



A method to explore social response for sustainable water management strategies under changing conditions

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A method to explore social response for sustainable water management strategies under changing conditions.

For Peer Review

ABSTRACT

Society aims at a sustainable water management, which means that it is effective (meeting targets for people, planet and profit), robust (able to cope with uncertainties) or flexible (easy adaptable to changing conditions). The past has demonstrated that extreme weather events and their impacts are important triggers for adaptations in water management. Furthermore, societal changes or events lead to changes in perception of desired situations, goals, and valuation of costs and benefits. Insight in the dynamic nature of societal perspectives and responses provides information about the (non-) support and sustainability of water management strategies. The method presented here comprises the 'Perspectives method', derived from Cultural Theory to classify, analyze and explore present and future perspectives and according social response. These are presented in a so-called perspective map. We illustrate the method with a historic example of the river Meuse.

Keywords: sustainable water management, social uncertainties, social response

Introduction

Water management has always been adapting to changing conditions. Although mostly successful in the end, adaptation processes are often costly and accompanied by disturbances in society (for example after a flood). For the next 100 years water management may be challenged more through expected climate change and socio-economic developments. More techniques and knowledge are available but the increasing population has resulted in limited space and increasing flood risk. The challenge is to cope sustainably with potential global impacts and the inherent future uncertainties in both the water system and the social system (see also Haasnoot *et al.* 2009). Uncertainties in the physical system relate to (changes in) drivers and pressures and their effects on the state, like the effects of climate change on discharges. Uncertainties in the social system involve core beliefs, demands, goals, and values like a moral sense to care for the environment and the demand for more environmentally friendly developments. If we strive for identifying sustainable water management strategies, which are able to cope with different possible futures or can be easily adapted to different futures, we need to take into account a wide range of uncertainties in both the water and social system.

Recent water management studies (for an overview see (Haasnoot *et al.* 2009) analyze the robustness of a strategy by calculating the performance in terms of effects on floods and droughts for different possible futures. Most studies often only included possible climate futures and a few included possible socio-economic developments, which for example often ignore situations in which economy declines (see also Haasnoot *et al.* 2009). However, in reality the success (or failure) of a given strategy depends not only on its performance in terms of floods and droughts. Levelling up dikes could be very effective in terms of flood prevention, even if our climate would change. However, if society disagrees with this (for example because higher dikes block the view on the river or if they are seen as unnecessary or unnatural), the support for a policy may decrease and it may get impossible to implement the chosen strategy. In other words, the dominant societal perspective is crucial for the success or failure of a water management strategy.

This observation generally holds for issues of sustainable development. The nature of this concept is highly contested, complex, and multi- interpretable. Furthermore, it has been proved that the perception of sustainable development changes (Williams and Millington 2004). The concept of sustainable development can thus be interpreted through different perspectives. The importance attached to people, planet and profit may differ from person to

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3 person. For example, there is a lot of disagreement about the roots of sustainability problems,
4 and ways to solve them. An often used distinction is between weak and strong sustainability
5 (Williams and Millington 2004). Weak sustainability sees the inefficient use of resources as
6 one of the major sustainability problems and thinks that solutions have to be found in the use
7 of innovative technologies to increase resource supply (a technological fix approach). Strong
8 sustainability on the other hand focuses on the demand side of resource use. Humans
9 (especially in the developed world) consume more than the carrying capacity of the earth can
10 handle. In the strong sustainability movement solutions should be found in behavioural
11 change and a decrease of human demands (Williams and Millington 2004). Change of the
12 interpretation of sustainable development on such a fundamental level can have significant
13 implication for the appropriateness of management options.
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18 Previous research (Hoekstra 1998; van Asselt *et al.* 2001) has shown how social perspectives
19 can be taken into account for developing robust water management strategies. In this paper,
20 we build upon their approach by elaborating on the implication of societal perspective change.
21 To this end, we adopt the starting point that a sustainable water management strategy is 1)
22 effective, indicating that objectives for people, profit and planet are achieved as much as
23 possible; and 2) robust, which means that it is able to cope with a wide range of future
24 uncertainties or 3) flexible enough to adapt to changing physical and social conditions. To
25 assess the sustainability of river management strategies, one thus needs to test the success of
26 those strategies under a variety of non-linear developments of the coupled water - social
27 system
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31 In this paper, we will develop such a method for sustainability assessment, focusing on
32 exploring the social response for water management strategies under changing conditions
33 (Haasnoot *et al.* 2009). First we will shortly show how the water system and society are
34 related along a framework of Pressure – State – Impact - Response. Second, we describe our
35 method to explore social response. We describe the perspectives methodology, elaborate on
36 our approach to operationalise perspective diversity and perspective change, and show how
37 water system and society can be integrated within a tool (technological framework) to assess
38 the sustainability of different water management strategies under future uncertainties. Third,
39 an historical example of perspective change and its effects on water management policy is
40 given. Finally, we describe how this method can be used by scientists and policymakers to
41 explore the social system and future acceptance for water management strategies in order to
42 determine sustainable water management pathways.
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45 **2. The interaction of water systems with social systems**

