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ORIGINAL ARTICLE

Combining backcasting and exploratory scenarios to develop robust water strategies in face of uncertain futures

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Abstract Water management strategies in times of global change need to be developed within a complex and uncertain environment. Scenarios are often used to deal with uncertainty. A novel backcasting methodology has been tested in which a normative objective (e.g. adaptive water management) is backcasted within the context of exploratory scenarios that sketch four different plausible futures (Economy First, Policy Rules, Fortress Europe, and Sustainability Eventually). The main advantage of combining exploratory and normative scenarios is in the identification of robust actions: actions that are effective in the different socio-environmental contexts sketched in the exploratory scenarios. This paper has three objectives: (1) to present the methodology, focussing on its novel aspects (2) to test the methodology and evaluate its perceived success by analysing organiser and stakeholder feedback and (3) to analyse and evaluate the results, in order to study the impact of the exploratory scenarios on the backcasting results and the added value of robust actions. The methodology was successfully tested in 9 local and one regional case study in a water project water scenarios for Europe and for Neighbouring States (SCENES). Results showed that the exploratory scenarios influenced the content of the backcasts, thus making the identification of robust strategies possible. The list of robust strategies includes both technological and social/organisational strategies, highlighting the need for an integrated approach. The approach shows high potential, but as the methodology is in its infancy more research is needed, particularly in methods to facilitate and monitor information flow between exploratory scenarios and backcasts.

Keywords Backcasting · Exploratory scenarios · Robust strategies · Water management · Participation · Policy development

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1 Introduction

For mitigation and adaptation strategies for global change to be successful, the complex and dynamic environment in which they will be implemented needs to be taken into account. The long-term perspective of climate change adds to the uncertainty. Many scholars have argued that scenarios are a good tool to analyse and cope with uncertainties (Schoemaker 1991; van der Heijden 1996; Peterson et al. 2003; Cohen et al. 2011; van't Klooster and van Asselt 2011; Carlsen et al. 2012). Water management is one of the fields strongly impacted by global change, and scenarios are widely used in water management projects (Alcamo et al. 2000; Kämäri et al. 2008; Carlsen et al. 2012; March et al. 2012; Dong et al. 2013).

Several different approaches to scenario development exist, see for overviews, Schoemaker (1993), Van Notten et al. (2003) and Börjeson et al. (2006), two of which are included in this research: exploratory scenarios and backcasting. Exploratory scenarios are increasingly used to gain insights into uncertain future outlooks, by looking at several plausible futures (Peterson et al. 2003; Biggs et al. 2007). However, it is argued that they fall short in relation to studying how a desirable solution can be attained (Robinson 1990). The search to achieve desirable futures has led to the development of backcasting, which is a normative scenario approach (Dreborg 1996; Höjer and Mattsson 2000; Robinson 2003; Quist and Vergragt 2006). Both methodologies are briefly introduced, after which we argue why they should be combined.

1.1 Exploratory scenarios

Exploratory scenarios sketch plausible futures, showing the implications of several external drivers (Börjeson et al. 2006). They do not predict, but rather show, what may happen (van der Heijden 2000; Shearer 2005; Börjeson et al. 2006). Exploratory scenarios are often developed using participatory methods and can be either qualitative, often in the form of storylines, or quantitative, often in the form of models (Van Notten et al. 2003). Both types are increasingly combined (UNEP 2002; Millennium Ecosystem Assessment 2003; European Environmental Agency 2006; Kok et al. 2006; Stalpers et al. 2007). Often, two main external drivers are used as the starting point for scenario development. This "scenario-axes technique" is considered the state-of-the-art, despite critical observations in the literature (e.g. van't Klooster and van Asselt (2006)). Many of the existing scenarios fit on the axes of global versus regional and self-interest/reactive versus solidarity/pro-active (UNEP 2002; Millennium Ecosystem Assessment 2005; de Vries and Petersen 2009; vanVuuren et al. 2012).

For this paper, the most important feature of exploratory scenarios is their aim to describe distinctively different plausible futures, each showing different developments of social, economic and environmental factors. This diversity captures a broad range of uncertainty about the future. More details on exploratory scenarios can be found in e.g. van der Heijden (1996); Rotmans et al. (2000); UNEP (2002); Van Notten et al. (2003); Börjeson et al. (2006); Meyer (2007); Nowack et al. (2011)).

1.2 Backcasting

Börjeson et al. (2006) place backcasting within normative, transforming scenario studies. Being more an approach than a method (Dreborg 1996), backcasting can be implemented in a large variety of ways (Quist et al. 2011). Most methods have two main characteristics in common: their normative nature and "working backwards from a particular desired future

end-point" (Robinson 2003). This often translates into methods that include *at least* the following two steps: 1) the development of desirable images of the future (visions) and 2) a backwards analysis of how these visions can be realised (see also (Robinson 1988; Höjer and Mattsson 2000; Quist et al. 2011)). Some argue that the vision-making process is part of the backcasting methodology (Quist and Vergragt 2006; Giurco et al. 2011; Svenfelt et al. 2011), whereas others refer to backcasting as the part of working backwards from the vision to the present (van der Kerkhof 2006; Kok et al. 2011). We use the term backcasting in the latter way.

Similar to exploratory scenarios, some backcasting studies have a strongly quantitative nature, depending strongly on models (Robinson 2003; Geurs and van Wee 2004; Gomi et al. 2011), whereas others take a more qualitative (and often participatory) approach (Partidario and Vergragt 2002; Carlsson-Kanyama et al. 2008; Svenfelt et al. 2011). Some more recent studies have started to structurally include an analysis of different (plausible) futures (Carlsson-Kanyama et al. 2008; Robinson et al. 2011; Berkel and Verburg 2012). More details on backcasting can be found in Robinson (1982), Dreborg (1996), Robinson (2003), Van Notten et al. (2003), Börjeson et al. (2006) and Quist et al. (2011).

1.3 Combining exploratory and normative scenarios

Both normative and exploratory approaches have their advantages and disadvantages, and scenario developers from both sides have acknowledged the added value of both types (Kok et al. 2011). Both approaches to scenario development are highly complementary and, following e.g. Berkel and Verburg (2012) and Kok et al. (2011), we argue that there is an added value in combining them.

In a combined backcasting and exploratory scenarios approach, the exploratory scenarios function as external scenarios (Börjeson et al. 2006), acting as socio-environmental contexts. Backcasting the same desired goal within the context of different exploratory scenarios takes into account the key uncertainties in the main drivers (see Fig. 1). This, in turn, makes it possible to study the robustness of the developed strategies. Robust strategies are effective under different socio-environmental contextual scenarios (Hallegatte 2009; van der Voorn et al. 2012). It is likely that various adaptation strategies will be deemed effective in each exploratory scenario, therefore increasing the number of strategies studied (see Fig. 2). At the same time, robust strategies are those strategies that are more likely to be effective irrespective of the uncertain dynamics of the contextual environment.

An important additional added value of a combined method includes maximising stakeholder involvement, as different methods appeal to different stakeholders (Kok et al. 2011).

1.4 The SCENES project

This paper is based on participatory workshops that took place within SCENES (Water Scenarios for Europe and neighbouring states), an European Commission (EC) 6th FP project that ran between 2006 and 2011. SCENES aimed to develop and analyse a set of comprehensive exploratory scenarios of Europe's freshwater futures up to 2050, including climate change impacts (Kämäri et al. 2008). Scenarios consisted of a qualitative part—within which storylines were developed in a highly participatory way (Khadra et al. 2011; Kok and van Vliet 2011; Kaljonen et al. 2012); see Appendix 1)—and a quantitative part—within which data, models and indicators were developed Schaldach et al. (2012). These parts were linked via the Storyline and Simulation (SAS) approach (Alcamo 2008).

