniques et humaines importantes, ainsi que de larges investissements. Ainsi, cette option est estimé peu flexible.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	L'eau constitue une richesse nationale qui doit être développée, protégée et utilisée d'une manière garantissant la durabilité de la satisfaction de tous les besoins des citoyens et des secteurs économiques. L'économie de l'eau est considérée comme l'un des moyens les plus importants permettant le développement, la réservation et la rationalisation de l'utilisation des ressources hydrauliques. Les travaux visant le développement, l'économie, l'amélioration de la qualité et la protection des ressources hydrauliques nationales sont d'utilité publique. La gestion des systèmes d'alimentation en eau potable en milieu rural est assurée soit par la Société Nationale d'Exploitation et de Distribution des Eaux (SONEDE) pour son propre réseau, soit par des associations d'usagers dénommées Groupement de Développement Agricole (GDAP) pour les systèmes AEPR réalisés par les services du Génie Rural. Le nombre de GDAP avoisine 1400 groupements à la fin de l'année 2009. Ces groupements s'occupent, entre autres, de la gestion des systèmes AEPR (vente d'eau, entretien et maintenance des systèmes, etc..). Ils bénéficient de l'appui constant de l'Etat qui a mis en place une stratégie nationale de promotion des associations depuis 1992 afin de développer leurs capacités dans les domaines technique, financier et organisationnel.
Acceptabilité	L'option est globalement estimée être acceptable pour l'ensemble des acteurs. Cependant, le manque de moyens financiers et de capacité technique posera des contraintes en termes de participation et de mise-en-œuvre. Les acteurs clefs de cette option sont : le Ministère de l'Agriculture, la SONEDE, et les GDAPs. Le Ministère de l'Agriculture travaille notamment avec ses services déconcentrés aux Arrondissements de Génie Rural dans les CRDA (24 Arrondissements, soit un par CRDA). La DGGREE en particulier s'occupe de la définition des orientations stratégiques dans le domaine de l'AEPR, la planification des

	projets et l'assistance technique aux Arrondissements de Génie Rural pour améliorer la qualité des études et des travaux ainsi que la formation, l'encadrement et l'accompagnement des GDAPs. La réalisation des études, le suivi direct des travaux l'encadrement, la formation et le perfectionnement des GDAPs sont assurés par les services de l'Arrondissement de Génie Rural dans chaque CRDA comme suit : 1- Le service des études d'AEPR qui a pour rôle la réalisation et la supervision des études sous-traitées à des bureaux d'études privés, et qui intègrent la participation des bénéficiaires dans toutes les phases de l'étude. 2- Le service des travaux AEPR s'occupe de la supervision des travaux réalisés par des entreprises privées. 3- Le contrôle des travaux est assuré par des techniciens préalablement formés en la matière. Mais, compte tenu des moyens humains et matériels très limités au niveau des CRDA, certains d'entre eux ont commencé à sous-traiter cette tâche à des bureaux d'études privés. 4- Le service d'encadrement, de formation et de perfectionnement des GDAP s'occupe du suivi et de l'assistance technique des GDAP dans les domaines technique, financier et social, et ce, dans le cadre d'une stratégie de promotion des GDAP mise en place à l'échelle nationale depuis 1992. La SONEDE intervient en milieu urbain ainsi qu'en milieu rural regroupé et limitrophe à son réseau de distribution selon la même approche appliquée en milieu urbain. Grâce à ses districts régionaux, la SONEDE assure par ses propres moyens la réalisation des études, le suivi des travaux qui sont confiés à des entreprises privées ainsi que l'encadrement, la formation et le perfectionnement. Les Groupements de Développement Agricole (GDAPs) sont créés sur demande de la majorité des propriétaires, exploitants agricoles et pêcheurs concernés. Leur création se fait par arrêté du gouverneur de la région. Chaque GDAP est doté d'un Conseil d'Administration formé de 3 ou 6 membres dont un président élu par les bénéficiaires pour une période de 3 ans. En vertu du décret 2004-24, leurs attributions sont élargies pour toucher d'autres activités ayant trait à la protection des ressources naturelles et la rationalisation de leur utilisation, l'aménagement de l'espace rural, l'encadrement et la formation.
Implications des acteurs	-Organiser des sessions de formations et d'encadrement pour la population locale et les agriculteurs. -Organisation de réunions qui regroupe les responsables dans le domaine pour discuter l'importance de la mise en œuvre de cette option.
Pré-conditions	-Organiser des sessions de formations et d'encadrement pour la population locale et les agriculteurs. -Organisation de réunions qui regroupe les responsables dans le domaine pour discuter l'importance de la mise en œuvre de cette option.
Exemples	A développer en 2016

WMO4: Application de taxes

Description	L'option propose le renforcement de l'application des taxes sur les rejets des eaux usées par les usines. Cette taxation permet de préserver la qualité de l'eau pour l'agriculture et l'eau potable.
Enjeux ciblés	Cette option contribuera à la protection de la qualité des ressources en eau souterraines et de surfaces.
Localisation dans le bassin et utilisations de l'eau ciblées	La zone industrielle de Hamem zriba, zone industrielle de Zaghouan.
Bénéfices	Les bénéfices de cette sont : renforcement des lois et des règlements existants, la protection des ressource en eau.
Impacts négatives possibles	Les taxes peuvent imposer des surcoûts sur les populations et les activités concernées.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Le renforcement de la mise en œuvre des taxes requiert principalement des capacités administratives renforcées, et donc des moyens financiers plus importants.
Robustesse	L'option est principalement de nature administrative et organisationnelle, ce qui fait qu'elle est capable d'être maintenu quel que soit les conditions futures (sous différentes formes si nécessaire).
Flexibilité	L'option est principalement de nature administrative et organisationnelle, ce qui fait qu'elle est capable d'être adaptée en fonction des changements sociétaux, économiques ou environnementaux.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	La politique environnementale reconnait la pollution industrielle comme l'une des sources les plus importantes de dégradation de la qualité des ressources naturelles et de la situation sanitaire et environnementale. Elle vise donc à développer les moyens et les méthodes de prévention de la pollution industrielle. À cet égard, l'aspect juridique a été soutenu et développé à travers la préparation du Code de l'Environnement, et la publication de nombreux textes juridiques et réglementaires.
Acceptabilité	Le ministère de l'environnement est chargé de la coordination et de l'animation de la politique de l'état en matière de développement durable, de la prise de toutes les options susceptibles d'améliorer la qualité et l'efficacité de l'action de l'état dans les domaines environnementaux, ainsi que des options pouvant être requises par la nécessité d'informer les secteurs concernées.
Implications des acteurs	Cette gestion repose sur un soutien aux efforts de communication, de sensibilisation et d'éducation environnementale considérée comme élément de base de toute stratégie visant le changement des comportements. L'option peut être accompagnée de campagnes de sensibilisation auprès du secteur public et du secteur privé.
Pré-conditions	-Etude de mise à jour des normes environnementales pour qu'il soit compatible avec le développement technologique et économique.
Exemples	A développer en 2016