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47 Water management generally aims at providing protection against floods and adequate
48 amounts of water of proper quality for various water-related services. It involves finding a
49 balance between water demand and water availability. The water demand is determined by
50 water-related services and individual behaviour, which are part of the social system. The
51 water availability is determined by the climate and geomorphologic characteristics (in other
52 words the water system, which on its turn may be influenced by policies and measures
53 resulting from the social system and vice versa). Flood and drought events may result in an
54 impact on different water functions, such as drinking water supply, agricultural damage or
55 habitat development. These events may also have an effect on our perception on the
56 functioning of the world. It may confirm, amplify or change our expectations about the future
57 climate or the extend to which water can be controlled. The development of water
58 management strategies is often based on past water events and average conditions,
59 expectations of the future state and the current (sometimes implicitly) objectives and values of
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3 society. In other words, the water and social system interact and consideration of both
4 contributes to the identification of sustainable water management strategies.
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7 **FIGURE 1 HERE**

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9 **Figure 1. The PSIR framework which shows the relation between the water system and**
10 **the social system (Valkering *et al.* 2008b; Valkering *et al.* 2009)**
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12 The *PSIR* concept (OECD 1993; Rotmans and de Vries 1997; Hoekstra 1998; Valkering *et al.*
13 2009) describes these interactions in the form of a pressure-effect chain (Figure 1)..
14 Environmental (P) pressures such as climate change and land use changes influence the water
15 availability. Socio-economic pressures (P) determine the water demand and spatial claims.
16 These factors thus influence the system state (S), including water quantity and water quality.
17 The state has an impact (I) on social, economic and ecological services, such as drinking
18 water supply, agriculture and habitats. The responses (R), finally, are divided in water policy
19 and autonomous responses. Water policy refers to practices, measures and implementations
20 resulting from actions taken by policy institutions (local, regional, national or international).
21 The autonomous responses include agricultural practices by farmers, the recreational use of
22 water, lifestyle issues and patterns by the general public. The nature of the response (what do
23 people actually do?) as well as the perception of problems is highly influenced by one's
24 perspective.
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28 **3. A method to explore social response and acceptance under changing conditions**

29 **3.1 Perspectives**

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31 To understand the social system we explore attitudes relevant for coping with water
32 management challenges. For this purpose we use the Perspectives method. Perspectives can
33 be defined as: perceptual screens through which people interpret the world (the worldview)
34 and which guides them in acting (the management style) (van Asselt 2000). They are steering
35 for the content of the response. The Perspectives method is derived from Cultural Theory
36 (Douglas 1973; Thompson 1990). This typology was initially developed to classify, analyze
37 and interpret communities' behaviour according to their (religious) rituals (Douglas 1973) and
38 is less spatially or temporally bound than some other typologies (Pendergraft 1998). Later on
39 it has been used to analyze different views on nature and resources (Thompson 1990),
40 uncertainty (van Asselt 2000; Valkering *et al.* 2008b) and climate change (Pendergraft 1998).
41 Furthermore, it is a useful typology to interpret and classify perspectives on water (Hoekstra
42 1998; Valkering *et al.* 2008b).
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48 Three active, stereotypical perspectives can be distinguished: the *Hierarchist*, *Egalitarian* and
49 *Individualist*. Applied to water (Figure 2) (Hoekstra 1998; van Asselt *et al.* 2001; Middelkoop
50 *et al.* 2004; Valkering *et al.* 2008b), the *Hierarchist* believes in controlling water and nature,
51 high government responsibilities, the importance of research and expert knowledge. Water is
52 mainly seen as a threat to human safety. A sustainable water system highlights safety and
53 flood prevention and leaves space for some economic and natural development. As a
54 consequence, preferred water policy options would be: building dikes, levelling up or
55 broadening dikes, and channelling. *Egalitarians* on the other hand, prioritize ecological
56 recovery and natural development. They urge for more space for nature, water and natural
57 developments. Humans went too far in controlling nature, or even thinking they are able to
58 control. They call for participatory decision making processes with a more equal voice for
59 everyone. Also the needs of animals and plants should be seriously considered. As a
60 consequence, preferred water policy options are space for the river, decreasing human

