Background document

River Basin Adaptation Plan

2016

Methods applied to identify and evaluate water management options for four Mediterranean river basins

Methods applied to identify and evaluate water management options for four Mediterranean river basins

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Contents

1. Introduction

Climate change is expected to affect most regions across the world. The Mediterranean region is a region where changes in climate are expected to have strong impacts, particularly on water resources. To address sustainable water management and adaptation to the impacts of global change in the Mediterranean, an iterative, bottom-up approach was developed in the BeWater project to ensure that stakeholders from local societies play an active role and become engaged in determining appropriate strategies for management of their river basins. We applied the approach to four Mediterranean case study river basins: the Tordera river basin (Spain) in the west, the Vipava river basin (Slovenia) in the north, the Pedieos river basin (Cyprus) in the east and the Rmel river basin (Tunisia) in the south. The objective of this document is to describe the participatory approach, focussing on the methods applied to identify, formulate and evaluate options for future water management to address global change.

2. Material and methods

2.1 General approach

To formulate and evaluate water management options (WMOs) to adapt the functioning of the river basins to global change, we conducted a series of steps (i) to elicit the main challenges in each river basin based on the current state and future expectations, (ii) to formulate water management options for each of the challenges, and (iii) to evaluate the water management options. The general approach is schematically presented in Figure 2.1.

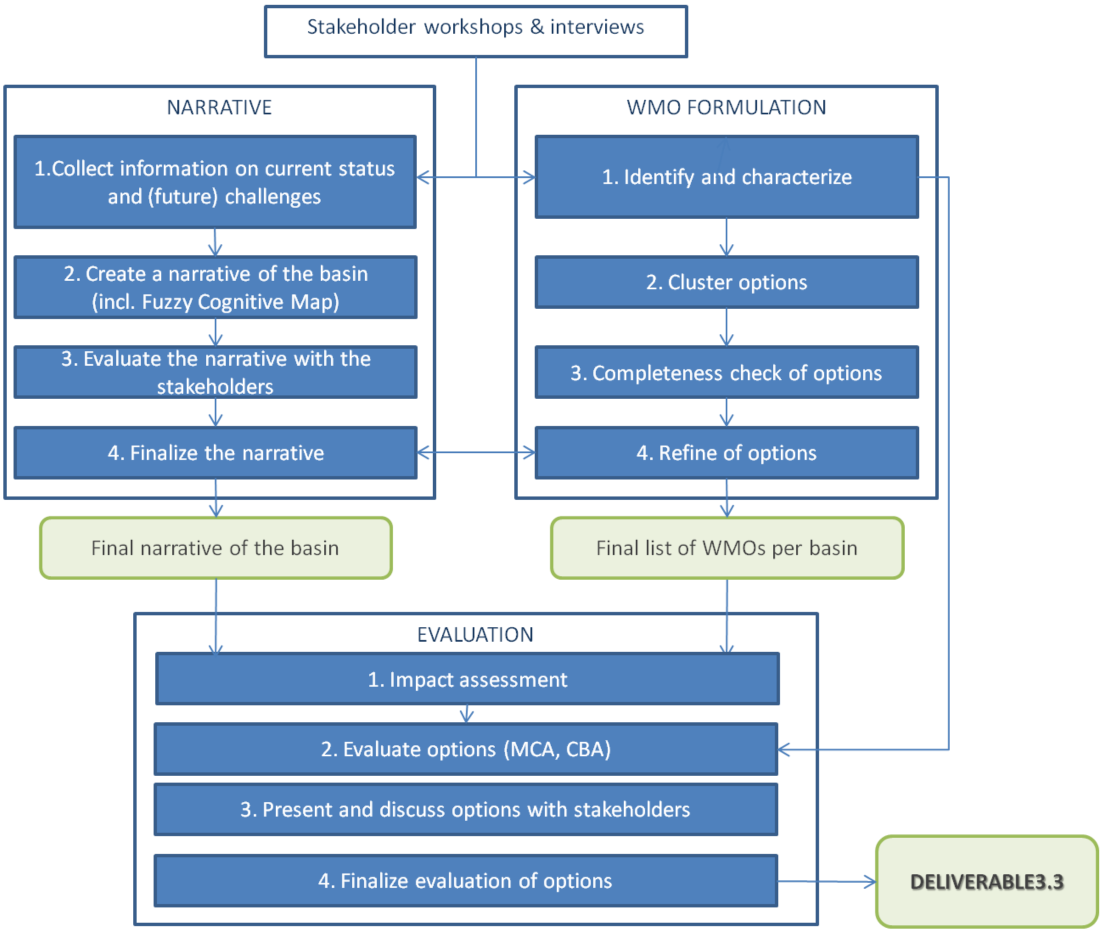

Figure 2.1: schematic overview of all steps to formulate and evaluate water management options for each river basin.