WMO5: Mettre en place des coopératives agricoles

Description	L'option vise à encourager les agriculteurs à s'organiser en coopératives, à former les employeurs dans le domaine de l'agriculture, à guider les agriculteurs en organisant des campagnes de sensibilisation, à renforcer le marché de l'agriculture durable, et à organiser une société englobant les agriculteurs, l'économie locale et les communautés.
Enjeux ciblés	Le regroupement des agriculteurs au sein des coopératives permettra de faciliter plusieurs actions (avoir les intrants, écoulement des produits après récolte) et donc le développement de l'agriculture.
Localisation dans le bassin et utilisations de l'eau ciblées	L'option porte principalement sur les agriculteurs de l'Oued Sbayhia.
Bénéfices	L'option sécurisera les activités agricoles dans un contexte de faibles rendements et de vulnérabilité financière, et ainsi augmentera la capacité des agriculteurs à faire face aux changements globaux futurs.
Impacts négatifs possibles	Non-maitrisée, une intensification des pratiques agricoles peut résulter dans des impacts environnementaux négatifs (ex. pollution de l''eau, utilisation de l'eau), augmentant le risque de conflits entre usages.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	
Robustesse	Le renforcement des institutions collectives dans le domaine agricole et de la coopération entre acteurs renforcera leur capacité à répondre aux changements globaux futurs.
Flexibilité	L'option est peu intrusive et favorise la collaboration volontariste des agriculteurs. Elle peut être ajustée dans le futur pour mieux prendre en compte les changements de contexte.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Cette option est synergique avec les objectifs de la plupart des programmes d'état prônant une structuration plus forte du secteur agricole et la collaboration entre agriculteurs. Cette option peut se reposer sur la Loi relative aux Société de Services Agricoles. L'objectif est donc de renforcer l'application de la Loi au bassin versant Rmel.
Acceptabilité	L'option devrait être bien perçue par les agriculteurs via les avantages associés (ex. achat d'intrants, accès renforcé aux filières de distribution). Cependant, l'expérience démontre un manque de participation des agriculteurs en partie dû aux difficultés rencontrées pendant la mise en place de l'association, le manque de confiance entre adhérents et le manque de financement collectif. De plus les coopératives n'impliquent pas forcement l'intégration de tous les agriculteurs concernés.
Implications des acteurs	-Sensibilisation des agriculteurs à l'importance de s'insérer dans une coopérative.
Pré-conditions	-Information et encadrement des agriculteurs pour la bonne gestion des coopératives -Faciliter les actions législatives de la création des coopératives (possible révision de la loi et des financements)
Exemples	A développer en 2016

WMO6: Bon usage de terres agricoles

Description	L'option vise le bon usage des terres cultivables afin d'améliorer la productivité et réduire la consommation d'eau en introduisant des cultures adaptées. Elle consiste à promouvoir l'agriculture conservatrice, introduire des cultures adaptées (des cultures qui s'adaptent aux périodes de sécheresse) et diffuser les bonnes pratiques.
Enjeux ciblés	Cette option contribuera à l'amélioration et à l'organisation de l'exploitation au niveau des terres agricole.
Localisation dans le bassin et utilisations de l'eau ciblées	Cette option concerne toutes les zones du bassin versant.
Bénéfices	Cette option offre plusieurs bénéfices dont: réduction de l'utilisation de l'eau, réduction de la pression sur la ressource, réduction de l'érosion, réduction de la vulnérabilité à la sècheresse.
Impacts négatifs possibles	L'option peut résulter sur le cours terme en une réduction de la production agricole et donc une perte de revenu. Elle peut aussi engendrer des coûts d'installation pour l'exploitation agricole par exemple le besoin d'acheter le matériel adéquat pour les nouvelles cultures ou par le besoin de formation.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option fait face au problème du morcellement du foncier et demande certaines connaissances techniques (ex. agronomie).
Robustesse	L'option vise à adopter de nouvelles pratiques agricoles et des cultures plus adaptées à la sècheresse et donc permet de répondre à la possibilité d'évènements météorologiques extrêmes plus fréquents dans le futur.
Flexibilité	Cette option est plutôt flexible car elle se base sur des changements de pratiques agricoles et non des investissements lourds. Cependant certains changements importants pour l'exploitation agricole, comme l'adoption de nouvelles cultures, peuvent représenter un investissement important pour l'exploitant et donc limiter la possibilité de changements futurs.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Cette option est soutenue par le Code des Eaux (protection des terres agricoles) qui vise la protection des terres agricoles contre les menaces de l'érosion hydrique des terres. Le Code interdit en particulier l'utilisation de tout outil ou technique destinés au travail de la terre et pouvant entraîner la destruction de la structure du sol dans les zones menacées par l''érosion hydrique qui rendent difficile la protection de ces terres. De même, la stratégie nationale de développement du ministère de l'environnement met l'accent sur la mise en œuvre des innovations et des développements en la matière du changement climatique pour se confronter à l'impact du changement qui va accentuer les phénomènes de la dégradation des terres agricoles.
Acceptabilité	L'option devrait être bien perçue par les agriculteurs. Le Ministère de l'Agriculture en collaboration avec les associations doivent se concentrer sur la sensibilisation de la société civile de l'importance de la protection des terres agricoles et la nécessité de développer des cultures adaptées au changement climatique.
Implications des acteurs	-Sensibilisation des bénéficiaires de l'impact du changement climatique sur leurs productions agricoles -Impliquer les associations dans l'organisation des campagnes de sensibilisation
Pré-conditions	-Révision du code de conservation des eaux et du sol. -Introduction des nouvelles techniques et plantes résilientes au changement climatique
Exemples	A développer en 2016

WMO7: Développer des instruments financiers de sensibilisation

Description	Cette option vise à améliorer l'accès aux sources de financement agricoles. Elle consiste à mettre en place des programmes de conseils afin d'aider les agriculteurs à accéder aux subventions agricoles et réduire la fiscalité. Ceci passe par une amélioration de la situation foncière et du morcellement, une meilleure implication des agriculteurs dans la procédure de subvention et une réforme des instruments financiers. Elle passe aussi par la diversification des mécanismes de financement (ex. banque, associations de développements).
Enjeux ciblés	Cette option contribuera au développement et l'élargissement du secteur agricole.
Localisation dans le bassin et utilisations de l'eau ciblées	Cette option concerne toutes les zones du bassin versant.
Bénéfices	Cette option offre plusieurs bénéfices dont : une consolidation du secteur agricole, une amélioration de la production, un renforcement des sources de financements et des revenus pour les agriculteurs.
Impacts négatifs possibles	Cette option peut résulter dans l'intensification de la production agricole et des dégâts environnementaux plus importants.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option ne requiert pas d'investissements lourds. Elle requiert cependant des changements administratifs et juridiques qui peuvent être complexe.
Robustesse	La consolidation du secteur agricole, l'amélioration des revenus et un meilleur accès aux instruments financiers mis en place par le gouvernement aideront le secteur agricole à faire face à différents futurs possibles.
Flexibilité	L'option requiert des changements administratifs et juridiques qui peuvent être complexes et longues, et difficiles à modifier dans le futur.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Cette option est soutenue essentiellement par le Code d'Incitation aux Investissements. Ce code offre des crédits fonciers qui peuvent être accordés pour l'achat des terres agricoles par les techniciens agricoles et les jeunes agriculteurs ou pour l'acquisition des parts des coindivisaires des promoteurs de projets agricoles dans une exploitation agricole constituant une unité économique. Cette option est limitée par l'absence de titres fonciers qui empêchent l'obtention des crédits.
Acceptabilité	Les opérateurs locaux sont peu mobilisés vu les défaillances au niveau des articles concernant le mécanisme de financement dans le code d'investissement.
Implications des acteurs	La sensibilisation des agriculteurs et les impliquer au sein des coopératives.
Pré-conditions	-Révision du code d'investissement -Création d'une cellule de rayonnement agricole. -Mise en place d'un programme de formation et vulgarisation spécifique à la zone du projet
Exemples	A développer en 2016