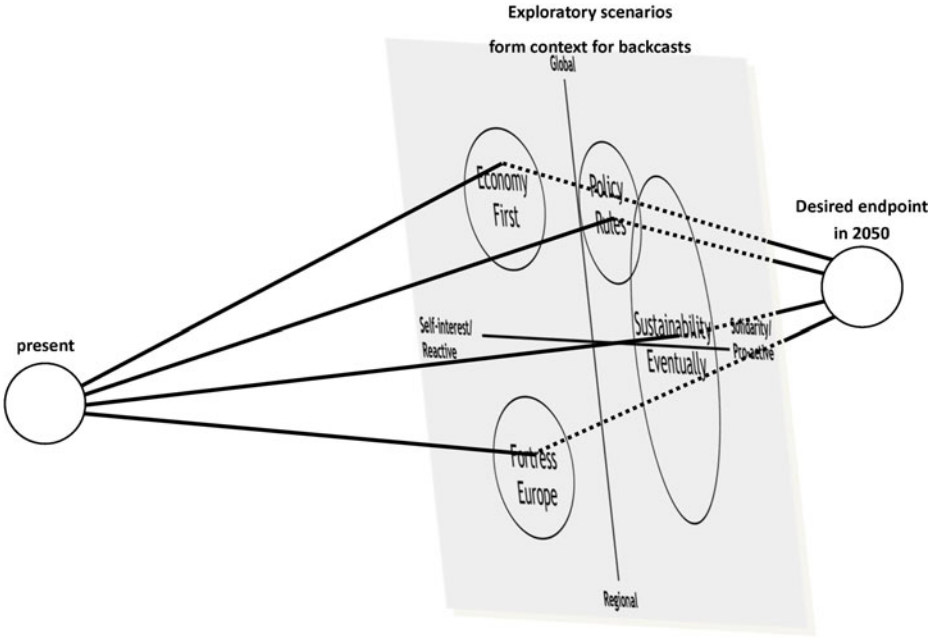

Fig. 1 Relation between the exploratory scenarios and the backcasts. One desired endpoint is chosen for 2050 and strategies are developed to achieve that endpoint. These strategies need to be effective in the context of one of the four exploratory scenarios by working backwards from 2050 to the present. This is done for each exploratory scenario, thus creating four backcasts

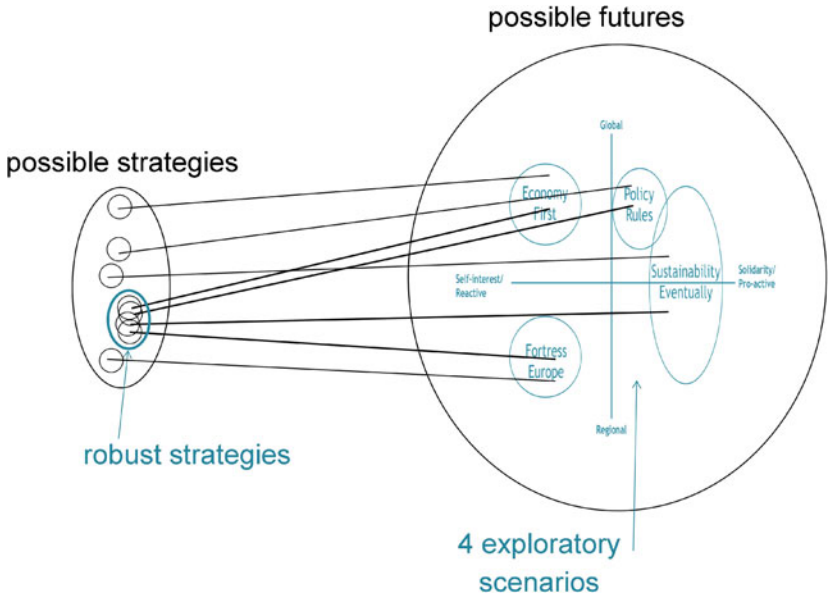

Fig. 2 Identifying robust strategies. Strategies are developed within the context of four exploratory scenarios that try to capture part of the uncertainty of all possible futures. This leads to an overview of possible strategies. Strategies that are effective in all four exploratory scenarios are robust

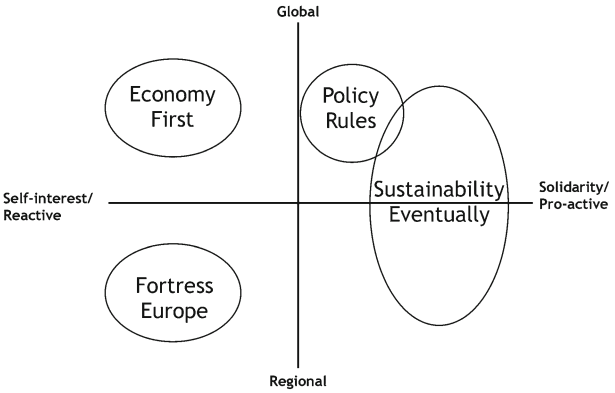

Fig. 3 The exploratory scenarios developed in the first two workshops and used in the backcasting workshop. Illustrated by their place on the axes global versus regional and self-interest/reactive versus solidarity/pro-active (based on Kok et al., 2011)

Figure 3 shows the SCENES socio-environmental exploratory scenarios developed for this study in two consecutive workshops (Kok and van Vliet 2011; Van Vliet 2011) that preceded the workshops presented in this paper. The exploratory scenarios study changes in society, economy and environment, including climate change, and their effects on water management and related fields such as agriculture, industry and tourism (see Appendix 1 for short abstracts).

The participatory workshops presented in this paper were held in local-, regional- and pan-European-scale case studies between June 2009 and February 2010. This paper presents the results of nine local case studies and the Baltic regional case study. For more information on the pan-European scale; see Kok et al. (2011). Workshops lasted one to two days, and included a diverse group of about 15–20 stakeholders. Participants worked mainly in the water sector (between 30 % and 70 % in the different case studies), but also in other sectors such as nature and agriculture. Most participants worked in government administration (including irrigation and water boards), the private sector and research.

1.5 Objectives

The main hypothesis of this paper is that combining exploratory scenarios and backcasting has added values particularly by yielding robust strategies. It is possible to determine robust strategies when the backcasts take the exploratory scenarios into account. We therefore focus particularly on how and to what extent exploratory contexts were used during backcasting.

The paper has three aims:

(1) to present the methodology for combining backcasting and exploratory scenarios, focussing on its novel aspects,
(2) to evaluate its perceived success by analysing organiser and stakeholder feedback from ten case studies,
(3) to analyse and evaluate the backcasting results, in order to study whether the backcasts reflect the context of the exploratory scenarios and to discuss resulting robust strategies.

2 Methods and materials

2.1 The combined methodology used in the participatory workshops

The different steps of the combined methodology as applied here are now summarised. The methodology is based on Robinson's (1982) backcasting approach and builds upon the work of van der Kerkhof (2006) and Patel et al. (2007), while also linking to the bouncecasting approach (Kahan et al. 2004). The exploratory scenarios were developed before by the same group of stakeholders in two previous workshops.

Two novel aspects, not mentioned in the existing literature, are included in this study:

(1) An explicit step asking workshop participants to identify obstacles and opportunities *specific to the contextual exploratory scenario* within which the backcast was developed.
(2) A step during which the robustness of scenario-specific actions and strategies was discussed with all workshop participants.

In detail, the backcasting method followed five steps:

Step 1. Desired endpoint in 2050

A desired endpoint was chosen in plenary session. It needed to be a major goal upon which all participants agreed. The same desired endpoint was used for all exploratory scenarios. Therefore it had to be specific enough to focus the discussion, but not so specific that it would limit the room for action within any of the scenarios. The desired endpoint differed by case study.

Step 2. Obstacles, opportunities and milestones

2a. In small groups, participants studied the contextual exploratory scenario that they had developed previously in order to identify the obstacles (e.g. lack of financial resources) and opportunities (e.g. investment in new technologies) encountered in relation to achieving the desired endpoint. Various products (e.g. storylines and conceptual models) created in the exploratory scenario development workshops were used.

2b. At the same time, milestones were defined. The milestones formed the main steps from the desired endpoint back to the present. They were often linked to one or multiple obstacles and opportunities, and thus to the exploratory scenario.

Step 3. (Policy) actions

The milestones, obstacles and opportunities provided a framework for the identification of more concrete actions. These actions were designed to overcome obstacles and lead to the achievement of milestones and the desired endpoint. The actions were plotted on a timeline to show the relations between them, and their relations with milestones, obstacles and opportunities (see Fig. 4).

Step 4. Strategies

Strategies are main sequences of actions and milestones leading to the desired endpoint. They summarise the backcasting timeline. They were identified roughly by the participants. After the workshop, they were fine-tuned by the workshop organisers.