2.2 Case study river basins

BeWater focused on four river basins spread across the region in which to carry out case studies. The river basins are located in the four cardinal points of the Mediterranean: the Tordera river basin (Spain) in the west, the Vipava river basin (Slovenia) in the north, the Pedieos river basin (Cyprus) in the east and the Rmel river basin (Tunisia) in the south. The four river basins are covering various Mediterranean conditions with regard to climate, topography, environment, socio-economic and political conditions, land use and water demands. The locations of the river basins are shown in Figure 2.2 and key characteristics are given in Table 2.1.

Figure 2.2: location of case studies

Table 2.1: key characteristics of the four case study river basins

	Pedieos	Rmel	Tordera	Vipava
Area	120 km^2	860 km^2	865 km^2	589 km^2
Inhabitants	192,000 inh	40,000 inh	157,500 inh	52,000 inh
Main land uses	Forest (42%) Agriculture (31%) Urban (27%)	Forest (20%), agricultural land (75%),	Forest (81%), agriculture (10%)	Forest (61%), agriculture (33%)

2.3 Stakeholder participation

Stakeholder participation is an essential part of the overall BeWater approach. Stakeholders are not merely informed or consulted, but are engaged to ensure they can:

- provide input to feed in to the approach depicted in Figure 2.1;
- discuss and validate outcomes at various points in the scientific approach.

Furthermore, integrating stakeholder participation in the scientific approach also means that moments of interaction with stakeholders need to meet well-defined objectives i.e. the stakeholder workshops aim at achieving very specific purposes and outcomes needed to conduct the steps of the basic scientific approach. This targeted stakeholder participation was planned at key moments

and conditions the workshop process design (participant mix, workshop format, types of outcomes). This way, the approach presented in Figure 2.1 represents a bottom-up, stakeholder driven process.

As part of our participative approach a number of stakeholder workshops and other consultations were organised in each of the basins. Initially, two major participatory stakeholder workshops were planned to be organised in each river basin. It was however considered important to organise additional consultations or events to further improve the quality of the water management options, as well as to maintain the level of stakeholder engagement. These major stakeholder events were complemented by interviews and other interactions with selected stakeholders. An overview of the number of participants is given in Table 2.2.

Table 2.2: type of stakeholder interactions and number of stakeholders involved

Type of interaction	Pedieos	Rmel	Tordera	Vipava
Stakeholder workshop I (May-June 2014)	20	30	24	32
Stakeholder interviews (September-November 2014)	10	10	11	14
Stakeholder consultation I (Dec. 2014-March 2015)	12	42	22	19
Stakeholder workshop II (May-June 2015)	19	18	16	12
Stakeholder consultation II (October 2015)	84	30	15	16

All workshops and consultations were held in the local language (i.e. Greek, Arabic, Catalan and Slovenian), but in the Rmel river basin also French was used.

2.4 Eliciting the current state and future expectations

As part of the participatory process we organised a first stakeholder workshop in each basin. During these workshops, the participants answered the following questions:

- From your perspective, what are the biggest challenges in the medium-long term for this river basin?
- If you are allowed to dream and looking from your perspective, what should water management have achieved by 2030, in this river basin?
- What options do you see to help achieve that desired state by 2030?

In addition to stakeholder workshop I, interviews were conducted with stakeholders that were not able to participate in the workshops. These stakeholders were asked the same questions as in the workshop. With the help of these questions, we tried to elicit the most pressing issues with regards to water management to be addressed in each river basin.

To organize and synthesize all the information, we compiled narratives for each basin. These narratives describe stakeholders' beliefs and expectations from the water management in each river basin along a common storyline. Each narrative consisted of a written and a graphical component. The written component describes the context, the status and the challenges of water management in the river basins in a verbal form, while the graphical component – presented as a FCM – focuses on the functioning of the basin and highlights the relationships between main drivers, factors and challenges as perceived by stakeholders.

FCMs can be constructed with various degrees of stakeholder involvement; stakeholders can be invited to a workshop during which a FCM is constructed and FCMs can be constructed based on expert knowledge only. In BeWater, we privileged a stakeholder perspective. However, due to time and resource constraints, we opted for an approach by which the FCMs were created by scientists, based on stakeholders' statements and comments in various interactions.