WM08: Utiliser des techniques d'irrigation performantes

Description	Cette option vise à encourager les agriculteurs à mieux utiliser les eaux d'irrigation en utilisant des techniques économes en eau en vue d'en tirer le meilleur profit tout en maitrisant la demande à un niveau compatible avec les ressources en eau disponibles.
Enjeux ciblés	Cette option contribue à l'enjeu « quantité d'eau ».
Localisation dans le bassin et utilisations de l'eau ciblées	Cette option concerne les surfaces irriguées dans le bassin versant.
Bénéfices	Cette option offre plusieurs bénéfices dont : rationaliser l'utilisation de l'eau agricole et maximisation des profits.
Impacts négatifs possibles	Cette option ne résulte pas forcement en une réduction de la demande et de la pression sur les ressources existantes si elle n'est pas accompagner par un contrôle sur les prélèvements.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option demande des moyens financiers pour faire recours à des techniques modernes dans le domaine agricole et un savoir-faire technique sur l'entretien et la maintenance des réseaux.
Robustesse	Une meilleure maitrise de la demande en eau en irrigation et une utilisation plus efficace sont bénéfiques quel que soit les changements globaux futurs.
Flexibilité	Les investissements dans les techniques d'irrigation est un effort financiers importants, ce qui peut limiter la capacité des agriculteurs à investir et adapter leur pratique à court et moyen terme.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Il existe une stratégie nationale d'économie des eaux. L'objectif principal des programmes d'économie d'eau est de rationaliser l'utilisation de l'eau agricole, en vue d'en tirer le meilleur profit économique et de maintenir la demande de l'irrigation à un niveau compatible avec les ressources en eau disponibles. L'option est synergétique avec plusieurs articles du Code sur l'Eau. Chapitre 1: article 19 : présentant des propositions concernant l'élaboration d'une politique nationale d'économie de l'eau à travers les programmes visant la rationalisation de la consommation d'eau. Chapitre VI : article 86 : L'économie de l'eau est considérée comme l'un des moyens les plus importants permettant le développement, la réservation et la rationalisation de l'utilisation des ressources hydrauliques. Les travaux visant le développement, l'économie, l'amélioration de la qualité et la protection des ressources hydrauliques nationales sont d'utilité publique. De même, l'option est synergétique avec le code d'investissement. Article 29 : les investissements réalisés dans le cadre de l'économie de l'eau d'irrigation par les groupements d'intérêt collectif prévu par le code des eaux promulgué par la loi n°75-16 du 31 Mars 1975 bénéficient des avantages accordés à la catégorie «A». Article 33 : les composantes de l'investissement agricole ci-après indiquées donne lieu au bénéfice de primes spécifiques globales à l'exclusion de toute autre prime : l'installation d'un système d'irrigation permettant l'économie d'eau d'irrigation ou renouvellement des équipements avec amélioration du système d'irrigation ; (décret n° 2001-2185 du17 septembre 2001). Article 42 bis6 : Les investissements visant à réaliser l'économie d'eau dans les différents secteurs, à l'exception du secteur agricole, et les investissements permettant le développement de la recherche de ressources en eau non traditionnelles, leur production et leur exploitation conformément à la législation en vigueur, et les activités d'audit des eaux donnent lieu au bénéfice d'une prime spécifique globale dont le taux, les conditions et les modalités d'octroi sont prévus par décret.
Acceptabilité	Cette option est acceptable par les citoyens. Cependant, le manque de connaissance des agriculteurs à l'égard de l'utilisation des techniques d'économie d'eau est un problème. L'état et l'administration restent les acteurs principaux dans la mobilisation, le transfert et le transport

Implications des acteurs	jusqu'à l'usager. En irrigation, le Ministère de l'agriculture est organisé dans la mobilisation et la gestion des eaux de surface et des eaux souterraines. De même, au sein du CRDA, une cellule assure le suivi et l'assistance des agriculteurs et des acteurs privés. Les faibles performances de l'irrigation ne peuvent que refléter un problème de formation des usagers directement sur le terrain. Les acteurs privés via les Groupements d'Intérêt Collectif viennent suppléer le dispositif administratif dans la gestion de l'eau agricole, et s'ils ne sont pas des individus, ils sont alors regroupés en GIC (Groupement d'intérêt collectif) ou sociétés de mise en valeur agricole, qui exploitent directement la ressource en eau et les réseaux hydrauliques.La formation pour améliorer l'efficience technique n'est pas suffisante. Les performances techniques peuvent parfois être handicapées par des problèmes d'organisation (commercialisation de produits, achat d'intrants) et le système hydro-agricole demeure défaillant, malgré les prouesses techniques. L'union Tunisienne de l'agriculture et de la Pêche (UTAP), encadre aussi les agriculteurs. Dans la plupart des périmètres irrigués, l'eau est encore mal gérée par les agriculteurs et insuffisamment valorisée. Cette utilisation peu rationnelle de l'eau d'irrigation peut avoir des répercussions parfois néfastes sur certains périmètres irrigués. L'Union pourrait encourager l'entretien et la réhabilitation des réseaux d'irrigation défaillants pour minimiser les pertes d'eau. Les entreprises d'étude et de travaux ayant à travailler dans le secteur de l'eau (entretien des équipements, travaux neufs et équipements des réseaux, sous traitance des travaux de maintenance etc.). Le comportement de l'agriculteur vis à vis de l'irrigation et de l'application des conseils et autres services d'information et de formation dépend de sa vision économique de l'eau. La tarification est dès lors un des outils, qui doit être calée dans le temps et dans l'espace, pour améliorer la sensibilité de l'exploitant à l'économie de l'eau. Les organisations professionnelles agricoles et les ONG jouent un rôle important pour catalyser le développement agricole en général (groupements). La série d'actions et les encouragements mis en œuvre par l'Etat Tunisien, ont abouti à une sensibilisation des agriculteurs et des organisations professionnelles au principe "Economie d'Eau" et à l'utilisation par les agriculteurs d'équipements économes en eau au niveau de la parcelle. Les associations doivent activement contribuer à la sensibilisation du public à la rareté de la ressource en eau, à sa bonne gestion, à sa préservation et sa protection. Il faudrait aussi encourager les cultures les moins consommatrices d'eau.
Pré-conditions	-Avoir un financement important et faire l'étude d'impact sur l'environnement. -La formation des usagers pour une meilleure gestion des eaux d'irrigation est indispensable.
Exemples	A développer en 2016