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3 demands, relocation at higher areas, and precautionary actions. A sustainable water system
4 focuses on strong sustainability with space for natural and ecological processes and
5 reconsideration of human demands. *Individualists* adhere to a more optimistic point of view.
6 They do not see water as being a thread; on the opposite: water offers great opportunities in
7 terms of economy, images, creativity, self development and recreation. They claim for an
8 adaptation approach, great trust in technology and a liberal market. On correspondence with
9 their beliefs, their preferred water management policies focus on innovative projects, like
10 amphibian living*, living on water, and building off shore islands. A sustainable water system
11 is inspired by weak sustainability (Williams and Millington 2004) with a focus on economic
12 opportunities and innovative, technological solutions to unsustainable situations. In cultural
13 theory a fourth perspective, the *Fatalist*, is distinguished (Douglas 1973; Thompson 1990). A
14 stereotypical *Fatalist* is not concerned about the future and sees life as a lottery. Everything is
15 determined by destiny which can not be influenced. One has to enjoy every day, party, buy
16 expensive and luxurious products and make the most of the present. Policy does not exist and
17 sustainable development is not worth to discuss about: fate is unchangeable. Because our
18 research is directed towards policy understanding and the formulation of strategies we
19 decided to exclude the *Fatalist* in our first analysis.
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26 **FIGURE 2 HERE**

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28 **Figure 2. The perspective triangle with a short description of every perspective**
29 **(Valkering *et al.* 2008b). * refers to the present, average perspective of Dutch water**
30 **professionals (see paragraph 3.2)**
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32 **3.2 Towards an operationalisation of perspectives: perspectives mapping and dynamics**

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34 Although there are some examples of operationalisation of perspectives (see for example
35 Dake 1991; Rippl 2002) there are only a few examples of the operationalisation (Hoekstra
36 1998) or measurement of social perspectives on water. To use Cultural theory for water
37 management purposes, the above presented descriptions have been further elaborated for
38 different core beliefs and characteristics related to water management (Table 1, left column).
39 For each belief, the stereotype interpretation of the three perspectives is given. This can be
40 used to measure the perspective of a group or individual and map it in a so-called Perspective
41 triangle, thereby indicating the similarities with the three archetypes (Figure 2). When all
42 features of a group correspond with one of the stereotypical Perspectives, e.g. the *Egalitarian*,
43 this group can be classified as an *Egalitarian* stereotype and mapped at the right corner of the
44 triangle. If a perspective exists of interpretations of different stereotypes, it will be located
45 somewhere in the middle of the triangle, depending on the exact completion of the map.
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51 The three different perspectives are theoretically well distinguishable, however, in reality they
52 are not. Real life perspectives are heterogeneous (Douglas 1973; Pendergraft 1998; Valkering
53 *et al.* 2008b). While previous empirical studies focused on classifying individuals or groups in
54 one of the stereotypical (and thus extreme) positions in the triangle of Figure 2, we allow
55 Perspectives to be heterogeneous (Valkering *et al.* 2008b). Preliminary results of our study
56 confirmed this heterogeneous character of perspectives (Table 1). Real life perspectives on
57 water turned out to consist of combinations of different interpretations coming from different
58 perspectives. This implies that it is possible to have characteristics of more than one
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* Amphibian living: buildings or infrastructures are (partially) built on the water surface and follow the dynamics of the water surface. They are suited both to float on the water surface as well as to be on solid ground.