To construct a first version of a FCM for each basin, we used statements expressed by stakeholders during stakeholder workshop I and the subsequent interviews. To do this, we conducted the following steps (Figure 2.3; Özesmi and Özesmi 2004; Kok 2009; Jetter and Kok 2014; Penn et al. 2013; Cole and Perichitte 2000):

i. **Extracting statements:** We compiled all the statements provided by the participants in the stakeholder workshops and subsequent interviews regarding the current issues and challenges in the basin. During the compilation, we kept track of the source of each of these statements to ensure transparency;
ii. **Refining and clustering:** In each basin a large number of statements were compiled and we aimed to reduce this to a total maximum number of 20 factors. To identify the main factors, we grouped statements that referred to the same topic although sometimes stated in different ways by the stakeholders. To do this, we created so-called “rosettas”, in which we identified the key concept to be included in the map together with its related concepts that were not included in the map. This allowed us to keep track of what is behind each of the factors in the map. We also categorised all factors as being challenges, drivers, or other relevant factors. We systematically included *water quality and water quantity* among the challenges in the map, as these issues were the main premises for the BeWater project. Other basin-specific challenges were included as well. Once we identified the challenges, we proceeded with the drivers. Drivers are factors of importance to the dynamics in the basin, but they are not affected by other factors in the system (i.e. drivers only exert influence on the system) and included climate and other socio-economic variables.
iii. **Identifying links:** in a next step we identified which factors exerted influence on other factors and connected these factors by means of arrows;
iv. **Identifying direction of influence:** after identifying the relationships, we qualified the relationships as being positive or negative. A positive relationship indicates a positive causality, i.e. the factors related by the arrow will move in the same direction when the causal factor experiments a change: if the causal factor increases (decreases), the factor receiving the arrow also increases (decreases). A negative sign indicates a negative causality, i.e. the factors related by the arrow will move in opposite directions when the causal factor experiments a change: if the causal factor increases (decreases), the factor receiving the arrow decreases (increases).
v. **Identifying strength of influence:** for each of the identified relationships we assigned a strength of the relationship in three classes: strong (+++ or ---), medium (++ or --) or weak (+ or -).

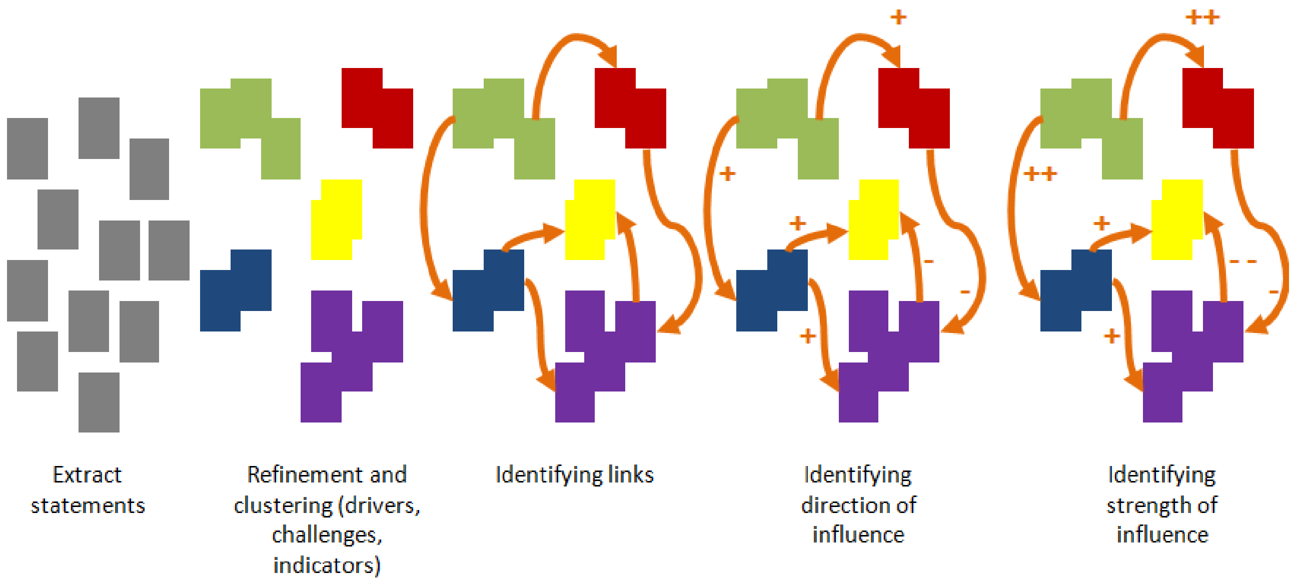

Figure 2.3: schematic overview of the steps to create Fuzzy Cognitive Maps

On the basis of the first versions of the FCMs compiled for the Rmel, Tordera and Vipava river basins, we consulted the stakeholders (stakeholder consultation I; Table 2.2). This consultation was done in the form of interviews in the Vipava river basin and in a workshop setting in the other two basins. In the three basins, stakeholders commented and suggested improvements of the FCMs. In most cases, this resulted in factors and relationships being added or modified. For the Pedieos river basin, a slightly different approach was adopted. Here, the FCM was constructed by conceptualizing the climate change drivers and key physical systems and processes in the basin. An interdisciplinary group of expert stakeholders and researchers were subsequently invited to solicit suggestions for missing systems or processes, and to identify and quantify the strength of the relations between all systems and processes.