WM09: Améliorer le traitement des eaux usées

Description	Cette option vise à améliorer le traitement des eaux usées pour réduire l'impact sur la qualité de l'eau dans le milieu naturel et la réutilisation de l'eau pour d'autres usages. Elle consiste à augmenter l'exploitation et la valorisation des eaux non conventionnelles (ex. traiter l'eau pour ensuite l'utiliser pour l'irrigation de cultures spécifiques), la mise au norme des stations des eaux usées, l'extension des réseaux d'égouts, et la création de stations de traitement des eaux usées.
Enjeux ciblés	Cette option participera à l'amélioration de la qualité de l'eau et à la gestion et l'économie des ressources en eau par la valorisation agricole des eaux usées traitées.
Localisation dans le bassin et utilisations de l'eau ciblées	Les délégations concernées par cette option sont celles de Zriba et de Zaghouan.
Bénéfices	Cette option offre plusieurs bénéfices dont : maximisation de l'utilisation des ressources en eau, l'amélioration de la qualité de l'eau et la diminution de la pression croissante sur les ressources naturelles.
Impacts négatifs possibles	Cette option requiert des investissements matériels importants qui pourront à terme augmenter le prix de l'eau.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	La mise en œuvre de cette option requiert des capacités techniques importantes, ainsi qu'un cadre législatif et de contrôle efficaces notamment pour sécuriser utilisation des eaux usées dans l'agriculture.
Robustesse	Cette option participera à réduire les risques de dégradation des ressources en eau conventionnelles par le recours aux eaux non conventionnels afin de lutter contre les changements globaux dans les années prochaines.
Flexibilité	Ce type de option demande un investissement important.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Cette option est principalement soutenue par le Code des Eaux qui vise à la lutte contre toutes actions pouvant provoquer ou accroitre la dégradation des eaux en modifiant leurs caractéristiques physiques, chimiques, biologiques ou bactériologiques, qu'il s'agisse d'eaux superficielles ou souterraines. Il interdit d'effectuer tout dépôt en surface susceptible de polluer, par infiltration, les eaux souterraines, ou par ruissellement, les eaux de surface. Ce code prévoit que l'utilisation d'eaux usées à des fins agricoles n'est autorisée qu'après traitement approprié de ces eaux usées en station d'épuration et sur décision du ministre de l'agriculture, prise après accord du ministre de la santé publique. Dans tous les cas, la réutilisation des eaux usées, même traitées, pour l'irrigation ou de l'arrosage de crudités est interdite.
Acceptabilité	Cette option nécessite principalement l'information et la sensibilisation de l'ensemble des industries (publics et privés), les acteurs principaux, de l'importance de respecter les règles de rejets des eaux usées. L'utilisation de l'eau usée en agriculture peut faire face à une opposition de la part des agriculteurs.
Implications des acteurs	Des campagnes de sensibilisation doivent être organisées pour les industriels publics et privés de l'importance de leurs rôles dans la protection des ressources naturelles en général et les ressources en eau en particulier. Cette option nécessite aussi une implication importante des associations afin de sensibiliser les agriculteurs.
Pré-conditions	-Avoir un financement important -Amélioration et développement des stations de traitement selon les normes. -Améliorer la sensibilisation des industriels
Exemples	A développer en 2016

WMO10: Contrôle des rejets de polluants dans l'eau

Description	L'action vise à promouvoir le contrôle des rejets de polluants par le renforcement de l'application de réglementation et la valorisation des déchets (en particulier des presses d'olive). Ceci passe par la création la mise en place des systèmes de gestion des déchets solides (collecte+transport+traitement) dans les agglomérations rurales et les sites industriels, ainsi que la création de nouveaux sites de décharge contrôlés et l'utilisation des déchets agroalimentaires comme des engrais (épandage).
Enjeux ciblés	Cette option permettra directement à la protection des ressources en eau et indirectement à la protection de l'environnement.
Localisation dans le bassin et utilisations de l'eau ciblées	La zone industrielle de Hamem zriba, zone industrielle de Zaghouan.
Bénéfices	L'option vise à améliorer la qualité de l'eau ce qui sécurisera sa possible utilisation par d'autres usages (ex. agriculture, eau potable) ainsi que pour les usages environnementaux (protection du milieu aquatique).
Impacts négatifs possibles	L'option demande une réorganisation majeure du traitement des déchets industriels et des stations d'épurations. La création de sites de décharges peut poser des problèmes pour les riverains (ex. odeurs).
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option ne demande pas de capacités techniques spécifiques, seulement un renforcement des actions existantes.
Robustesse	L'option vise à renforcer les capacités de collecte, stockage, traitement et utilisation des déchets polluants pour les ressources en eau. L'option semble donc bénéfique dans le cours terme ainsi que sur le long terme (performance possible quel que soit les impacts des changements globaux futurs).
Flexibilité	L'option se compose de options institutionnelles (ex. renforcement des activités existantes) ainsi que la mise en place d'infrastructures plus lourdes (ex. décharges). Ainsi sa capacité à être adaptée dans le temps est moyenne et demande une attention particulière au séquençage des activités afin de maximiser les bénéfices immédiats et futurs.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	La gestion des déchets est un élément central de la politique environnemental en Tunisie, avec une Agence Nationale de Gestion des Déchets (ANGED). Il s'agit d'une Stratégie Nationale de Gestion Intégrée et Durable des Déchets, qui a pour objectif d'établir un réseau de décharges et le développement de filière de collecte et de valorisation. Le Code sur l'Eau requiert un traitement systématique des eaux usées d'origine domestique ou industriel si elle pose un risque en aval pour l'alimentation en eau à usage domestique ou agro-alimentaire. Cependant la mise en œuvre est peu suivi par manque de moyen. De plus le *Code d'Incitations aux Investissements* a mis en place un programme qui défiscalise certains investissements dans la collecte, la transformation et le traitement des ordures et des déchets.
Acceptabilité	Le traitement des déchets devrait à première vue être une activité bien acceptée par l'ensemble de la société vu son rôle central dans la qualité de vie des citoyens. Cependant, la mise en œuvre fait face à de nombreuses barrières, dont, un manque d'information et de sensibilisation des citoyens, un manque de concertation et de communication entre acteurs, et la tendance à mettre en priorité d'autres objectifs de développement économiques. Les collectivités locales et communales sont particulièrement affectées par le manque de ressources humaines et financières. De même le secteur privé participe peu.
Implications des acteurs	L'option peut être accompagnée de campagnes de sensibilisation auprès du public et du secteur privé des comportements positifs envers l'environnement. De plus, une plus grande participation des associations peut être encouragée (via formation, assistance technique et financière) et la collaboration entre association et collectivités locales.
Pré-conditions	-Augmenter le financement de la gestion des déchets -Améliorer la sensibilisation des citoyens et renforcer les attitudes pro-environnementales

Exemples	La gestion des déchets industriels, à travers la réalisation d'une décharge spécialisée en 2007 à Jradou (Zaghouan) et de 3 centres de transfert couvrant tout le territoire national et permettant le traitement d'environ 60% des déchets industriels et spéciaux.