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3 stereotypical perspective (e.g. to have a *Hierarchical* interpretation for the belief ‘water
4 problems versus manageability’ and an *Egalitarian* interpretation of the belief ‘water system
5 organization’). Besides, it is also possible to adhere to more than only one perspective for one
6 belief (e.g. I believe both in water as a source of rest and well being, as well as a reliable
7 source to fulfil different functions). The dominant Dutch perspective measured under Dutch
8 water professionals in 2008[†] consists of a combination between *Hierarchism* and *Egalitarianism*,
9 with some *Individualistic* characteristics (Table 1). In general, expectations about the future,
10 as well as responsibility issues are dominantly approached in a *Hierarchical* way. However,
11 the *Hierarchical* idea of water as being a threat against we have to fight is less popular at the
12 moment. Instead, professionals are searching for ways to combine natural developments,
13 space for water and nature with innovative, technological opportunities. Water offers
14 opportunities, the ideas and wishes of citizens and other stakeholders should be heard, but the
15 government stays the final responsible for water management. The location of this
16 heterogeneous perspective can then be assessed by calculating a score for every perspective
17 (the sum of every column standardized to 3) and plot this outcome within a standard triangle,
18 which results in a dot (see for example the asterisk in Figure 2). It is also insightful to make
19 different triangles for different combinations of beliefs. The first five beliefs in Table 1 are
20 beliefs on a worldview level (how does the world function?), the last four beliefs are directed
21 towards the process part of water management (how should we arrange our water
22 management?). The remaining beliefs focus on the content of water management (what
23 should be done?).
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29 In society different perspectives occur. Within this broad spectrum of perspectives usually a
30 dominant perspective and (one or more) undercurrents can be distinguished (Loorbach 2007)
31 A dominant perspective consists of interpretations of beliefs upon which the majority of
32 people in a group (family, policy, nations) explicitly or implicitly agree. This could be a
33 *Hierarchical* idea of control and regulation, resulting in reinforcing dikes. Undercurrents refer
34 to interpretations of beliefs according to the minority of people in a group or a subgroup, e.g.
35 resulting in an *Individualistic* perspective with focus on opportunities and innovation and a
36 strong preference for amphibian living. Because of the dynamic nature of perspectives, the
37 interpretation of beliefs could change over time, as well as the distribution between dominant
38 perspectives and undercurrent(s). Eventually, an undercurrent could become dominant at costs
39 of the previous dominant perspective. In our example this would imply a loss of support for
40 further dike reinforcements and growing popularity and attention for amphibian
41 infrastructures.
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45 46 **TABLE 1 HERE** 47 48

49 Perspectives change due to surprises (Thompson 1990; Verweij *et al.* 2006; Valkering *et al.*
50 2008b). Surprises are events, developments and occurrences (possibly catalyzed by people or
51 the media) which show that the day-to-day reality deviates with once expectation about the
52 reality. In that case, there is a mismatch between perspective (expectation, or how people
53 think the world functions) and actuality. For a *Hierarchist*, with great trust in dikes, it would
54 be a surprise to face a dike breach. However, in practice perspectives offer resistance against
55 surprises. When confronted with a surprise, people will try to ignore its occurrence, or try to
56 explain it in such a way that it still fits within the former expectations (Thompson 1990). This
57 ignorance however, is only tenable up to a certain tipping point. At this tipping point, reality
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[†] This inventory (N=90, Cronbachs' Alpha= 0.78) was meant to be a first test case for a next, large scale information gathering by questionnaires to be held among Dutch stakeholders in 2009.

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3 can not be denied any longer, and the perspective will change. Perspectives change if at least
4 one interpretation of one belief in Table 1 changes according to new insights. With a changing
5 dominant perspective, the social support for a given water management strategy may also
6 change. To avoid protests, indefensible situations and any other difficulties concerning the
7 implementation of a strategy, the robustness of a strategy for changing perspectives, in other
8 words the social robustness, has to be tested in advance. A sustainable strategy is able to cope
9 with developments in the water system as well as developments in the social system
10 (perspective change). This contributes to make the water system sustainable and future proof
11 (in stead of only climate proof).
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14 15 **3.3 IAMM tool to analyze to interaction between social and water system**

16 To analyze the interaction of the social and the water system through time an Integrated
17 Assessment Meta Model (IAMM) is being developed based on simple cause-effect relations
18 (Haasnoot *et al.* 2009). With this model it is possible to analyze the PSIR chain for many
19 transient scenarios without a large calculation time. Transient scenarios comprise time-series
20 of the climate, including flood and drought events, socio-economic trends, social events,
21 surprises and interactions between the water system and society. At any moment in time it is
22 possible to evaluate a water management strategy and adapt if necessary. As described by
23 Haasnoot *et al.* (2009) this evaluation is – amongst others- based upon performance
24 indicators. These indicators may differ according to once perspective. For example, for an
25 *Egalitarian* who values nature and ecological development over economic issues, shipping
26 suitability[‡] is allowed to be lower than for *Individualists* who highly value economic
27 prosperity (see section 5). The result is a set of storylines, together making up an ensemble of
28 transient runs including dynamics due to natural and social variability and interaction between
29 the water and social system. Each storyline will be evaluated on events, management style,
30 impacts (damage, costs, and effects on nature) and changes in perspectives. Threats and
31 opportunities for different strategies will become clear, which can then be used to improve the
32 strategies. We could for example identify no-regret or regret measures, analyze the risk of
33 doing nothing or waiting and then analyze the range of possible futures.
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39 **4. From theory to practice: historical perspective changes in the Meuse valley**