Step 5. Robust actions

Actions that were identified in the context of all exploratory scenarios were identified as robust. In some case studies, robust actions were also identified by looking for actions that were not mentioned in all backcasts, but that could be effective within all exploratory scenarios.

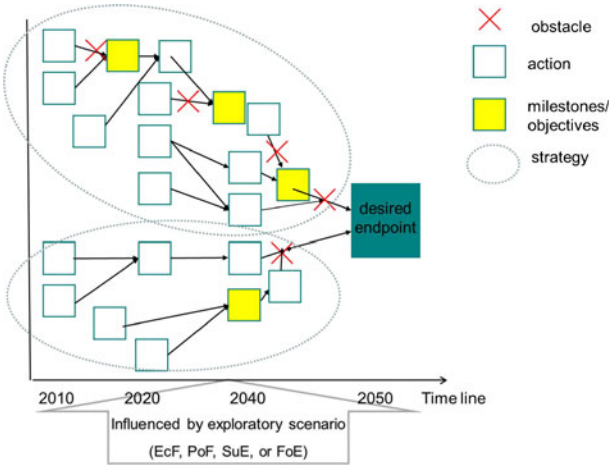

Fig. 4 Simplified example of the result of a backcasting in the context of an exploratory scenario exercise. *EcF* Economy First, *FoE* Fortress Europe, *SuE* Sustainability Eventually, *PoR* Policy Rules

The main outputs of the backcasting exercise were threefold:

1. Four timelines with actions, milestones, obstacles, opportunities and the desired endpoint, illustrated by time trends, showing how the desired endpoint can be reached; one for each exploratory scenario.
2. A summarising overview in the form of strategies, for each exploratory scenario.
3. A list of robust actions, independent of the scenarios.

2.2 Methods and materials used to evaluate the success of the combined methodology

The evaluation of the combined methodology consists of two main parts. First, we evaluated the views of participants and organisers as provided directly after the workshops. The level of acceptance among organisers is illustrated by an overview of how the combined methodology was applied in the ten case studies. Organiser reports were available from all case studies. A questionnaire was administered to the participants in six case studies. It included questions on satisfaction with the workshop, desired endpoint and resulting policy strategies. On most questions, a score of 1 to 5 could be given, with 1 being the worst score and 5 the best.

Second, the influence of the exploratory scenarios on the backcasting results was studied by analysing the identified obstacles, opportunities and strategies. Data on the developed strategies were available for all case studies. Obstacles and opportunities were not assigned in all case studies and, moreover, were not always reported on in detail. Detailed data on obstacles were available for seven case studies and on opportunities for three.

To analyse the influence of exploratory scenarios on the backcasts, the backcasting results were compared with the characteristics of the exploratory scenarios (see Table 1). To do so, the results from step 2 (obstacles and opportunities) and step 4 (strategies) were used.

First, the numbers of obstacles and opportunities were compared. Then the obstacles, opportunities and strategies were coded (Woodrum 1984; Bryman and Teevan 2005). The coding categories consisted of the scenario characteristics mentioned in Table 1. The percentage

Table 1 Scenario characteristics. For each exploratory scenario the importance of one of the eight subject categories is given: − is low importance, + some importance and ++ high importance

Subject category	Economy First	Policy Rules	Fortress Europe	Sustainability First
Legislative/ policy	−	++	++	+
	little, market controls	very important	important, needed to steer changes	mainly on local scale
Management	−	+	+	++
	little	some, to execute the policies	some, to execute the policies	large changes, moving from top-down to bottom-up
Economic	++	+	+	−
	much attention, driving force	some attention	some, to maintain stability	economy becomes less important
Social	−	+	−	++
	low importance	important	low importance	large social changes
Environmental	−	+	−	++
	low importance	important	low importance	very important
Research/ technologies	++	+	−	+
	much innovation	some	little	some
Cooperation	+	++	+	+
	mainly global	on all levels	within EU	within eco-regions

of obstacles, opportunities and strategies per coding category was compared to the importance of that category in the exploratory scenarios.

To analyse the influence of the exploratory scenarios in more detail, the content of the obstacles, opportunities and strategies was studied in more detail. For instance, the type of technologies to be used might differ depending on the exploratory scenario (e.g. a highly technological or a natural approach).

3 Results

3.1 Main results

Most of the case studies followed the combined methodology as described in Section 2 to a large extent (see Table 2). In all the case studies, obstacles, actions and milestones were identified. In the Mediterranean region case studies, the specific endpoint focussed on water quantity issues (drought), e.g. adequate water availability for agriculture in the future or good water status compatible with socio-economic viability. The Baltic region focussed on water quality, often related to the European Union's (EU) Water Framework Directive goals. In the Black Sea region, both water quality and quantity aspects were seen as important, with a focus on water for irrigation, which included both availability and quality. In the Lower Danube region, the focus was mainly on water quality, but water quantity was also studied. The desired endpoints were often ambitious; in the Peipsi case studies (Estonia) they proved to be too ambitious as stakeholders could not

Table 2 Overview of results from the backcasting exercise and data availability per case study

Case study	Robust strategies	Scenarios used[a]				Number of backcasts	Detailed data available for[b]				
		EcF	FoE	SuE	PoR						
Baltic region	yes	X	X	X	X	4	ob	op	st	qu	re
Narew	yes	X		X		3×2[c]			st	qu	re
Peipsi	yes	X		X	X	3	ob		st	qu	re
Tisza	yes	X	X	X	X	4×2[c]			st		re
Danube Delta	yes			X		1			st		re
Crimea	yes	X	X	X	X	4	ob		st	qu	re
Lower Don	yes	X	X		X	3	ob		st	qu	re
Candelaro	yes		X		X	2	ob	op	st	qu	re
Guadiana	yes	*PoR+EcF and PoR+SuE*[d]				2	ob	op	st		re
Seyhan	no			X		1	ob		st		re

[a] *EcF* Economy First, *FoE* Fortress Europe, *SuE* Sustainability Eventually, *PoR* Policy Rules

[b] *ob* obstacles, *op* opportunities, *st* strategies, *qu* questionnaires, *re* report. Only availability of detailed information, the number of obstacles and opportunities was available for more case studies

[c] Each group used two scenarios

[d] Scenarios were a combination of the scenarios mentioned

find ways to stabilise anthropogenic eutrophication in the lake and to decrease the average total P concentration to a level below 0.04 mg/l.

In total, about 500 actions, 350 milestones, 190 obstacles and 80 opportunities[1] were identified, summarised in 130 strategies. In total, there were thus about 1,120 'post-its' placed during all workshops. Of these, at least 24 % were directly linked to the exploratory scenarios in the form of obstacles and opportunities. The direct link is likely to be stronger, as not all case studies assigned opportunities, but in order to save time, directly translated them into milestones and actions. An overview of the obstacles, opportunities and strategies on which detailed information was available can be found in Appendix 2.

The number of obstacles, opportunities and strategies in the backcasts differed by contextual exploratory scenario. Fortress Europe (FoE) had the highest average number of obstacles and strategies (see Table 3), showing that reaching the goals was relatively difficult within the context of this exploratory scenario. Sustainability Eventually (SuE) had, on average, most opportunities, but also the second highest number of obstacles. Policy Rules (PoR) had the fewest obstacles, but also the fewest opportunities. Economy First (EcF) was always in the middle in the number of obstacles, opportunities and strategies.

The type of opportunities, obstacles and strategies were not spread evenly over the scenario characteristics categories (see Table 3). All backcasts contained a relatively large number of economic opportunities, whereas there were relatively few opportunities in the categories legislation/policy, cooperation, other and, to a lesser extent, research/technologies. All backcasts had a relatively high number of management strategies, illustrating the often large changes needed to reach the ambitious endpoints.

[1] This includes all 'post-its' from the ten case studies. Detailed information was not available for all case studies, therefore other numbers will appear in other parts of this paper where detailed information was needed for the analysis.