To be able to use the maps for further analyses (see section 2.6), it was needed to refine them, which is a common step in participatory modelling (Jetter and Kok 2014; Vanclay et al 2006). In this model refinement we:

- Reduced the amount of factors (again) to 20 at maximum, as this is generally seen as the maximum amount of concepts in a cognitive map that can still be interpreted by stakeholders;
- Removed factors acting as transmitters (i.e. factors that receive one and send one arrow) from the FCMs as much as possible;
- Removed factors acting as receivers (i.e. factors that only receive arrows) from the FCMs;
- Removed as much as possible redundant arrows expressing the same relationship covered by other arrows.

These refinement steps resulted in a final version of a FCM for each basin, which were presented to stakeholders in Stakeholder workshop II.

2.5 Formulating water management options

To address the challenges specified by stakeholders, we asked stakeholders during the 1st stakeholder workshop and the subsequent stakeholder interviews to suggest water management options to address these challenges. Out of all suggestions made by stakeholders, we distinguished separate options and merged options when they were similar. We only considered suggestions for options that addressed at least one challenge. Next, options were characterised using a set of descriptors concerning the approach to tackle the challenges, the part (upstream, downstream) of the basin as well as costs and timing (Annex I).

Building on the characterisation of the WMOs, we checked for gaps and redundancies in the identified WMOs. We checked for redundancy based on the similarity of the descriptors of the identified options and also on the addressed challenges; options that appeared very similar were combined in one. We also checked to what extent identified challenges were addressed by the identified WMOs to ensure that several options tackle each challenge. This is required to allow for a selection of the options when preparing the adaptation plans. We also checked that the options represented a range of different options (e.g. WMOs addressing the demand and WMOs addressing the supply). Based on the gap identification, a decision was made whether the list of water management should be complemented with water management options derived from existing river basin plans or adaptation plans from other sectors (e.g. agriculture, forestry, etc.).

It should be noted that in practise these steps were not necessarily conducted in a linear order, e.g. the compilation of options and the clustering of options were in all basins frequently combined in one single step. After these steps, we had a first list of WMOs, which we presented to and discussed with participants of stakeholder workshop II. In this workshop, participants were invited to read descriptions of the options and discuss them with other participants. In several cases, participants indicated the formulation of the WMOs had to be refined, improved or corrected. These comments were recorded and used to provide a second version of the list of WMOs. This revised list was again presented to and discussed with participants of stakeholder consultation II. This iterative approach resulted in a final set of WMOs for each basin.

2.6 Evaluating water management options

We evaluated the identified water management options for their environmental and economic impacts, as shown in Figure 2.4