WMO11: Réduction de la pression de la société sur les forêts

Description	L'option vise la protection des forêts via des options de prévention et de contrôle qui réduisent le surpâturage, l'implication et l'intégration de la population locale dans la gestion et la protection des forêts, et l'indemnisation des propriétaires forestiers. L'intégration de la population locale peut passer par la mise en place de groupements de developpment agricole. L'indemnisation peut être requis afin de permettre aux autorités publiques de prendre des options pour éviter la surexploitation des forêts.
Enjeux ciblés	La réduction des pressions exercées par la société civile sur les forêts contribuera à l'enjeu sur la protection et la valorisation des ressources forestières.
Localisation dans le bassin et utilisations de l'eau ciblées	Les forêts choisies sont: forêts sidi Zid,forêts de Jimla et forêts de jebel Zaghouan.
Bénéfices	Cette option offre plusieurs bénéfices, dont la conservation de la couverture forestière, la protection des sols à un régime hydrologique naturel, l'amélioration des conditions pastorales, et la création d'emploi par le développement des activités génératrices de revenus pour les usagers des forêts.
Impacts négatifs possibles	Cette option vise en partie à réduire la pression pastorale sur les forêts ce qui peut engendrer des pertes de production pour les agriculteurs et populations locales.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option repose sur des options institutionnelles (ex. contrôle, participation du public, indemnisation) et leur renforcement sur les zones à risque. L'implication des usagers implique la mise en place de nouveaux modes de gestion collective (besoin de retour d'expérience existante et de formation).
Robustesse	La réduction des pressions sur les forêts contribuera à la capacité de résilience des forêts face aux évènements extrêmes (ex. sècheresse, orages, inondations).
Flexibilité	L'option se base sur des activités institutionnelles qui apparaissent modulables dans le temps.
Coûts	Le coût nécessaire pour cette option sur une période de 15 ans est évalué 3 million DT.
Synergies et conflits avec objectifs des politiques actuelles	Cette option peut se reposer sur le code forestier qui fixe un certain nombre de règlements sur les usagers qui vise à contrôler leur impact. De plus, le Code Forestier permet aux usagers de se regrouper pour des actions de protection et d'exploitation. Cependant, il est fréquent que les usagers ne respectent pas les règles et les droits d'exploitation des ressources forestières. Le manque d'aide financière et des procédures administratives longues empêchent la création d'association d'usagers forestiers.
Acceptabilité	Il y a un manque d'intérêt de la part des populations forestières de mettre en œuvre le Code, en particulier la création des associations.
Implications des acteurs	La sensibilisation des usagers et leur participation aux associations collectives devraient être renforcées.
Pré-conditions	-Sensibilisation des usagers -Un cadre règlementaire plus incitatif
Exemples	A développer en 2016

WMO12: Protection contre les incendies de forêts

Description	L'option vise la protection des forêts contre les incendies par la provision des techniques et des équipements nécessaires (ex. organisation de la surveillance par la création de postes-vigies et de patrouilles volantes, entretenir et élargir les tranchées pare-feux existantes, création et entretien des pistes forestières et des tranchées pare-feu) et l'implication des usagers dans l'exploitation des forêts par l'organisation des campagnes de sensibilisation pour la valorisation des forêts.
Enjeux ciblés	La protection contre les incendies de forêts contribuera à l'enjeu sur la protection et la valorisation des ressources forestières, et indirectement à la protection des sols et à un régime hydrologique naturel.
Localisation dans le bassin et utilisations de l'eau ciblées	Les forêts de Jimla ont été choisis vues le nombre d'incendies.
Bénéfices	Cette option offre plusieurs bénéfices, dont la limitation du nombre d'incendies, la protection de la superficie des forêts, le contrôle de la désertification, la protection de la fertilité des sols et le contrôle du phénomène de ruissellement (à sol nu).
Impacts négatifs possibles	Cette option peut entrainer des pertes forestières et une fragmentation de la forêt (tranchées pare-feux, infrastructure routières, etc).
Mise en œuvre temporelle	Cette option peut se mettre en place dans le court terme. Elle peut se reposer sur le programme de 10 ans de la Direction Régionale des Forêts.
Faisabilité	Le combat contre les incendies via la maintenance des sous-bois et l'installation d'allées pare-feu est une pratique courante en Tunisie. De même les équipements d'intervention et la mise en place de vigie en période critique sont présents sur l'ensemble du territoire. Finalement, le code forestier impose des interdictions strictes sur les comportements à risque. Il faudra donc tout d'abord renforcer ces modes d'action existants ainsi que mettre en place un programme de sensibilisation du grand public.
Robustesse	La protection des forêts contre les incendies permet de réduire le phénomène de désertification et conserve la fertilité du sol ce qui aura des effets bénéfiques sur la capacité des forêts à s'adapter à différents futurs changements climatiques possibles.
Flexibilité	A part l'installation et élargissement des tranchées pare-feux, les activités proposées sont institutionnelles qui sont facilement modulables.
Coûts	Le coût nécessaire pour cette option sur une période de 15 ans est évalué à 1,8 milliard DT.
Synergies et conflits avec objectifs des politiques actuelles	Cette option peut reposer sur les objectifs du code forestier ainsi que plusieurs article règlementant les activités en ou proche des forêts afin de limiter le risque d'incendie. Une barrière importante vient de la complexité des textes de lois relatives à l'exploitation des ressources forestières.
Acceptabilité	Les populations locales sont peu mobilisées sur la question de la gestion durable de la forêt.
Implications des acteurs	Un enjeu important est d'augmenter l'intérêt des populations locales à protéger la forêt (ex. forêt comme une source de revenue) notamment via des projets de cogestion collaboratif entre riverains et propriétaires fonciers et les autorités publiques. La sensibilisation est aussi un axe d'action important.
Pré-conditions	-Révision de différents articles du Code Forestier -Sensibilisation de la population locale de l'importance de la protection des ressources forestières
Exemples	A développer en 2016

WMO13: Introduction de nouvelles espèces pour l'agroforesterie, protection des forêts et enrichissement de forêts existantes