Table 3 Percentages of obstacles, opportunities and strategies coded by category and scenario, and the number of obstacles, opportunities and strategies per scenario

Category	EcF			PoR			FoE			SuE		
	ob	op	st	ob	op	st	ob	op	st	ob	op	st
Legislative/policy	17 %	0 %	20 %	7 %	8 %	24 %	12 %	10 %	13 %	8 %	8 %	11 %
Management	24 %	19 %	22 %	37 %	17 %	28 %	14 %	10 %	24 %	38 %	12 %	30 %
Economic	15 %	25 %	18 %	24 %	25 %	7 %	33 %	30 %	9 %	8 %	24 %	14 %
Social	16 %	13 %	10 %	10 %	25 %	7 %	11 %	10 %	22 %	21 %	24 %	23 %
Environmental	9 %	13 %	10 %	12 %	8 %	26 %	26 %	30 %	11 %	10 %	32 %	16 %
Research/technologies	4 %	19 %	6 %	2 %	8 %	6 %	2 %	10 %	11 %	4 %	0 %	2 %
Cooperation	7 %	0 %	8 %	0 %	0 %	2 %	0 %	0 %	2 %	12 %	0 %	0 %
Other	11 %	13 %	8 %	7 %	8 %	0 %	2 %	0 %	9 %	2 %	0 %	5 %
Number[a]	37	13	33	34	11	32	35	7	39	35	19	31
Average[b]	7.4	6.5	5.5	6.8	5.5	6.4	11.7	7.0	7.8	8.8	9.5	4.4

[a] Total number, aspects could be placed under multiple categories; the number given here excludes doubles

[b] Average per backcast

3.2 Evaluating the backcasting workshops

3.2.1 Extent to which the combined methodology was used

Overall, there were fewer changes to the general combined methodology than in the previously held exploratory scenario development workshops (see for instance van Vliet et al. (2012)). One important deviation from the methodology was that two local case studies developed only one backcast within one exploratory scenario. They did this because of lack of time, and because the SuE scenario was perceived as the only desired scenario and therefore the participants wanted to work only with that scenario. One of them did study robustness by discussing the effectiveness of strategies within the other three exploratory scenarios. The other case study did not study robustness. An other deviation was that not all case studies included opportunities, and some discussed obstacles at the end of the exercise. In these case studies, the link with the exploratory scenarios was made in a less explicit way: e.g. opportunities were translated directly into milestones.

3.2.2 Organisers feedback

All organisers were very satisfied with the workshops, but not everything went smoothly. A number of problems were identified by the coordinators in their reports:

- Several case studies reported that it was difficult to define one specific desired endpoint that made sense for all four scenarios. Some participants would have liked to use different endpoints, to better match the exploratory scenario. (E.g. "The main confusing issue during the workshop was how to reach the desirable objective in a previously defined [exploratory] scenario that can be opposite to the desired objective" Guadiana report.)
- The distinction between actions and milestones was difficult. (E.g. "All workgroups faced some difficulties when trying to make a distinction between the targets and measures, e.g. whether the wastewater treatment is an action or a milestone?" Peipsi report.)
- The policy aspect was difficult for non-policymakers. (E.g. "For formulation of policy strategies there is no relevant knowledge and experience on available policy instruments like those well known in Europe. Therefore, stakeholders wanted to have more time and felt unsure during formulation of policy strategies" Crimea report.)
- Working backwards was difficult. (E.g. "One participant claimed that it is more difficult to imagine 2040 than 2015, therefore a chronological approach would be easier" and "I had to remind people to work backwards during the backcasting session" Narew report.)

3.2.3 Participants' feedback

Participants were enthusiastic about the backcasting method. On average, 88 % of the participants graded the workshop at 4 or higher. The vast majority were satisfied with the chosen desired endpoint and the policy strategies identified (see Table 4).

Participants acknowledged the usability of backcasting; they thought it helped to create a clear link between the exploratory scenarios and present-day decision-making needs (75 % gave a score of 4 or higher), and helped to get a better understanding of the policy strategies needed. However, only 69 % of the participants found the results directly useful for river basin management planning.

3.3 Influence of the exploratory scenarios

There were differences between backcasts developed within the different contextual exploratory scenarios. EcF had the highest percentage of economic strategies, PoR the highest percentage of legislative/policy strategies and SuE the highest percentage of management and social strategies. These differences in focus resonate well with the scenario characteristics shown in Table 1.

3.3.1 Economy First

Strategies developed within the context of EcF had to be effective within the globalised, strongly economy-focussed world with strong climate change as described in this scenario. The backcasts contained many economy and research/technology opportunities (e.g. improve purification processes), and a low number of policy and environment opportunities (see Table 3). Backcasts within EcF had the highest proportion of economic strategies compared to the other backcasts, whereas social and environmental strategies were underrepresented. Economic strategies included, among others, stimulation of environmentally friendly technologies, creation of favourable conditions for investments, and pollution taxes. The main economic obstacle was a lack of financial support for the desired endpoint, as society was more oriented to other goals. Given the focus on economic gains in this exploratory scenario, the relatively low proportion of environmental obstacles was unexpected. Legislation and policies were perceived as obstacles in this market liberalisation-orientated scenario, resulting in the highest percentage of legislation obstacles (17 %). This can explain the high proportion of legislative and policy strategies (20 %) needed to overcome the obstacles. The backcasts also had a high number of management obstacles as well as opportunities. This led to a high proportion of management strategies, although still less than in the other backcasts.

3.3.2 Policy Rules

This exploratory scenario described a more environment-friendly globalised world, in which most changes are policy driven. It was thus not surprising that backcasts within PoR had the

Table 4 Results from questionnaires administered to the participants after the backcasting workshop in six case studies

Question/statement	Score
How would you grade this workshop as a whole?	88%[a]
Are you satisfied with the chosen desired endpoint?	91 % yes [b]
Are you satisfied with the policy strategies identified in the backcasting? / Did the backcasting help to find policy options?	90 % yes [b]
The produced backcastings are useable for river basin management planning	69 %[c]
Participating in the workshops has helped me to understand the policy strategies needed	84 %[c]
The backcasting in the third workshop created a clear link between the future visions and the present-day decision-making needs	75 %[c]

[a] Percentage of score 4 or 5 on a scale of 1 to 5 with 1 being poor and 5 excellent

[b] Percentage of yes (from three possibilities: yes, no, no answer)

[c] Percentage of score 4 or 5 on a scale of 1 to 5, with 1 being disagree completely and 5 agree completely

fewest policy-related obstacles. Common policy obstacles included the difficulty of coordinating the many new polices. Furthermore, current policies (such as the Common Agricultural Policy) sometimes obstructed the desired endpoint. The proportion of legislation/policy opportunities was remarkably low for such a policy-oriented scenario. Typical policy opportunities were large programs and improved planning. By and large, the backcasts included many legislation/policy strategies, including improvement of legislation and enforcement, support for environment-friendly businesses and stricter EU pollution guidelines. Given the attention to environment and society in this exploratory scenario, the relatively low number of social and environmental obstacles was expected, but there were also fewer environmental opportunities than expected.

3.3.3 Fortress Europe

This scenario described a strongly regionalised world, in which Europe closes its outside borders and tries to be self-sustaining, but economic growth is low and little attention is paid to the environment. Chances of getting funding for a water quality-related endpoint were low within this scenario, as reflected in the high proportion of economic obstacles. The backcasts had a relatively low percentage of social opportunities and many social, economic and environmental obstacles. The low importance of the environment in FoE is further reflected by the common obstacle of a high pressure to produce food and energy. The many social obstacles (e.g. difficulties involving stakeholders and governance problems) led to a high percentage of social strategies. Given the low attention on environmental issues in FoE, the relatively low proportion of environmental strategies was expected. There was a relatively high percentage of legislation/policy related opportunities, but this was not reflected in the proportion of strategies. Typical for FoE was the focus on centralisation as an opportunity.

3.3.4 Sustainability Eventually

This scenario described a sustainable future with high levels of social and environmental awareness. The world (eventually) regionalises with low economic growth, although quality of life increases. Backcasts within SuE had a high percentage of social and environmental opportunities, such as organic farming and a shift in social values. Given the scenario characteristics, one might expect fewer social obstacles. The large focus on social and environmental aspects was also reflected in the high percentage of social and environmental strategies, such as participation and awareness raising. An important management obstacle that had to be overcome within SuE was the large changes needed to move from a top-down to a localised and governance approach. In several cases, problems with (the introduction of) participatory processes were identified (e.g. because of lack of experience). The relatively low proportion of legislative strategies was expected under this more bottom-up-oriented scenario. More economic obstacles and fewer opportunities were expected because of low economic growth. However, many economic opportunities were identified, relating to issues such as local markets and lower costs of technologies because of their widespread use.