40 To gain more insight in perspectives and perspective change, four stakeholder workshops for
41 the case study of the Meuse valley in the province of Limburg, Netherlands were organized.
42 In the first workshop we explored historic perspectives and drivers (surprises) for change. To
43 this end, a number of water management experts were invited, including representatives of
44 government (regional and national scale), NGOs, and researchers. In a facilitated discussion,
45 they were asked to reflect on the historic perspective changes and their drivers concerning the
46 Meuse, resulting in a historical timeline linking, event, developments, influential people and
47 perspective change. Summarized four periods could be distinguished according to the
48 participants (Valkering *et al.* 2008b):
49

- 50 1. From 1800 till 1960 could be characterized as a combination between *Hierarchism* and
51 *Individualism*. In a context of economic growth, technological innovations,
52 industrialization and mining activities (and the related increased demand for fast and
53 large scale shipping of coal to the port of Rotterdam), this period caught on
54 manipulability, which resulted in regulation of the Meuse for large scale coal
55 transportation throughout the whole year.
56
- 57 2. Starting as from the 1960s, the dominant perspective moved towards *Egalitarism*
58 (although the first undercurrents date back to the early 1920s). Main driver was a growing
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[‡] Expressed in the percentage of time with hindered navigation time.

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3 environmental awareness, catalyzed by some major, visible calamities (like the
4 Endosulfan poisoning of the river Rhine, and the explosion in the power plant of
5 Chernobyl) and some initiatives (like 'plan Ooievaar', which asked for more space for
6 water and nature). With increased attention for both water and ecological quality as well
7 as the right for future generations which should be able to meet their needs, attention for
8 nature and natural recovery became more popular. The accumulation of calamities
9 empathetically served as surprise for the *Hierarchical- Individualistic* perspective with
10 trust in technology, control and the belief that nature is robust for external disturbances.
11 Reality could not be denied any longer which made the perspective change towards
12 *Egalitarianism*.
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16 3. In 1993 and 1995, the Meuse area was hit by floods, which caused the dominant
17 perspective to become more *Hierarchical* again. An increased awareness of unsafety and
18 the expected effects of future climate change on discharges, combined with an increased
19 pressure on the Meuse valley (mainly due to an increased urban area), a more
20 *Hierarchical* perspective came into force. Within this perspective, there was high attention
21 for protection against floods, combination of different water functions, and strong
22 government responsibilities. Here we see that events and developments besides their role
23 as surprise also function as a reproduction mechanism. A reproduction mechanism is an
24 event or development which reflects expectations about reality, and strengthens a given
25 perspective. After the 1960s there was still a group who believed in the controlling
26 capacity of dikes and their importance for human safety (undercurrent). Because of the
27 1993 and 1995 floods, their perspective was reproduced and eventually won popularity
28 again.
29
30 4. Around 2006 the dominant perspective consisted of a combination of all stereotypes.
31 *Hierarchical* elements were protection against floods as leading principle, government
32 responsibilities, and controlling/ regulating measures (like off-shore sand supplement and
33 raising the levels of the IJsselmeer Lake). *Egalitarian* characteristics include participatory
34 decision making processes, citizen involvement and reservation of natural area (as
35 preventive measure against the possible consequences of climate change). *Individualistic*
36 elements were financing measures to pay the costs for natural development or
37 conservation with profits from recreation, catering or education. In addition, the increased
38 attention for the innovative use of water and space (like amphibian living) suits perfectly
39 in the *Individualist* perspective.
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44 This short summary shows the dynamic nature of perspectives, the relation between
45 perspectives, societal support, and preferred water policy options (both content wise, e.g.
46 dike reinforcement as well as process wise, e.g. expert knowledge or participatory
47 decision making). Mostly, perspectives changed due to *external* events or developments,
48 occurring outside the area of the Meuse and often external to the water system (like the
49 Chernobyl disaster). Further it states that the role of undercurrents should not be
50 underestimated. The eccentric ones at this moment could possibly be the dominant ones in
51 the next decades.
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56 **FIGURE 3 HERE**

57 **Figure 3. Visualization of the historical transition path for perspective change in the**
58 **Dutch Meuse valley from 1800 till 2007 (Valkering *et al.* 2008b).**
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5. Sustainable water management paths that are robust and flexible