Description	Cette option vise à garantir un meilleur développement et une meilleure protection de la forêt. Elle consiste dans l'introduction de nouvelles espèces pour l'agroforesterie, la protection des forêts et l'enrichissement de forêts existantes (ex. eucalyptus, argon…).
Enjeux ciblés	L'introduction de nouvelles espèces participera à la valorisation et la gestion des ressources forestières, et donc à l'amélioration du niveau de vie.
Localisation dans le bassin et utilisations de l'eau ciblées	Les forêts choisies sont: forêts de Jimla, forêts Sidi Zid.
Bénéfices	Cette option offre plusieurs bénéfices, dont la valorisation des produits forestiers et l'amélioration du niveau de vie de l'exploitation par les ventes des fruits forestiers.
Impacts négatifs possibles	Cette option peut résulter dans des couts importants pour l'exploitant sur le court terme.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Cette option ne requiert pas de compétences techniques nouvelles et n'est pas particulièrement complexe du point de vue technique.
Robustesse	L'enrichissement des forêts contribuera à la capacité de résilience des forêts face aux évènements extrêmes (ex. sècheresse, orages, inondations).
Flexibilité	La diversification des forêts renforcera la capacité d'adaptation des exploitants forestiers aux changements futurs.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	L' option est cohérente avec les objectifs du code forestier qui vise à assurer la protection, la conservation et l'exploitation rationnelle des ressources forestières et aussi de garantir aux usagers l'exercice légal de leurs droits. La protection du territoire national contre la désertification et le développement des ressources sylvo-pastorales constituent des actions d'intérêt national. Ces actions bénéficient de l'encouragement de l'Etat sous forme de subventions, de crédits, d'aides en nature ou toute forme d'encouragement. Les options d'encouragement prises par l'Etat dans le cadre de la présente loi, visent à susciter la participation des particuliers, des collectivités ou de toute autre personne morale, à la réalisation d'actions destinées à accroître la production ligneuse et fourragère. Ces options d'encouragement ont également pour objectif, l'amélioration des conditions de vie économique et sociale des populations forestières. Un des grands défis est cependant d'augmenter l'application du Code forestier. De plus, la faible contribution des propriétaires à la réalisation des travaux est un problème. L'option est cohérente avec l'objectif du 11ème plan de Politique Agricole (2007-2011) qui vise entre autre « Le développement durable des ressources naturelles », et en particulier la protection et le développement des ressources forestières.
Acceptabilité	Le Ministère de l'Agriculture (Directive des forêts) encourage la promotion des actions sylvo-pastorales. Cependant, la contribution de la population locale à la réalisation des travaux est faible. Il y a un manque d'intérêt de la part des populations forestières de mettre en œuvre ce type d'action, à cause de la longue durée nécessaire pour l'exploitation des produits introduits. De plus, la population forestière vise essentiellement l'amélioration de la production ainsi que leurs revenues.
Implications des acteurs	La mise en œuvre de cette option demande un renforcement des actions de sensibilisation et de formation auprès de la population locale. Ces actions peuvent aider à dépasser les problèmes de surexploitation des ressources forestières.
Pré-conditions	Organisation de la population locale Valorisation des produits forestiers non ligneux.
Exemples	A développer en 2016

WMO14: Meilleure gouvernance des ressources forestières

Description	L'option vise à améliorer la gouvernance des ressources forestières. Elle consiste en une meilleure application des lois forestières existantes et le règlement de la situation de bail des communautés forestières.
Enjeux ciblés	La bonne gouvernance des ressources forestières contribuera à la protection et la bonne gestion de ces ressources.
Localisation dans le bassin et utilisations de l'eau ciblées	Cette action concerne toutes les ressources forestières dans le bassin ; les forêts de sidi Zid, forêts de Jimla et forêts de jebel Zaghouan.
Bénéfices	Cette option offre plusieurs bénéfices, dont la conservation de la couverture forestière, la protection des sols et l'amélioration des conditions pastorales.
Impacts négatifs possibles	-
Mise en œuvre temporelle	A développer en 2016
Faisabilité	L'option repose sur des options législatives qui visent à l'amélioration et le renforcement des lois et des règlements existants. Le renforcement des groupements de développement agricoles sera aussi une nécessité pour assurer le développement du secteur forestier.
Robustesse	Cette option permet de réduire la dégradation de cette richesse et conserve la fertilité du sol ce qui aura des effets bénéfiques sur la capacité des forêts à s'adapter à différents futurs changements climatiques possibles.
Flexibilité	L'option se base sur des activités législatives qui apparaissent difficilement modulables dans le temps.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	La création d'un environnement institutionnel et réglementaire ainsi que des capacités favorables à l'engagement durable des parties prenantes (usagers, partenaires institutionnel) est un élément central de la *Stratégie Nationale de Développement et de Gestion Durable des Forêts et des Parcours*. Cependant, cette action est limitée par l'absence de textes régissant les rapports entre les départements régionaux et centraux au sein du ministère, l'absence de processus formels entre l'administration forestière et ses partenaires institutionnels et partenaires potentiels relevant d'autres secteurs ainsi que l'absence de synergie entre les structures de développement et les structures de recherche et d'enseignement supérieur.
Acceptabilité	Les acteurs clefs de cette option sont le Ministère de l'Agriculture et plus précisément la Direction Régional des forêts (instances publiques) et la population forestière (acteurs non-institutionnels). Cette option aura des impacts bénéfiques directs sur l'administration forestière. Elle promeut le renforcement de ses capacités. De plus, elle permet à la population forestière d'avoir un accès judicieux aux ressources ainsi qu'un partage approprié des efforts et des avantages. Certaines barrières existent cependant. Le fait que le code forestier demeure trop centré sur la conservation du patrimoine sans ouverture convenable aux problèmes de développement et à la participation des autres intervenants. Les organisations (GDA, Associations, etc.) n'a pas atteint les objectifs et de faire participer d'avantage les communautés dans la gestion des programmes où le rôle de ces organisations est resté passif sans pouvoir réel.
Implications des acteurs	Un enjeu important est de donner une plus d'importance à la législation existante dans le domaine forestier via le renforcement des capacités institutionnelles et individuelles du secteur, et obtenir une coordination entre les départements régionaux et centraux au sein du ministère et entre ministère, recherche et société civile.
Pré-conditions	-Révision de différents articles du code Forestier. -Création d'un mécanisme national de financement du secteur moyennant l'élaboration et la mise en

	œuvre d'un schéma de payement pour les services des écosystèmes et la révision/adaptation du code d'investissement. -Se concentrer sur le rôle des associations pour la gestion des ressources forestières
Exemples	A développer en 2016

WMO15: Campagne de sensibilisation et d'enseignement sur la gestion des ressources naturelles

Description	Cette option vis l'amélioration de l'exploitation et de la gestion des ressources naturelles en sensibilisant la société civile à l'importance des ressources naturelles et leur protection. Elle consiste notamment à faciliter le travail des associations et organiser des campagnes de sensibilisation.
Enjeux ciblés	La sensibilisation et l'implication progressive de la société civile concernée participera à la réalisation des objectifs en matière de protection des ressources naturelles pour assurer une gestion durable de ces ressources.
Localisation dans le bassin et utilisations de l'eau ciblées	Cette option est très intéressante pour toutes les zones du bassin.
Bénéfices	Cette option offre plusieurs bénéfices dont : la collaboration entre les agents de développement, les chercheurs et la société civile et la facilitation de la mise en œuvre de différents actions en relation avec la société civile.
Impacts négatifs possibles	-
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Cette action dépend de principalement de la flexibilité de la société civile.
Robustesse	Cette option contribuera à réduire les risques de dégradation des ressources naturelles quel que soit les impacts des changements globaux futurs (climatique, augmentation de la demande).
Flexibilité	Cette option est de nature institutionnel et est donc facile à modifier en fonction des changements globaux futurs.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Les différentes stratégies futures (ressources en eau, ressources forestières, conservation des eaux et du sol) mettent l'accent sur l'importance de la société civile pour le déroulement d'un tel projet. En effet la sensibilisation et la formation des opérateurs deviendront donc une nécessité.
Acceptabilité	Cette option nécessite essentiellement l'intégration des associations. Cependant le manque de coordination entre les différents acteurs rend l'acceptabilité de la société civile à une telle action très difficile.
Implications des acteurs	Il faudra introduire progressivement et graduellement de nouvelles formes de partenariat (ONG) afin de promouvoir l'auto-développement de la population et d'assurer la durabilité des actions d'un projet dans la zone. De plus l'organisation des campagnes de sensibilisation qui regroupent tous les niveaux de décision possibles et à toutes les phases de la mise en œuvre afin d'améliorer la compréhension de l'environnement pour bien identifier les contraintes et les solutions optimales aux principaux problèmes de la zone.
Pré-conditions	-Donner plus d'importance aux campanes de sensibilisation en augmentant le nombre de session.
Exemples	A développer en 2016