3.3.5 Comparison

There were clear differences between the backcasts developed in the context of the various exploratory scenarios. The results showed that in general the proportions and content of most obstacles, opportunities and strategies matched the characteristics of the exploratory scenarios.

The opportunities linked strongly with the general background of the scenarios. In general, characteristics of the exploratory scenarios translated to higher proportions of types of actions as expected. However, there are also clear differences between the exploratory and normative scenarios. The large proportion of environmental opportunities in backcasts within FoE, for example, seems counterintuitive in an exploratory scenario that is not very environmentally friendly. One possible explanation is that it shows the creativity of the workshop participants to 'convert' potentially obstructing aspects in the contextual scenarios into opportunities. The increased regionalisation in FoE was translated into opportunities to promote the need for improved water quality where required for important industries.

Regarding obstacles, the link with the exploratory scenarios is less obvious. Especially in SuE and FoE, the proportions were not always as expected based on the exploratory scenarios. However, the detailed descriptions of the obstacles change this impression. Regarding social obstacles, for instance, involvement of stakeholders is difficult in the highly centralised FoE world. In the bottom-up, governance-oriented world of SuE, however, stakeholder involvement seems easier, but the capacity to do it right is currently absent in several countries in Central and Eastern Europe, leading to the identification of an obstacle.

Most backcasting strategies related closely to the exploratory scenario within which they were developed. In backcasts developed within the SuE context, for instance, there was a strong focus on awareness raising and increasing participation, whereas control of population and rules for water use were common in backcasts developed within FoE.

3.4 Identification of robust strategies

In total, 59 robust strategies were identified (see Appendix 3 for a full list of robust strategies). The number of robust strategies ranged from two to 12 per case study, strongly depending on the number of scenarios taken into account. Most of them fitted in the legislation, management, social and environment categories (each about 20 %). About 10 % of the robust strategies fell within the economy and research categories. The last 4 % related to cooperation. The robust strategies covered all main identified categories, illustrating that no single type of solution can help solve complex water management problems.

Some of these robust strategies were identified in several case studies. These include (the number of case studies is in brackets):

- Financial mechanism, taxes, subsidies and investment programs (6)
- Development of integrated legislation (5)
- Increase awareness (5)
- New technologies (water saving and lower pollution) (4)
- Education (4)
- Monitoring (4)
- Wastewater treatment (3)
- Update water infrastructure (3)
- Cooperation (cross border and sectoral) (3)
- Improve governance capacity (2)
- Development of tourism sector (compatible with the environment) (2)

Because of the very different cultural, geographical and political backgrounds of the case studies and the different focuses (water quality versus water quantity), no strategies were identified as robust across all case studies.

The list of robust strategies is rather long, with 11 strategies that could be effective in more than one case study. However, examination of common elements in the detailed descriptions of the strategies results in lists rapidly become shorter and elements more general. For instance, the use of financial mechanisms such as taxes, subsidies and investment programs is mentioned as a potentially robust strategy in six case studies. The exact mechanism and intended effect, however, differ per case study because robustness is a function of different exploratory scenarios as well as different social, political and cultural backgrounds. Some of the robust strategies identified in just one case study were more detailed and practical, such as: implementation of best environmental practices at local level, development and implementation of ecological monitoring, modernisation and rehabilitation of water infrastructure, integration of sectoral policies and installing a cross-border water commission in the Baltic region.

Many robust strategies were linked to governance questions such as better legislation, better enforcement, participation and cooperation with stakeholders. The need for an integrated approach in complex issues was shown by both the diversity in strategies and the call for more integration between sectors.

Most of the case studies were local, but participants also identified strategies at higher levels, including the EU. One robust strategy, for instance, aimed to change the Common Agricultural Policy; another highlighted the need for better guidelines, specific targets and relevant indicators for the Water Framework Directive. This shows the direct linkages that exist between levels, including in the perception of stakeholders.

Climate change was not often explicitly mentioned in the backcasts. It did not—and did not need to—trigger changes at local level, whereas it was often an opportunity to make change happen at pan-European level (Kok et al. 2011). In the local case studies, it was rather an obstacle to change. However, the water problems studied were often expected to increase towards 2050 because of global change as described in the exploratory scenarios, including climate change and other socio-environmental changes.

4 Discussion

Below, we first discuss the results presented in Section 3, including the critical notes highlighted by the case study organisers. This leads to a comparison of the combined methodology with other approaches and a number of recommendations for future projects.

The results showed that the use of exploratory scenarios did influence the backcasts; the obstacles, opportunities and strategies reflected the exploratory scenarios' characteristics. As there was more freedom in developing strategies than in identifying obstacles and opportunities, it was expected that they would deviate more from the exploratory scenarios within which they were developed. This was not the case, showing that stakeholders kept within the context of the scenarios to a large extent, possibly because the participants had also developed the exploratory scenarios. The robust strategies showed the need for an integrated approach to water management, including awareness raising, changes in governance styles and more cooperation with other sectors. This highlights the importance of paying attention to governance aspects in addition to environmental, economic and hydrological components. In order to cope with climate change and its effects, actions should thus not be limited to the traditionally important water-related sectors, but should include those that promote societal change and monitoring to be able to react quickly to new changes. However, more practical solutions were also identified, highlighting the need for a good technical infrastructure, e.g. modernising irrigation networks and wastewater treatments.

4.1 Participants and organisers' feedback on the combined methodology

The case studies were carried out in a diverse set of countries, located along the eastern and southern borders of the European Union. Moreover, organisers and stakeholders in some case studies (Crimea, Lower Don) had little experience with participatory workshops, whereas in others (Spain, Italy) they were much more experienced. Despite the variability in experience and background, the workshops were successful across the board. However, there were also more critical notes, some of which were inherent to backcasting (working backwards is difficult). Others were more directly related to the presented combined methodology:

4.1.1 One specific endpoint for all four scenarios is limiting

It was often difficult for participants to deal with a desired endpoint that did not easily fit the logic of the exploratory scenario. Enough water for agriculture, for instance, is easier to reach in a scenario with high environmental consciousness (PoR or SuE). Once solutions were found to reach the desired endpoint in less friendly futures, participants became enthused, and the reasons for the process became clearer; it helps to show how a less friendly (and less desirable) future can be avoided. Good facilitation to spur creativity is important in these situations.

4.1.2 Division between milestones and actions is vague

The division between actions and milestones was made firstly to develop a backbone for the backcast, which could then be made concrete by assigning the actions needed to reach the milestones. Although it facilitated the iterative process of looking at both the long and short term, it also led to discussions on whether something was a milestone or an action. This could depend on the exact wording (e.g. 'setting up education programs' as action, or 'education programs set up' as a milestone). In future, it might be better not to use this distinction to avoid unnecessary discussions.

4.1.3 Policy aspect difficult for non-policymakers

Some local case studies reported that the policy aspect was difficult for non-policymakers. Policymakers formed a minority in these workshops, whereas in others more policymakers were present. Including more policymakers helps to ensure that policy aspects are better incorporated in the backcasts and enhances the link with actual policymaking processes. This in turn can lead to a larger impact and spin-off (Quist et al. 2011). However, the input from other stakeholders is equally important, as they can introduce actions that are not policy related. They can also provide the continuity between the workshops that is needed to maximise (social) learning (van der Kerkhof and Wieczorek 2005). On the other hand, when more stakeholders are included, it becomes harder to ensure that all voices are heard.

Combining exploratory scenarios and backcasting adds to the backcasting issues. This might argue against combining. However, the overall and widespread satisfaction of organisers and participants indicates that the advantages outweigh the problems. The methodology presented was tested in 10 case studies spread over Europe, with different cultural backgrounds and geographical and climatic conditions. This makes it likely that it can also be successfully used in other regions in the world. However, as it is a highly participatory method, it is likely to be better accepted (and executed) by water managers that have successfully used participatory methods before.