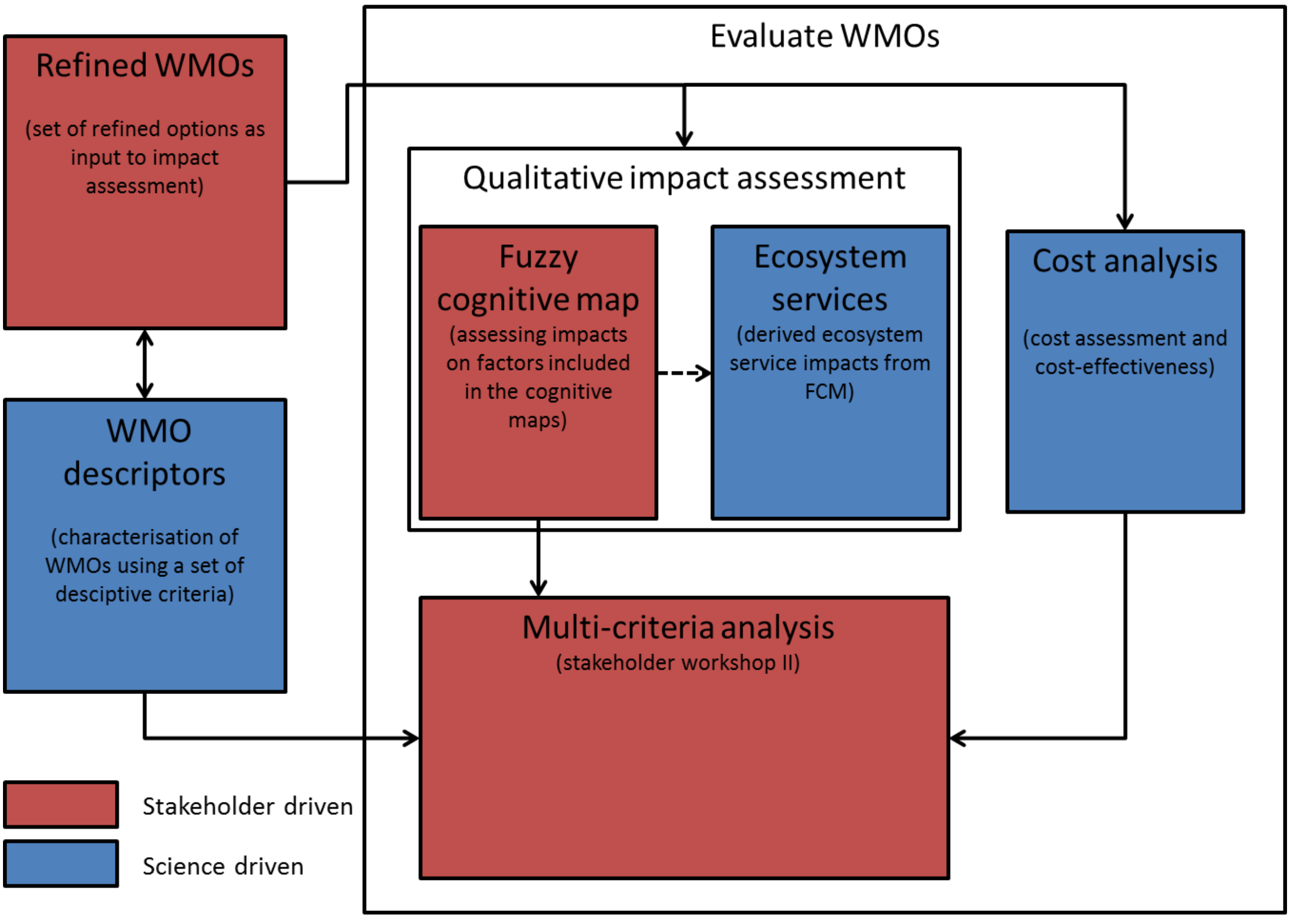

Figure 2.4: approach to design, characterize and evaluate water management options

2.6.1 Assessing impacts on river basin dynamics

We used FCMs as a semi-quantitative model to assess how the water management options would affect the dynamics in each river basin. To do this, FCMs were converted to simple mathematical models. Models for Rmel, Tordera and Vipava were linear whereas the model for Pedieos was non-linear. The FCMs were constructed in Mental Modeler (http://www.mentalmodeler.org/), but all model calculations were carried out in Microsoft Excel.

For the linear models, we assigned an initial value of 1 to drivers that were expected to increase in the future (e.g. temperature), an initial value of -1 to drivers that were expected to decrease in the future (e.g. precipitation) and an initial value of 0 as initial value to all other factors in the map. Whether a driver was expected to increase or decrease was determined based on literature. The strength of the relationships between factors was converted to semi-quantitative values (Table 2.4). By iteratively multiplying the initial values of all factors with the strength of the relationships, we were able to investigate how the change in drivers would affect the dynamics in each basin. The model converged generally after 30 iterations. We used these values for further analysis. These values were generally within the range [-2,2].

For Pedieos, a slightly different approach was followed. To prevent oscillations caused by the multiplication of negative relations with negative values, a sigmoid function was used to normalize all factors within the 0-1 range for each multiplication. A starting value of 0.659 was taken for the drivers and 0.5 for all other factors (these values are the inverse of 1 and 0, respectively, for the sigmoid function). The values of all factors stabilized within eight iterations.

Table 2.4: conversion of the strength of relationships in the FCM to semi-quantitative values

Strength of relationship	Pedieos	Rmel	Tordera	Vipava
+++	1	0.9	0.9	0.9
++	0.5	0.6	0.6	0.6
+	0.2	0.3	0.3	0.3
-	-0.2	-0.3	-0.3	-0.3
- -	-0.5	-0.6	-0.6	-0.6
- - -	-1	-0.9	-0.9	-0.9

For all basins, the impacts of the WMOs were assessed by (i) changing existing relationships between factors, (ii) introducing new relationships, (iii) introducing new factors and relationships, or by a combination of these three possibilities. The decision on how to implement a WMO was based on the description of each WMO separately. For example, a WMO suggesting the reconstruction of an existing irrigation system was introduced by modifying arrows already included in a FCM, while a WMO suggesting the construction of a new irrigation system was introduced by adding a new factor and arrow to a FCM. To avoid the loss of relationships in case of reduced intensity of 'weak' interactions (i.e. one + or one –) we added a 'very weak' category (+0.1 for positive arrows and –0.1 for negative arrows). By estimating the new equilibrium resulting from the modified models corresponding to each WMOs, we were able to assess semi-quantitatively the impacts of all WMOs for each basin separately.