WMO16: Améliorer la prise de décisions

Description	Cette option a pour objectif d'améliorer le processus décisionnel en impliquant les parties prenantes dans toutes les étapes de l'étude et du processus de décision. Le gouvernement peut encourager une réorientation des institutions existantes. Un soutien financier et un développement de la sensibilisation peuvent être utilisés pour améliorer la coordination entre les autorités publiques et la société civile, peut créer des entreprises intégrées entre diplômés et agriculteurs afin de gérer les terres de l'état (science + expérience), peut prendre en considération la co-création d'un lien entre enseignement, recherche, société et politique; la recherche doit adopter des méthodes interdisciplinaires afin de collaborer avec la société pour le développement de solutions et d'innovations pour une agriculture et une utilisation des eaux durables.
Enjeux ciblés	L'implication des acteurs dans la prise de décision est indispensable pour le développement et le sucée des projets.
Localisation dans le bassin et utilisations de l'eau ciblées	La totalité du bassin versant Rmel est concernée par cette option.
Bénéfices	Les principaux bénéfices sont : la coordination entre les autorités publiques et la société civile, création des entreprises intégrées entre les diplômés et les agriculteurs, la recherche doit adopter des méthodes transdisciplinaires afin d'intégrer la société dans le développement de solution et d'innovations pour une meilleure agriculture et une utilisation durable des eaux. Œuvrer pour développer un fond d'incitation à la bonne gestion des ressources naturelles.
Impacts négatifs possibles	Le dialogue entre les autorités et la société civile n'est pas toujours productif aussi la société civile n'est pas toujours prête à appliquer de nouvelles techniques basées sur la science.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	La faisabilité dépend du financement de la recherche scientifique (adopter des programmes qui facilitent l'intégration des diplômés dans les domaines agricoles) aussi l'intégration de la société civile dans toutes les étapes de la prise de décision.
Robustesse	Cette option contribuera à faciliter l'acceptation des opérateurs aux actions techniques proposées par l'état et donc la réduction des pertes et de dégradation des ressources naturelles quel que soit les impacts des changements globaux futurs.
Flexibilité	La flexibilité peut être accéléré par l'amélioration des programmes universitaires académiques et adopter une méthode pour intégrer les diplômés dans le développement de solution pour la gestion des ressources naturelles comme première point et la société civile dans une deuxième étape.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Les différentes stratégies futures (ressources en eau, ressources forestières, conservation des eaux et du sol) considèrent le facteur humain comme le partenariat principal dans toute opération de développement et de conservation des ressources naturelles. Une approche participative devient donc une nécessité. Les méthodes d'intervention qui se basaient sur l'approche verticale ne permettaient pas d'associer les opérateurs à toutes les étapes de la planification et de la mise en œuvre, ils ne se sentaient pas concernés par ce problème.
Acceptabilité	Cette option nécessite une collaboration entre les agents de développement, les chercheurs et la société civile. En effet, en absence d'une coordination, l'approche participative serait une complication supplémentaire aussi bien pour l'administration que pour les opérateurs et entretient un environnement d'incertitude qui va influencer négativement sur le comportement des opérateurs.
Implications des acteurs	-Organisation des campagnes de sensibilisation regroupant les différents acteurs (autorités publics, société civile) afin de discuter les principaux points relatifs à la zone.

Pré-conditions	-Organisation des réunions qui regroupent les responsables de la prise de décision. -Préparation et réalisation des plans d'aménagement participatifs.
Exemples	-Etude de planification participative dans le basin versant de l'oued Sbaihya du gouvernorat de Zaghouan.

WMO17: Promotion de projets permettant d'accroître les revenus

Description	Cette option vise à améliorer les moyens de subsistance en encouragent l'investissement dans des projets générateurs de revenus et d'emploi. Ceci passe principalement par des incitations économiques pour des projets d'éco-tourisme, l'introduction d'activités d'artisanat pour les femmes dans les régions rurales, la promotion de nouvelles activités de production et le développement de l'agriculture biologique.
Enjeux ciblés	Cette option contribuera à encourager les projets en se basant sur les ressources naturelles et les caractéristiques dans la zone afin d'améliorer le niveau de vie de la population locales.
Localisation dans le bassin et utilisations de l'eau ciblées	La totalité du bassin versant Rmel est concernée par cette option.
Bénéfices	Les bénéfices de cette option sont : amélioration du niveau de vie, faciliter l'accès aux biens de première nécessité et augmenter la production, protection de l'environnement.
Impacts négatifs possibles	-
Mise en œuvre temporelle	A développer en 2016
Faisabilité	Cette option ne demande aucune capacité technique particulière.
Robustesse	La mis en place de cette option participera à la bonne gestion des différents ressources naturelles qui aideront à diminuer les risques des impacts du changement globaux futurs.
Flexibilité	La flexibilité dépend de la motivation de la population locale (femme et jeunes) à participer à ce type d'action.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	L'option est cohérente avec le Code d'Incitations aux Investissements qui encourage l'utilisation des ressources naturelles disponibles. Les options d'encouragement prises par l'état visent à susciter la participation de la population locale et principalement les femmes et à la réalisation d'actions destinées à accroître leurs revenus et l'améliorer leurs conditions de vie économique et sociale.
Acceptabilité	Les instances publiques (le ministère de l'agriculture, le ministère d'industrie et commerce et le ministère de l'environnement) encourage la promotion des actions sociale et économique par l'identification des options et des actions de développement spécifiques telles que la formation et l'appui à la création d'activités génératrices de revenu. Il y a un manque d'intérêt de la part des opérateurs de mettre en œuvre ce type d'action, à cause du manque de mécanisme de financement.
Implications des acteurs	-Sensibilisation commune de la société civile par l'identification des options et des actions de développement spécifiques sur leurs rôles dans l'utilisation des ressources naturelles et sur leur responsabilité dans la protection et la conservation de ces ressources. -Intégration des associations dans la sensibilisation.
Pré-conditions	-Encourager les projets qui sont tolérants à l'environnement /Œuvrer à créer un fond d'incitation.
Exemples	A développer en 2016