4.2 Comparison with other literature

Other approaches can be found that combine backcasting with other scenario types or other future approaches. Berkel and Verburg (2012), for instance, used two exploratory scenarios developed beforehand with an agent-based model. Model outcomes were presented to frame and inform participants' understanding about the feasibility of their goals. Robustness was not explicitly studied, but the interventions were compared across the two scenarios to show how endogenous processes influence the effectiveness of these interventions. Uncertainty about the future was addressed by the two exploratory scenarios. After the workshop, the agent-based model was used to study the impact of the short- and longer-term actions developed.

Svenfelt et al. (2010) conducted an exercise to check the robustness of actions with four exploratory scenarios, in order to "incorporate an uncertainty perspective in environmental policy-making" (Svenfelt et al. 2010). Their actions were derived via questionnaires. It became clear that the vast majority of actions could only be used in the two scenarios with much government regulation (see Fig. 2 in their paper), showing a lack of robustness against a situation with a non-regulated market. Svenfelt et al.'s approach is especially useful when one wants to include the knowledge of larger groups of stakeholders than possible in a workshop setting but still study the robustness of actions against different plausible futures.

Carlsson-Kanyama et al. (2008) used exploratory scenarios (Images of the Future) in a participatory backcasting, in order "to accommodate diverging opinions as regards to the best way to realise sustainability." Different participants regarded different futures as most desirable. Therefore, using different exploratory scenarios can better inspire diverse stakeholders, some of whom might otherwise feel left out. Robustness was not specifically addressed. The goal of the backcasting exercise was to find pathways to the desired future. This approach might be an interesting alternative to combining exploratory scenarios with backcasting, increasing stakeholder buy in. However, it also increases the likelihood that negative exploratory scenarios will not be taken into account, thus lowering the range of possible futures (and uncertainty) considered.

Haasnoot et al. (2013) developed a new method for developing robust decisions under "*deep uncertainty*" that combines adaptive policymaking with adaptation pathways. Their method (Dynamic Adaptive Policy Pathways) consists of ten steps: (1) describe current situation, objectives and uncertainties; (2) analyse the problem, vulnerabilities and opportunities using exploratory scenarios; (3) identify actions; (4) assess efficacy, sell-by date of actions; (5) develop adaptation pathways, including short and longer term actions; (6) select preferred pathways by using different social perspectives; (7) contingency planning; (8, 9, 10) write, evaluate and monitor dynamic adaptive plan. The scenarios function as reference cases to study whether there are gaps between the desired objective and possible future situations. Our methodology is very useful in steps 1 and 2 and is more strongly oriented towards stakeholder participation. As Haasnoot et al. (2013, p. 496) state, participation can help to further explore "uncertainties arising from decision making, and preferences (…) arising from different perspectives." As the exploratory scenarios also include different social perspectives, they can give a first input for step 6. At the same time, Haasnoot et al. include a more modelling-based evaluation of actions, which is currently lacking in our approach. They also focus more on implementation, and monitoring and evaluation of the plan. Combing those two methods therefore seems to add value.

Van der Voorn et al. (2012) combined backcasting with adaptive management for climate adaptation. They developed exploratory scenarios aiming to "explore enabling conditions"

of the desired adaptive water management and the development of the catchment vision. The exploratory scenarios were, however, not used during the actual backcasting exercise (defined as the process of working backwards from the vision to develop actions) in which pathways to several goals from the desired adaptive water management were developed. In their discussion, van der Voorn et al. (2012) note the need to "to span the gap between the projected trends in the context scenarios and the pathways identified in the backcasting analysis, highlighting those intermediate events that bring about a desirable future." Our combined methodology could be used to span this gap, possibly in combination with their approach or some of the other abovementioned approaches. Such a future study could learn from this study to further aid the development of robust strategies.

4.3 Recommendations

As time was limited in the workshops, the backcasts did not reach the level of detail that would be needed to feed directly into water management decision processes. Therefore, 'only' 69 % of the participants found the produced backcasts useable for river basin management planning. Inclusion of more policymakers could overcome the problems with the policy content, as well as make the backcastings more useable in policy processes. At the same time, water managers from different organisational levels should participate to ensure the inclusion of technical and management knowledge. Cognitive diversity is important for such workshops (Franco et al. 2013). Moreover, in the workshops there was not enough time to address critical questions on responsibility, costs and implementation procedures. We recommend that future processes reserve time and resources for subsequent workshops in which the robust strategies can be fine-tuned by answering the questions posed above. When these questions are being fine-tuned, it would probably be useful to quantify the impact of the strategies, for instance via cost–benefit analysis (Leary 1999; Ganderton 2005)), using hydrological (Alcamo et al. 2003; Moel et al. 2013) or agent-based models (Berkel and Verburg 2012). These should take into account that the effectiveness of strategies might differ per scenario. In order to stimulate a learning process and combine stakeholder knowledge with modellers' knowledge, a second round of backcasting workshops should be held to discuss the modelling results.

In order to further improve the usability of the results and their implementation in policy processes, projects should be linked to on-going policy processes. Parts of the dynamic adaptive policy pathways methodology (Haasnoot et al. 2013) and the work of van der Voorn et al. (2012) could form a good framework for doing so, as both pay more attention than we do to implementation, monitoring and evaluation.

In order to shorten the whole process, in future projects the development of exploratory scenarios could be limited to one workshop, instead of the two workshops in SCENES. It is important to keep in mind that the same group of stakeholders should develop the exploratory scenarios to internalise these in the stakeholders' mind and should thus not be skipped completely. Moreover, it is also a first step towards opening up stakeholders' perspectives on possible futures and the value of creativity; this might in turn lead to more creativity in the backcasting workshop.

5 Conclusions

This paper has presented a methodology that combines backcasting and exploratory scenarios to develop strategies on the basis of different plausible futures. This allows fundamental

uncertainties that we face to be taken into account, particularly in relation to global change and the potential for mitigation and/or adaptation.

The combined methodology was tested in ten case studies within the SCENES project. The results have shown that it can be used successfully in participatory workshops. The robust strategies produced show how the stakeholders wanted to adapt to the global and regional changes depicted in the exploratory scenarios. They show that a combination of different types of strategies is needed, with attention to technical, environmental and governance aspects. The combined methodology gave rise to:

- Backcasts that include a large number of elements from the contextual scenarios.
- Backcasts that introduce elements of sustainability in otherwise negative futures.
- Generally more surprising types of strategies than would have been produced by working only with exploratory scenarios, or only with backcasting.
- A list of robust strategies in face of fundamental uncertainty that could not have been produced by only exploring or only backcasting

The small number of robust strategies (compared to all developed strategies) shows which strategies are most likely to be effective in the future. This makes it easier to communicate the results, and it increases the chance of the results being used in decision-making processes. More attention can then be given to these strategies, and the strategies can be quantified in the follow-up process.

Finally, methods for combining exploratory scenarios and backcasting are in their infancy. More research is needed, particularly on new methods to facilitate and monitor the information flow between exploratory scenarios and backcasts.

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Appendix 1. Summaries of explorative scenarios and backcasts

Economy First (EcF)

The economy develops towards globalisation and liberalisation with rapidly spreading innovations. Yet income inequality, immigration and urban sprawl cause social tensions. Water use increases because of, among others, slow adoption of waterefficient technologies and low water-saving consciousness. Water ecosystems providing ecological goods and services for economies and society are preserved and improved. Thus, the WFD changes its conceptual focus from a good ecological status to preserving socio-economically valuable ecological services. Towards the 2040s, a number of (pollution) incidents catch the interest of media and public, resulting in a social upheaval. By 2050, governments have started to work with non-governmental organisations (NGOs),

industries and other representatives of civil society to safeguard economic prosperity while making ground for social coherence.

Fortress Europe (FoE)

The world becomes increasingly unstable due to a number of crises, which causes instability and an increase in terrorism across Europe. In turn, this gives rise to an increased (perceived) need for more security, as a result of which Europe starts closing its borders. An aim for self-sufficiency and market protectionism eventually spreads over all sectors. This leads to an increased exploitation and strict management of domestic natural resources, paying less attention to environmental consequences, for example through the institutionalisation of the Water Security Framework. Towards 2030, climate change becomes an issue, triggering new sets of conflicts. These are resolved by strong EU leadership and the newly formed border police, or otherwise neutralised by the fear of individual countries to be excluded from the EU. By 2050, resources are strictly managed and profits are spread over the EU. The gap between the rich and poor countries widens, yet the EU survives.