2.6.2 Multi-Criteria Analysis

Water management options have different designs, characteristics and impacts on the basin. To compare them, we conducted a Multi-Criteria Analysis (MCA) based on stakeholders' weighted preferences. As input to the MCA, we used the set of descriptors that characterise the WMOs (see section 2.3), as well as the outcomes of the impact assessment based on the factors from the FCM. Among factors, drivers were excluded because they are not dynamic factors. We normalised the values of the factors from the FCM based on the minimum and maximum values of the data range for each factor over all WMOs.

During stakeholder workshop II, we asked each participant to select the five criteria that, according to their experience and opinion, should be considered in a decision making process. Then, the outcome was presented to the whole group, which was then asked whether the criteria having received less than two votes should be dropped. They were then asked to validate the final list of criteria. After this selection, in sub-groups, participants indicated what values of each criterion would represent the most and least preferred outcome (scoring of the criteria). Finally, participants individually gave a weight to each criterion on a scale of 1 to 10 depending on their importance (weighing of the criteria).

We combined (i) the scores and weights of the criteria given by the stakeholders, (ii) the characterization of the water management options and (iii) the normalised outcomes of the impact assessment to evaluate the water management options. We averaged the evaluation of the water management options over all participants of stakeholder workshop II, i.e. the opinion of each stakeholder was equally considered. We present the results on a scale of 0-100 with a 0 indicating the least preferred evaluation outcome and a value of 100 as the most preferred evaluation outcome.

We also conducted a sensitivity analysis to investigate how the outcomes of the MCA were related to the panel of participating stakeholders and to the list of considered criteria. The sensitivity estimation procedures were implemented in the statistical software package R (R Core Team 2013).

For the sensitivity to the panel of stakeholders, we estimated 1000 times the MCA results using a random selection of a sub-panel of 70% of the stakeholders. Extreme results show if some options would have received a very different evaluation if some stakeholders had not taken part in the evaluation. To complement this analysis, the variability of MCA results for each individual stakeholder was also analysed to look for possible outliers.

The sensitivity to the selection of criteria was tested by repeating 1000 times the MCA calculation using a random selection of 70% of the criteria. Weights were renormalized for every calculation to ensure comparability. A second systematic test consisted in the estimation of the MCA results with all but one criterion. The role of this test was to determine if one criterion played a major role in the outcomes of the Multi Criteria Analysis.

2.6.3 Economic assessment

An important element in the choice of a management option – especially when the implementation budget is limited – is its costs in relation to its capacity to address the challenges. A cost-benefit analysis of each option was suggested in the project. However, this approach proved impossible for many options because their impacts (benefits) could not be estimated in economic terms. This was the case not only for most soft options, whose outcomes depend to a large extent on the acceptability and the participation, but also for several technical options which impact on the water fluxes could not be precisely assessed because it depends on the actual implementation and no technical model is available to estimate the changes. Because of these limitations, the results of cost-benefit analysis would not be possible in all cases, and in some of the cases, they would not even be comparable between each other. Therefore, we decided to conduct a simplified cost assessment and cost effectiveness analysis, which would provide preliminary information for the elaboration of the river basin management adaptation plan.

The cost assessment consisted of the calculation of the discounted sum of the costs of the different actions that would be needed to implement the option. Both implementation costs and running costs should be determined and scheduled. Data come from:

a) cost estimates of the same option if it is mentioned/included in other plans for the basin
b) cost estimates of similar options in literature (scientific and/or grey);
c) expert/stakeholder knowledge.

Only additional costs resulting from the implementation of the options were included in the analysis. Costs were not taken into account if they would be supported in the baseline, which correspond to what would happen in the absence of the option. In some cases, the implementation of the option leads to a reduction in the running costs compared to the baseline. In such a case, the reduced expenses are considered as negative expenses. Costs were estimated from the year of the beginning of the implementation plan to a defined time horizon which should be the same for all options. We used 2016 or 2018 as a starting year and the final year was 2030 since it corresponds to the target in the project. We used a common discount rate for comparing all options for one basin, but rates differed between basins. Details on the cost assessment in each river basin are provided in chapters 3-6.