History illustrates that the process of perspective change can metaphorically be described as paths and roads on hiking maps (therefore the background in Figure 2 and Figure 3 represents a map). On a map, it is possible to identify where you came from, what your current position is, where you would like to go to and what expectable obstacles are (like rivers and gorges). However, it is not illusory that if the journey goes along, unexpected circumstances, (like washed away trails, broken bridges or bulls on a pasture) come across. The same is true for perspectives: we are able to identify the road being followed by perspective changes, the position we are right now, and which direction we wish to follow for the near by future. However, depending on social, technological and natural uncertainties there is a multitude of different futures possible: one can choose to turn into different pathways (different measures) and one could be confronted with different unexpected development (the surprises), like a flood or failure of technology. Besides, in reality there are a lot of unofficial roads, which are not stated on the map, but are used by some walkers as an alternative pathway; which is comparable with an undercurrent. At the moment these unofficial paths gain popularity and are being walked on by more and more people, they become more visible and eventually develop into an official road, indicated on a map and possibly resulting in a very good alternative.

Given the willingness to identify sustainable water management strategies and the thoughts of the map metaphor the following question arises: What is a good way to assess the most promising pathway to achieve a sustainable water system in a changing world? Partially, this is a matter of robustness as the path should be able to cope with different possible futures in terms of different circumstances and developments. For example, the path should still be accessible in case of heavy rainfalls or droughts and besides it should be suited for a lot of different personal situations. A flat trail is better able to cope with such personal circumstances (like injuries, fatigue, broken shoes) than for example a hilly trail. The same should be true for a water management strategy: it should be able to cope with natural developments, such as climate change, as well as societal developments (changing perceptions, goals and demands from society on water management), hence it should be *robust*. In addition, a sustainable strategy is a matter of flexibility. If a pathway turns out to be washed away, it should be easy and fast to find another trail, leading to the same destination as the initial road. If space for the river turns out to be ineffective in terms of climate change or societal response, it should be relatively easy to transform: the strategy has to be *flexible*.

A first step in the sustainability assessment thus consists of a social robustness analysis. This analysis explicitly draws from the added value of the diversity of perspectives that exist at any point in time. This diversity of perspectives can be illustrated by analyzing the current perspectives on Dutch water management (Valkering *et al.* 2008b), which can be placed within the perspectives triangle (Figure 4). Some of the perspective-based points of view may seem unbridgeable as they are based upon fundamental different assumptions about how the world functions and how the world should preferably be managed. However, this diversity does not automatically result in ignorance and solitary situations. Every perspective possesses certain core qualities which have to be combined (Douglas 1973; Thompson 1990) to achieve a constructive dialogue and starting point for a social robustness analysis. According to Douglas (1973) and Thompson *et al.* (1990) each perspective needs each of its rivals, either to make up for deficiencies, to exploit, or to define itself against. The *Hierarchist*, for example is decisive but innovation fails due to a web of governmental rules. The *Individualist* is a source of innovative ideas, however lacking attention for environment and solidarity, and the *Egalitarian* focuses on environmental issues and harmony, while lacking decisiveness

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3 (Douglas 1973; Verweij *et al.* 2006; Valkering *et al.* 2008c). However, that no perspective
4 can exist alone does not mean that every perspective has to be represented equally within a
5 group (Thompson 1990).
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10 **FIGURE 4 HERE**

11 **Figure 4. The perspectives triangle and possible measures categorized by perspective**
12 **(Valkering *et al.* 2008c)**
13

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15 A social robustness analysis to assess the performance of a strategy under different possible
16 social perspectives can be executed by a critical dialogue between representatives with
17 different perspectives. Every perspective comments on the preferred measures of the others
18 based upon their own worldview (Table 2). In this way risks and vulnerabilities of a strategy
19 become visible. Filling in the perspectives map and comparing the results between different
20 stakeholders could be very helpful in reaching agreements for a given strategy or even to
21 improve a strategy. This comparison elegantly visualizes the beliefs upon which people
22 disagree, or why a given strategy may be rejected by one or more parties. It offers
23 opportunities to direct the dialogue towards laying the finger on the sore spot and try to come
24 to agreement by making certain adjustments on the initial idea (e.g. to ensure enough attention
25 for human safety and natural developments for animal and plant species in the 'living on
26 water idea' to comply better to respectively the *Hierarchist* and *Egalitarian* who prioritize
27 safety and ecological recovery instead of innovation and self developments like the
28 *Individualist*). If it is impossible to find adjustments to make a strategy at least acceptable for
29 other perspectives, the strategy lacks robustness for social change.
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34 **TABLE 2 HERE**