WMO 18: Encourager les investissements

Description	Cette option vise à faciliter les investissements dans l'agriculture, l'industrie et le tourisme. Elle consiste notamment à faciliter l'obtention d'emprunts à court terme et de subventions pour les petits agriculteurs et les jeunes et faciliter l'accès à l'information sur les opportunités et les procédures de financement et d'investissement.
Enjeux ciblés	Cette option vise au développement de différents secteurs afin de créer de nouveaux emplois susceptible d'améliorer le niveau de vie de la population locale.
Localisation dans le bassin et utilisations de l'eau ciblées	La totalité du bassin versant Rmel est concernée par cette option.
Bénéfices	Les bénéfices de cette option sont : développement économique des territoires ruraux, augmentation des opportunités de travail, amélioration du niveau de vie et des revenus.
Impacts négatifs possibles	Le développement économique peut engendrer une utilisation plus intensive des ressources en eaux.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	La faisabilité dépend de la stratégie du pays qui doit fournir un budget pour les bénéficiaires et ajuster des critères à l'option.
Robustesse	La mise en place de cette option promeut les actions (industrie et tourisme) autre que l'agriculture qui va permettre de réduire les pressions sur les ressources en eau.
Flexibilité	Cette option repose sur la bonne volonté des opérateurs à investir et à créer et gérer des projets.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Le *Code d'Incitation aux Investissements* favorise les investissements réalisés dans les secteurs de l'agriculture, de l'industrie, du tourisme, de l'artisanat et dans quelques activités de services. Ceci est réalisé dans les zones d'encouragement au développement régional fixées par le décret prévu à l'article 23 susvisé. Ces zones bénéficient de la prise en charge par l'État et de la contribution patronale au régime légal de sécurité sociale au titre des salaires versés aux agents tunisiens. Cependant, les procédures sont longues et la contribution de l'état faible. La *Stratégie de Développement Nationale* est favorable à l'option. Dans l'optique de dynamiser les investissements et promouvoir les emplois dans le domaine de l'environnement qui représente un secteur porteur en la matière, la Tunisie a organisé en 2009, le deuxième Forum international de l'investissement et de l'emploi dans le secteur de l'environnement. Cette approche est considérée essentielle pour asseoir un climat social favorable à la politique de l'encouragement des investissements nationaux et étrangers dans les différents secteurs économiques, et au choix stratégique de l'économie du savoir : une économie dynamique, performante, innovante, créatrice de nouvelles richesses et des mécanismes d'autofinancement et de régulation. Afin de consolider les acquis en matière de tourisme écologique et de mieux définir le rôle et les missions des différents intervenants dans le secteur de l'écotourisme, le ministère de l'environnement et du développement durable a mis en place une étude concernant « la stratégie de la revalorisation de l'écotourisme en Tunisie », et ce en collaboration avec l'agence de coopération technique allemande. Cependant, il n'est pas automatique que les projets ne soient pas néfastes pour l'environnement.
Acceptabilité	Le ministère de l'agriculture encourage les investissements d'une façon générale et à l'investissement dans le secteur de l'agriculture et de la pêche. Ceci a été particulièrement institué par la loi 93-120 du 27 décembre 1993 portant sur la promulgation du code d'incitations aux investissements. Les dispositions de ce code s'appliquent aux opérations d'investissement relatives à la Création, l'Extension, le Renouvellement, le Réaménagement ou la Transformation d'activités. Dans l'Industrie, les Nouveaux Promoteurs (NP) et les Petites et Moyennes Entreprises (PME) qui réalisent des projets dans les activités des industries manufacturières, les activités de l'artisanat et les activités de services liés à l'industrie, bénéficient d'une Prime d'étude et d'assistance technique fixée

	à 70 % du coût avec un plafond de 20.000 D.
Implications des acteurs	-Sensibilisation et implication des bénéficiaires dans toutes les actions réalisées. -Certaines associations non-gouvernementales peuvent servir d'intermédiaire pour faciliter l'obtention des emprunts et des subventions.
Pré-conditions	La promotion des projets dans les secteurs de l'agriculture, l'industrie, l'économie et l'artisanat et la sensibilisation des jeunes d'investir dans le secteur privé qui est quasi abandonné par rapport au secteur étatique.
Exemples	A développer en 2016

WMO 19: Développer les capacités des jeunes

Description	Cette option vise à améliorer l'attractivité des jeunes du bassin en termes d'emploi, de faciliter l'intégration des jeunes dans la vie professionnelle et créer une génération de techniciens qualifiés dans l'utilisation de techniques. Elle consiste à organiser des programmes de formation et de stage, notamment dans des spécialités modernes.
Enjeux ciblés	Cette option donnera une importance aux jeunes afin de les préparer à gérer des projets qui vont participer à la suite au développement de la zone.
Localisation dans le bassin et utilisations de l'eau ciblées	La totalité du bassin versant Rmel est concernée par cette option.
Bénéfices	Les bénéfices de cette option sont : développement économique des territoires ruraux, augmentation des opportunités de travail, amélioration du niveau de vie et des revenus.
Impacts négatifs possibles	Ces formations n'aboutissent pas forcement à des emplois. Les jeunes parfois ne sont plus intéressés par la formation si les conditions ne sont plus favorables.
Mise en œuvre temporelle	A développer en 2016
Faisabilité	La faisabilité dépend du financement de ces formations ainsi que de la disponibilité des centres de formation.
Robustesse	Une amélioration des connaissances et des capacités techniques des jeunes peuvent contribuer à augmenter la capacité des communautés locales à planifier et s'adapter aux changements globaux futurs.
Flexibilité	Une amélioration des connaissances et des capacités techniques des jeunes peuvent contribuer à augmenter la capacité des communautés locales à planifier et s'adapter aux changements globaux futurs.
Coûts	
Synergies et conflits avec objectifs des politiques actuelles	Les entreprises de services totalement exportatrices créées avant la promulgation du Code d'Incitations aux Investissement peuvent recruter des agents d'encadrement et de maîtrise étrangers pour une période transitoire de deux ans à compter de la date de promulgation de la présente loi. Ceci est considéré après information du Ministère chargé de la formation professionnelle et de l'emploi. Cependant, les formateurs ou les agents d'encadrement ne sont pas toujours disponibles, d'où la possibilité de planifier des formations pour les jeunes. Ces formations s'avèrent actuellement limitées. La Stratégie Nationale de Développement cherche une mise à niveau global du secteur de la formation. Ce secteur, doit être au profit des principales parties concernées, à savoir, en priorité, les demandeurs d'emploi, les entreprises, les secteurs économiques, ainsi que les régions tout en considérant leurs besoins en matière de développement et d'investissement. Ce programme, doit ainsi permettre de relever les défis de la prochaine étape à la lumière des impératifs de l'évolution économique et technologique continue, et d'ouvrir de plus larges perspectives à l'investissement dans les secteurs prometteurs et innovants. Cependant, les programmes d'appui sont toujours relatifs à la demande du marché, des entreprises dans le secteur économique et agricole. Si aucune demande n'est faite, les formations sont absentes.
Acceptabilité	Cette option est acceptable parce qu'elle se fait sur la demande des bénéficiaires et du marché, mais elle rencontre quelques obstacles : il y a des problèmes de financement et de manque de sensibilisation relatif à l'importance de ces formations pour l'intégration des jeunes dans la vie professionnelle, les formations ne sont pas toujours fréquentes. Cette option est liée au degré d'intérêt des jeunes à ce type d'action. En effet, Les jeunes parfois ne sont plus intéressés par la formation à cause des conditions qui ne sont plus favorables. La société civile offre parfois l'opportunité aux jeunes pour les former dans les domaines qu'exige le marché. Les ONGs peuvent affecter des fonds nécessaires du budget à l'appui et au soutien aux projets de développement et ce, sur la base de la compétence, de la nature des projets et des activités programmées.

Implications des acteurs	-Implication de la société civile et les ONG. -Sensibilisation et implication des bénéficiaires dans toutes les actions réalisées.
Pré-conditions	-Sensibilisation des bénéficiaires de l'importance des capacités et du potentiel des jeunes. -S'adresser à des formateurs adéquats ainsi qu'à de centres de formation -Offrir des formations gratuites. De même pour la motivation des jeunes par des indemnités.
Exemples	A développer en 2016