The cost assessment analysis does not include any information concerning the effectiveness of the options. To take into account this aspect, we employed a cost-effectiveness analysis by implementing the weighted score approach (UK Department of Finances and Personnel 2015). In this approach, effectiveness is related to the capacity to make desired changes and is independent from the characteristics of the options. Therefore, we only consider partial MCA results calculated weights and scores of the criteria in the map. We define the effectiveness indicator as the difference

between the partial MCA results obtained for an option and the partial MCA result related to the baseline. The cost-effectiveness was calculated for each option as the ratio between the cost of implementing and the effectiveness indicator.

2.7 Methodological differences between river basins

While the general approach was the same for all river basins, there were small differences with regards to the implementation of the different steps in the general approach. These differences are summarised in Table 2.6.

Table 2.6: overview of methodological differences between river basins

Pedieos	Rmel	Tordera	Vipava
Near final version of the FCM was discussed and all relations were identified and quantified with expert stakeholders during a stakeholder event	Preliminary version of the FCM was discussed with a broad group of stakeholders during a stakeholder event	Preliminary version of the FCM was discussed with a broad group of stakeholders during a stakeholder event	Preliminary version of the FCM was discussed with a broad group of stakeholders during stakeholder interviews
Sigmoid conversion was applied when converting the FCM to a mathematical model	No conversion was applied when converting the FCM to a mathematical model	No conversion was applied when converting the FCM to a mathematical model	No conversion was applied when converting the FCM to a mathematical model
Uneven class widths were assumed to represent the strength of relationships in the FCM	Even class widths were assumed to represent the strength of relationships in the FCM to semi-quantitative values	Even class widths were assumed to represent the strength of relationships in the FCM to semi-quantitative values	Even class widths were assumed to represent the strength of relationships in the FCM to semi-quantitative values
Impacts on ecosystem services were only assessed for ecosystem services included in the FCM	Impacts on ecosystem services were assessed for ecosystem services included in and derived from the FCM	Impacts on ecosystem services were assessed for ecosystem services included in and derived from the FCM	Impacts on ecosystem services were assessed for ecosystem services included in and derived from the FCM
Stakeholder evaluation was based on MCA and on direct scoring of options on a scale of 1 (very bad) to 5 (very good).	Stakeholder evaluation of options was based on MCA only	Stakeholder evaluation of options was based on MCA only	Stakeholder evaluation of options was based on MCA only

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Annex I

Table I.1: list of descriptors to classify WMOs

Attribute	Classes	Description
Water status	Quantity	Option targeting the availability of water
	Chemical quality	Option targeting the chemical properties of water
	Ecological quality	Option targeting biological quality of surface water
	Hydrogeomorphological quality	Option targeting hydromorphological quality of the fluvial system
Water bodies	Surface water	Option targeting surface water
	Groundwater	Option targeting groundwater
River section	Up	Option targets the upper section of the river basin
	Middle	Option targets the middle section of the river basin
	Down	Option targets the down section of the river basin
	River as a whole	Option targets the whole river basin
Target water use sector	Local population	Option targets the water needed or used by residents within the basin
	Tourism	Option targets the water needed or used by the touristic/recreation sector within the basin
	Industry	Option targets the water needed or used by industry within the basin
	Agriculture	Option targets the water needed or used by farmers within the basin
	Forestry	Option targets the water needed or used by trees within the basin
	Energy	Option targets the water needed or used by the energy sector within the basin
	Water management	Option targets authorities responsible for water quantity and quality (e.g. waste treatment, issuing water permits)
	Others	Option targets water use sectors different from the previous *(please specify at the end of the row the specific sector)*
Target land use	Arable land (rainfed)	Land that is being farmed with crops that are sown and harvested within the same agricultural year, relying exclusively or rain water
	Arable land (irrigated)	Land that is being farmed with crops that are sown and harvested within the same agricultural year, relying exclusively irrigation water
	Permanent crops (rainfed)	Land that is being farmed with crops which last for many seasons, rather than being replanted after each harvest, relying exclusively or rain water
	Permanent crops (irrigated)	Land that is being farmed with crops which last for many seasons, rather than being replanted after each harvest, relying exclusively irrigation water
	Grassland	Land that is dominated by grasses or shrubs for grazing or fodder purposes
	Forests	Land that is predominantly covered by trees
	Built-up	Land that is used for housing, industry (incl urban fabric, industrial/commercial areas, transport networks, mineral extraction sites, dump sites, construction sites, etc.)
	Wetlands & deltas	Swamps and marshes, estuaries, deltas and tidal flats, near-shore marine areas and human-made sites such as reservoirs
	Beaches and dunes	Sands and muds from the coasts of the oceans not covered by sea water at low tide
	Other	Land that is used for other purposes