Policy Rules (PoR)

Efforts to strengthen coordination of policies at EU level, are slowed by regional pursuit of economic self-interest. Policies become slowly more ineffective, and ecosystem services begin to deteriorate very significantly. Until 2030, the EC is increasingly disappointed in level of water framework directive (WFD) compliance, particularly because of emerging and increasing pressures on water resources. After 2030, climate change hits hard, which replaces public apathy towards environmental issues with enthusiastic support that drives more innovative governance (public/private partnerships). This leads to WFD compliance that is higher than ever. Simultaneously, by 2030 public participation is increased which leads to a strong local government support for action. By 2050, Europe is at the forefront of a new socio-economic paradigm of public/private partnerships and is leading a global shift in this direction

Sustainability Eventually (SuE)

The main long-term changes towards 2050 include a transition towards environmental sustainability, in which the landscape has become the basic unit. The overall focus is on quality of life rather than economic indicators through local diversity which is governed by local networks. This transition to local sustainability is the result of a long-term process that starts with a set of strong top-down measures that is kick-started by a series of extreme events and which is later accompanied by behavioural change and a new governance structure. Because of the severity of the problem, measures are taken quicker and more effectively in water-poor countries, which results in a split with water-rich countries. Initially, a water pricing system is key in regulating water demand. By 2050, behavioural change structurally lowers water consumption, which in turn increases water quality and decreases water stress.

Complete storylines can be found in: Kok K, Bärlund I, Dubel A, Flörke M, Magnuszewski P, Sendzimir J et al. (2011) *Lessons Learnt: summary of scenarios: multi-scale stories, conceptual models and policy actions. SCENES Deliverable 2.12.* Wageningen University, Wageningen.

Appendix 2. Main opportunities, obstacles and strategies per scenario

Opportunities

Economy First

- Technological development: possibility to reduce pollution loads and water consumption, improve purification processes.
- Population decrease: will lead to overall reduction of pressures on the environment.
- Nuclear power plant: possibility to substitute water related energy production (hydropower plants, thermal power plants)
- Public awareness: significant tool to improve society's knowledge about environment related issues.
- EU Funds: still useful tool for financing of water improving measures, especially at the beginning of the scenario period.
- Private investments: with the increase of private capital
- Innovative financing mechanisms
- La Mancha Plain water pipe
- Water transfer Tagus-Segura
- Forest activity potential
- Reduced energy costs
- Technical development in rain fed agriculture
- Hunting potencial

Sustainability Eventually

- Decreased agricultural pollution loads (after 2010): due to reduction in agricultural production.
- Ecological farming (after 2010): less water polluting.
- Lower costs of technologies (after 2020).
- Lower municipal pollution loads (after 2010): less people produce less pollution; higher connectivity to sewage systems.
- Lower industrial pollution.
- Integration of Water Framework Directive with other policies (after 2010, raised effectiveness in 2020): integration in local scale and spatial planning policies.
- Development of ecotourism (2010–2017): provides additional income, partly returning for the environment improvement.
- Active NGOs (after 2020).
- Growing awareness of the society: in environmental values and being a part of the catchment (started but could speed up after achieving higher welfare level)
- Environmental taxes and charges (after 2025): bring more financing in longer perspective.
- Agriculture is the driver for economic development
- Agriculture maintains population in UG
- Regional government gives daily advice for crop watering
- Environment as opportunity for rural development
- Added value compared to products from elsewhere
- Local markets and organic production
- Subsidy elimination, technical farmer

- Shift in social values (post-modern)
- Farmer as rural environment keeper

Fortress Europe

- Water as a valuable resource: other countries would be interested to keep that clean.
- Common laws and standards: easier to adopt
- Single pollution control institution.
- Tourism development: a driver to keep good water status and improve water awareness.
- Use of solar and wind energy: use of alternative energy resources will reduce pressure on water resources.
- Organic farming (only till 2015).

Policy Rules

- New taxes
- Export market for organic agriculture (2030)
- Land use changes
- EU subsidies (after 2030)
- Ecotourism
- Awareness raising programmes (EU funded)
- Decrease in population
- Building water treatment plants
- New technologies (e.g., at homes)
- Field experimentation for the re-use of waste water
- Agricultural planning

Obstacles

Economy First

- Emerging pollutant technologies (2020): development of new technologies may lead to new types of water pollutants (e.g. nanotechnologies).
- Consumer lifestyle (2030): increased incomes and wealth of the society lead to increased consumption of different products and increased resource use and pollution,
- Population decrease (2010): wastewater collection and treatment facilities are built for certain population number; population decrease may lead to underexploitation of those facilities and less payments for wastewater services; in the Baltic States, the problem is already relevant.
- Nuclear power plant (2020): building nuclear power plants in Lithuania and Poland (potentially also Estonia) may lead to thermal pollution problems raised by cooling waters.
- Mass tourism development (2025): raised income levels can lead to higher willingness to travel and to increased pressures to some areas resulting in degradation of aquatic ecosystems.
- Urban sprawl (2010): increased wellbeing level usually stimulates people to move to individual houses that increases pressure on water.
- Insufficient governance capacity
- Insufficient governance capacity
- Division of water resources between the countries

- Foreign land-use.
- Drainage of wetlands.
- Old pollution of the lake.
- Reed at the coasts and increasing use of herbicides to handle the problem.
- Unsatisfactory condition of irrigation system, Lack of qualified staff, climate change
- Overproduction, Lack of regulatory policy in production, business competition
- Lack of financial support
- Lack of means, assets
- Disunion of offices/institutions
- Instable situation, no land market
- European legislation
- Laws
- Global economic crisis
- Political instability
- Deterioration of geopolitical situation, trans-boundary rivers management issues
- Development of water transport, lack of special technical means of collection and utilization of waste waters from vessels.
- Lack of effective control means
- Ineffective monitoring system
- Lack of free access to monitoring data
- Intensification of industry
- Corruption
- Lack of financing, unfavourable economic situation
- Thermo-solar energy production
- Public Deficit
- Political Instability
- Diffuse pollution
- Depopulation of rural areas
- Rural population with different values

Sustainability Eventually

- Lack of funding (2010–2030): less financing water improvement measures.
- Lack of will to implement environmentally friendly practices (2010–2025): especially problematic in agriculture; the awareness of farmers is lower and attitude more negative.
- Long recovery from pollution: especially big problem in large water bodies (lakes); recovery may take longer time than available in the scenario.
- Maintenance of hydropower plants: renewable energy is important in the scenario; existing small hydropower plants will continue to cause problems for aquatic environment.
- Environmental taxes and charges: additional tax burdens slow down economies, especially at the beginning of the scenario period.
- Inner load of the lake.
- Impact of climate change.
- Increased mineralisation due to forestry activities.
- More intensive agriculture in Russia.
- Over-fishing in the lake (Russian side)
- Increased support to agricultural producers.
- Russia does not fulfil environmental obligations
- Increased load from the catchment.

- Increasing economic pressure to the environment.
- Lack of civil society
- Lack of political support to special plan for the upper Guadiana (SPUG)
- Situation of economy
- Globalization as challenge for agriculture
- Farmers have not invested in marketing
- Irrigation efficiency has room for improvement in Middel-Guadiana (MG)
- High water consumption in MG
- Bad design of agricultural policies
- Over-production in agriculture (wine…)
- Quality of products not rewarded, only quantity is
- Lack of interest and goodwill of Administrations responsible for water governance
- Support to unsustainable market agriculture
- Political clientelism, lack of willingness of application
- Lack of investment and system rigidity
- Lack of indicators for agricultural and multifunctional sustainability
- Lack of NGOs capacity
- Insufficient human capacity and funding to finance the investments
- Rent seeking behavior
- Rent seeking behavior
- Conflict in centralization & participatory processes

Fortress Europe

- Difficulties to change people's habits (2015)
- Lack of understanding of water importance (2030): people tend not to understand problems if no serious problems arise.
- Lack of involvement of public stakeholders (till 2030).
- Transboundary waters shared with outside fortress (till 2050).
- Competition between sectors for water (2015–2030).
- Pressure to produce agricultural products (2015–2030)
- Need to use hydroenergy (till 2050)
- Need to use wind energy (in coastal waters), cutting peat, draining wetlands (till 2050)
- Use of certain sort of bioenergy plants (rape) (2015–2030)
- Lack of funding for water monitoring and management (till 2015–2030).
- Overheads for high technical level support
- Misbalance in pricing policy of different regions
- Disunity in sectors priorities
- Local climate change
- Technical problems
- Conflict of interests
- Lack of touristic infrastructure
- Bureaucracy
- +Disunity in sector priorities
- Reliability of information
- Lack of law enforcement mechanisms
- No land market
- Political instability
- Bad technical condition (deterioration) of infrastructure