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37 A second step in the robustness analysis consists of confrontation with surprises. To this end,
38 management strategies are confronted with a number of possible scenario developments
39 and events that will typically contain surprises. In the IAMM tool, users will be confronted
40 with surprises and reproduction mechanisms (see paragraph 4) by means of news paper
41 headlines (Figure 5). Also a score for public support for a given strategy and the performance
42 of a strategy including flood and drought events will be given. Although history has given
43 some insights about the effects of these surprises and reproduction mechanisms (e.g. change
44 or enforcement of perspectives), little is known about the direction of change (e.g. if a
45 *Hierarchist* gets confronted with a couple of surprises, will he or she change into the direction
46 of *Egalitarianism* or *Individualism*?). To gain more information about drivers and thresholds for
47 change, the direction of change and the role of undercurrents herein we use the IAMM tool
48 game in a participatory setting (Valkering *et al.* 2008a). We will carefully analyze choices,
49 changing perspectives and support for a given water management strategy, resulting in a
50 second robustness test. We will also investigate opportunities to adapt to loss of social support
51 for a strategy. The latter is important if a strategy (e.g. dike reinforcement) scores well for the
52 water system (e.g. no floods occur, ecological diversity is high), but society is dissatisfied
53 with the (results) of the strategy because it is unsightly, unnecessary or it takes away the
54 beautiful view on the river for example. Furthermore, the score for the results of a strategy
55 (the performance indicators) depends on objectives. These objectives are part of an extended
56 perspectives map (an extension of Table 1.) and differ for every perspective (e.g. a
57 *Hierarchist* does not accept any flood, whereas *Egalitarians* accept some small floods in a
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3 given time span; the *Individualist* requires a very high shipping suitability whereas
4 *Egalitarians* and *Hierarchists* are satisfied with less).
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8 **FIGURE 5 HERE**

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10 **Figure 5. Examples of headlines in the IAMM tool. The left one is a surprise for the**
11 ***Hierarchist* (and a reproduction mechanism for the *Individualist* and *Egalitarian*). The**
12 **right one is a reproduction mechanism for the *Individualist* and a surprise for the**
13 ***Hierarchist* and –to a lesser extent because of the space given to the water- the**
14 ***Egalitarian*.**
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18 **5. Conclusion and prospects**

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20 Sustainable water management involves analysing the interaction between the social and
21 water system. A sustainable water management strategy is effective, robust and flexible.
22 Effective means that targets for people, planet and profit are being met. Robust means being
23 able to cope with different future events and developments in the social and water system
24 (like changing social perspectives, floods, droughts, and increased discharges). Flexible
25 means that a strategy can be adapted to changing social and physical circumstances. In other
26 words, a sustainable strategy has to be acceptable under different futures or it should be easy
27 to adapt it in order to become acceptable again. Identification and implementation of
28 sustainable water management strategies has several benefits: it saves costs if there is no need
29 to replace, or change costly measures taken before because the strategy turns out to be
30 unsustainable. Therefore, a dialogue based negotiation process with a focus on highlighting
31 positive aspects of every perspective is needed. This leads to a more satisfying situation for all
32 involved, since the strategy should be acceptable under all different perspectives and futures.
33 Furthermore, it offers opportunities for analyzing vulnerabilities of strategies, and exploring
34 and visualizing differences in perspectives and disagreement resulting from that. There are
35 different perspectives on promising ways for sustainable water management strategies. The
36 Perspectives method can be used to classify, interpret and analyze these different
37 perspectives. In this way they can be used to analyze the response to future social and water
38 events and the future social acceptance of different water management strategies. The
39 outcome of this analysis will be used in an IAMM tool and integrated with information of the
40 water system into storylines. These storylines will be evaluated for their social and physical
41 robustness and their capacity to adapt to changing conditions. First results of this type of
42 analysis show that surprises are important for decisions on water management strategies and
43 the performance for strategies for the nearby future is mainly determined by climate
44 variability, while for the longer term (> 50 years) climate change is important to take into
45 account. A sustainable strategy could then be a strategy which is robust for climate *variability*
46 (fluctuations *within* the climate) and social change in the near future, and flexible enough to
47 adapt to climate *change* (fluctuations *between* different climates) and social change on the
48 long term.
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56
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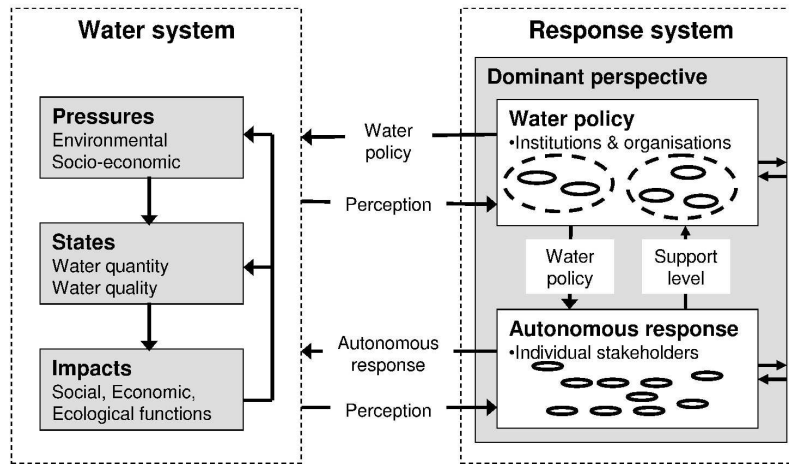
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Table 1. A first operationalisation towards perspectives on water (Valkering *et al.* 2008b). The underlined texts refers to the present dominant perspective on water for Dutch water professionals (n=90). For every belief (left column) respondents have to choose which interpretation fits best to their personal impression. For every belief, one, two or even three interpretation can be selected.