Attribute	Classes	Description
Extreme events	Drought	Option targets droughts
	Flooding	Option targets floodings
	Storm	Option targets storms
	Fire	Option targets wildfires
	Not related	Option does not target an extreme event
Implementation scale	National	Option is to be implemented at national level
	Regional	Option is to be implemented at regional level
	Basin	Option is to be implemented at basin level
	Municipal	Option is to be implemented at municipal level
Implementation time horizon	Short	Option can be functioning on short term (<5yrs)
	Medium	Option can be functioning on medium term (5-20 yrs)
	Long	Option can be functioning on long term (>20 yrs)
Expected lifetime	Short (< 5 years)	Expected time for which the option is operational without major rehabilitation is short (less than 5 years)
	Medium (5 -20 years)	Expected time for which the option is operational without major rehabilitation is medium (5 - 20 years)
	Long (> 20 years)	Expected time for which the option is operational without major rehabilitation is long (more than 20 years)
Timelag between implementation and effectiveness	Short (< 5 years)	Expected time since the option is implemented until it starts to have the desired effect is short (less than 5 years)
	Medium (5 -20 years)	Expected time since the option is implemented until it starts to have the desired effect is short (less than 5 years)
	Long (> 20 years)	Expected time since the option is implemented until it starts to have the desired effect is long (more than 20 years)
Character	Demand	Option targeting the need for water
	Supply	Option targeting the availability of water
	Support	Option targeting improved governance (incl. awareness raising, monitoring, stakeholder involvement)
	Environmental conservation	Option targeting the recovery of the ecological status
Implementation costs *(one-time set up cost of implementing the measure, after which there will only be recurring operational or running costs)*	< 10,000 €	Direct capital costs of implementing the option are below 10,000 €
	10,000 - 100,000 €	Direct capital costs of implementing the option are in the range 10,000-100,000 €
	100,000 - 1,000,000 €	Direct capital costs of implementing the option are in the range 100,000-1,000,000 €
	> 1,000,000 €	Direct capital costs of implementing the option are over 1,000,000 €
Operational costs *(costs incurred annually to maintain the measure operating)*	< 10,000 € / yr	Total annual running costs for this option are below 10,000 €
	10,000 - 100,000 € / yr	Total annual running costs for this option are in the range 10,000-100,000 €
	100,000 - 1,000,000 € / yr	Total annual running costs for this option are in the range 100,000-1,000,000 €
	> 1,000,000 € / yr	Total annual running costs for this option are over 1,000,000 €
Effectiveness (capacity to tackle the specified challenge)	High	Option is highly effective in tackling the specified challenge
	Medium	Option is medium effective in tackling the specified challenge
	Low	Option is low effective in tackling the specified challenge
	Uncertain	Uncertainty about how the option may tackle the specified challenge
Approach to adaptation	Green	Ecosystem-based approaches that use services of nature
	Grey	Technological and engineering solutions

Attribute	Classes	Description
	Soft	Managerial, legal and policy approaches that change human behaviour and styles of governance
Nature of approach	Bear the loss	Occurs when those affected have no capacity to respond in any other ways
	Share the loss	Occurs when the losses are shares among a wider community (either extended family or village-level in traditional societies or through public relief, rehabilitation and reconstruction or insurance)
	Modify the threat	Occurs when the measure exercises a degree of control over the environmental threat itself (e.g. flood control measures such as dikes)
	Prevent effects	Occurs when the option involves steps to prevent the effects of climate change and variability (e.g. modification in crop management practices)
	Change use	Occurs when the continuation of an economic activity is changed due to the difficulty of continuing it (e.g. agricultural use changed into forest use)
	Research	Occurs when the option means use of new technologies and new methods of adaptation
	Educate, inform and encourage behavioural change	Occurs when the option is based on dissemination of knowledge through education, public campaigns leading to behavioural change
Potential to address climate change	Robustness	An option is considered robust to uncertainties if it can maintain its effectiveness under different climatic and socioeconomic development scenarios.
	Flexibility	An option is considered flexible when it can be adjusted/ complemented or reversed when it turns out to be inadequate or inappropriate in practice.
Feasibility	No major obstacle	No barriers for the implementation
	Minor obstacles	Physical, technical or organizational obstacles that can easily be overcome
	Serious obstacles	Physical, technical, regulatory or organizational obstacles that would be difficult to overcome within the time horizon of the project
Acceptability (a priori)	High	There is not significant reason a priori for anyone to reject the option.
	Low	There are obvious signs that one or several actors of the RB will reject the option because of its design.

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