- Monopole of the energy market
- Employment in water sector is not prestigious
- Conflict of interests and offices
- Failure to comply with laws
- Lack of material and financial background
- Lack of vision, social perspectives
- Epidemiological hazards, increase of social tension, system ecological and political crisis.
- Structural organization of the agricultural sector
- Extension of the consortium governance model to the other water resources
- Identification of stakeholders and involvement of stakeholders

Policy Rules

- Industrial pollution (2025)
- No clear indicators available(2015)
- Lobby groups against rules (2045)
- Agricultural pollution (2030)
- Land use (2025)
- EU subsidies (till 2030)
- Hydropower plants (from 2010)
- Mass tourism (before 2020)
- Polluted sediments (after 2030)
- Increase share of land used for agriculture and accompanied pressure
- Possible development of pulp and paper industry in the area.
- Insufficient governance capacity
- Lack of markets on food production
- Unstable political situation
- Lack of coordination of water and land users
- Lack of financing for research and development (RD) program
- Lack of investors
- Lack of government guarantees for investors
- Lack of material and technical provisions
- Lack of knowledge and experiences in new policy implementation
- Food quality does not correspond to international standards
- Lack of legislation for decartelized integrated water resources management (IWRM)
- Lack of incentives of food producers
- Lack of land bank and market
- Shortage of state budget
- Problems of watershed / river basin
- Outdated technologies
- Low priority of agriculture
- Corruption
- Passivity of thinking
- Economic difficulties
- Binding limits for the re-use of waste water
- Increasing of water demand for the growing population
- Inefficiency of the authority in the control of the distribution of agricultural surfaces

Strategies

Economy First

- Cross-border projects
- Cross-border private incentives
- Exchange of technologies
- Infrastructure planning
- Property taxes
- Spatial planning
- Pollution taxes and charges
- Environmentally friendly technologies
- Social policies
- Legislation act on temperature of cooling waters to be released into natural waters
- Installation of artificial basins for cooling waters
- Development of alternative cooling technologies
- Information on products and labels
- Financial instruments
- Education measures
- Social equity
- Good status of water ecosystems
- Agricultural sustainability and multi-functionality—
- Economic development
- Energy
- Management and Policy
- Water consumption decrease
- First part follows MaF assumptions, second part is very similar to SuF
- Whole environmental and water quality infrastructure is built for the Tisza-valley
- Actions focused more on improvement of infrastructure and technologies
- Pushed from the private sector towards the government to
- Create more favorable conditions for investments
- Gradually improve water management system by
- Implementation of new technologies,
- Stimulation of environment friendly technologies use economical and regulatory means and
- Overcoming of economical and administrative obstacles by
- Implementation of improved water resources governance system and
- State support of proper business

Sustainability Eventually

- Establishment of coherent legal system
- Change in ecological awareness
- Reduction of pollution
- Innovative technologies
- Appearing of charismatic leader
- Environmental monitoring
- Sufficient financial support
- People's approach is a key issue, can be followed through the whole system
- Campaigns for raising awareness

- Economic instrument (public sector) implemented
- Economic instrument (voluntary) implemented
- Technical measures
- Setting specific criteria for "good water status"
- WFD implemented
- Water quality upstream
- Water quality in Danube Delta (DD)
- Fisheries
- Ecotourism
- Navigation
- For legal actions more control from society is added and
- Water user's association start to play a role in operation and maintenance of irrigation systems
- Public participation
- Policy implementation
- Agricultural production
- Water savings
- Land use diversification
- Policies lead to legislative actions
- Determining necessary education and finally
- The construction of the required infrastructure
- Policies to increase the capacity of water related NGOs
- Followed by treatment of water saving within agricultural subsidies

Fortress Europe

- Establishing one EU institution
- Monitoring system
- Rules for water storage
- Rules for distribution of water
- Subsidies at the beginning
- Infrastructure
- Planning
- Education
- Promotion
- Promoting markets
- Innovations in technologies
- Fish support (spawning ground)
- Research
- Educated farmers
- The same right for all countries
- Education at schools
- Competition&award
- Infrastructure
- Supporting subsidies
- Consumer education
- New technologies
- Promoting (eco) fishing
- Forbidding straightening rivers

- Creating artificial lakes
- Polluter pays principle
- Cooperation
- Infrastructure development
- Aim was in some kind of contradiction with the Fortress Europe approach
- Provide stronger regional policy
- Actions for policy implementation with stricter control from the society
- Introduction of a strong dictatorship
- Closed societies of rich spend money on new technologies for themselves and to some extent for poor classes
- Can be achieved only via strong control of the labor class and
- Good education for the reigning class
- Optimization of water use
- Decrease w demand
- Increase awareness
- Increase water availability
- Research on nuclear waste

Policy Rules

- More legal and institutional building character
- Upgrading and research for irrigation
- Re-use of waste water
- Better control
- EU support returns several times, this is more about administrative and professional support than financial
- EU panel on water quality
- Polluter pays principle implementation
- Property taxes
- Awareness raising on tourism impact
- EU subsidies
- CAP reform stimulates less polluting technologies
- Lower direct payment increases agro-environmental schemes
- Land use plans
- New industry standards
- Creating set of indicators
- EU pollution guidelines
- National pollution law changes
- Transboundary agreements
- Monitoring new technologies
- Buffer zone regulations
- New technologies at home
- Control of pollution from private houses
- Taxes for sewage amount
- Increased connection to sewage treatment system
- Involvement of Russian side
- Improving management capacity
- Changing demographic policy
- Implementation of new technologies

- Improvement of legislation
- State support of environment-friendly businesses
- Environmental education
- Major driving forces: administrative (legislative and executive powers)

Appendix 3. Overview of robust strategies

The list below contains the robust strategies developed in the different case studies, and thus contains similar strategies.

- Keep water framework directive
- Stricter legal framework
- Improvement of legal frame
- Improvement of legislation
- Improvement of governance capacity
- Promotion of specific legislation,
- Improvement and development of legislation, government and regional programs and regulations;
- Institutional development and capacity building
- Improvement of water governance and management in organizations
- Development of government and public control on policy implementation
- Efficient control of policy compliance
- Development of government and public control on policy implementation
- Institutional development and capacity building
- Implementation and compliance of regulations
- Integration of sectoral policies
- Support of rural development
- Development of tourism sector
- Development of local markets
- Incentives for tourism development compatible with the environment
- Provide funds for implementation of current policies
- Development and implementation of new financial mechanisms
- Investment programs
- Taxes
- Payments for environmental services
- Subsidies
- More efficient implementation of legal acts in practice
- Water treatment at 100 %
- Decrease pollution load water treatment at 100 %
- Implementation of the WFD,
- Implementation of best environmental practices (BEP) at the local level,
- Provision with waste water treatment plant sewerage and water supply network
- Infrastructure must be updated
- Technical assistance
- Development and modernization of infrastructures
- Waste water treatment and reuse
- Measures for improving marketing
- Modernization and rehabilitation of water infrastructure
- Introduction and implementation of new technologies

- Encourage rain-fed agriculture
- Increase resource use efficiency
- Implementation of new technologies
- Technology development
- New technologies
- Development and modernization of infrastructures
- Awareness raising
- Provide information
- Stakeholder panels
- Education
- Charismatic leader
- Increase awareness
- Development of (environmental) education
- Environmental education
- Improvement of environmental awareness
- Provision of information for society and rising of awareness on all levels
- Increase of the awareness, through information and education campaigns
- Provision of information for society and rising of awareness on all levels
- Establishment and compliance with environmental flows
- Monitoring
- Monitoring programs
- Territorial monitoring and control
- Development and implementation of ecological monitoring
- Cross border cooperation
- Improved cooperation with Russia
- Cooperation between sectors and stakeholders
- Reduction of load from russian part of the catchment
- Sharing of water resources
- Cross-border water commission

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