	Hierarchist	Egalitarian	Individualist
<i>Value of water</i>	<u>Reliable source for fulfilment of functions</u>	Source for rest and well-being	Source of prosperity and self development
<i>Water problems vs manageability</i>	<u>Serious problem, but manageable</u>	Serious problem, and not manageable	No problem
<i>Expectation about climate change</i>	<u>Average trend as forecasted by experts</u>	<u>High trend (worst case)</u>	Low trend
<i>Trust in technology</i>	<u>Moderate positive, reserved trust</u>	Negative, low trust	Positive, great trust
<i>Expectation socio- economic context</i>	<u>Average trends</u>	Low trends (e.g. small population growth)	High trends (e.g. high population growth)
<i>Water priorities</i>	Preservation of current function; win- win	<u>Compensation and ecology</u>	<u>Innovation and economy</u>
<i>Managing safety</i>	Flood prevention	Avoidance of areas sensitive to floods	<u>Adaptation and utilizing opportunities</u>
<i>Water supply in dry times</i>	Demand driven	<u>Supply driven</u>	Market driven
<i>Water system organization</i>	Damming and regulation	<u>Naturally</u>	Opportunistically
<i>Spatial planning & water</i>	Water follows	Water steers	<u>Water offers opportunities</u>
<i>Responsibility</i>	<u>National and European governments</u>	Regional governments and NGOs	Private companies and individuals
<i>Process design</i>	Norms and expert knowledge	<u>Participatory decision making</u>	Free market - Privatization
<i>Identity & knowledge</i>	<u>Dutch water authorities</u>	<u>River catchment - local</u>	International companies
<i>Level of integrality</i>	Sectoral	<u>Integral</u>	Competition

Table 2. Three examples of measures and possible reactions and critiques on these measures from the other perspectives (Valkering *et al.* 2008c).

	Hierarchist	Egalitarian	Individualist
Relocate activities	Renounces the rich Dutch history of water management. Besides it is unnecessary because we have the capacity to control the water.	<i>Relocate infrastructure and buildings to higher areas which are not vulnerable to floods. Gives more space to the river.</i>	Too expensive and we are in need for more space for building areas, especially if populations continue to grow. Would be a missed change to profile the Dutch capacity to govern water.
Offshore islands	There is not enough scientific proof for its consequences. Might harm sea water quality for swimming due to changing sea streams	Disturbs and harms ecological dynamics, birds and other organisms. Not natural.	<i>Building innovative islands to protect the coast from erosion and flooding. Preferably the shape of these islands should be innovative too (e.g. the shape of a tulip) to boost innovative image.</i>
Level up dikes	<i>Levelling up existing dikes in order to better cope with increased discharges. The vulnerability of the dike goes down, the safety for people as a consequence goes up.</i>	Unnatural and only a short term solution with regards to climate change. Besides it is clumsy for people and prevents development of natural river banks.	Too soft, not innovative enough. Besides it's a bit old-fashioned, blocks peoples' view on the river. Same space could be used more efficiently and for a better living enjoyment.



The PSIR framework which shows the relation between the water system and the social system (Valkering et al. 2008b; Valkering et al. 2009).
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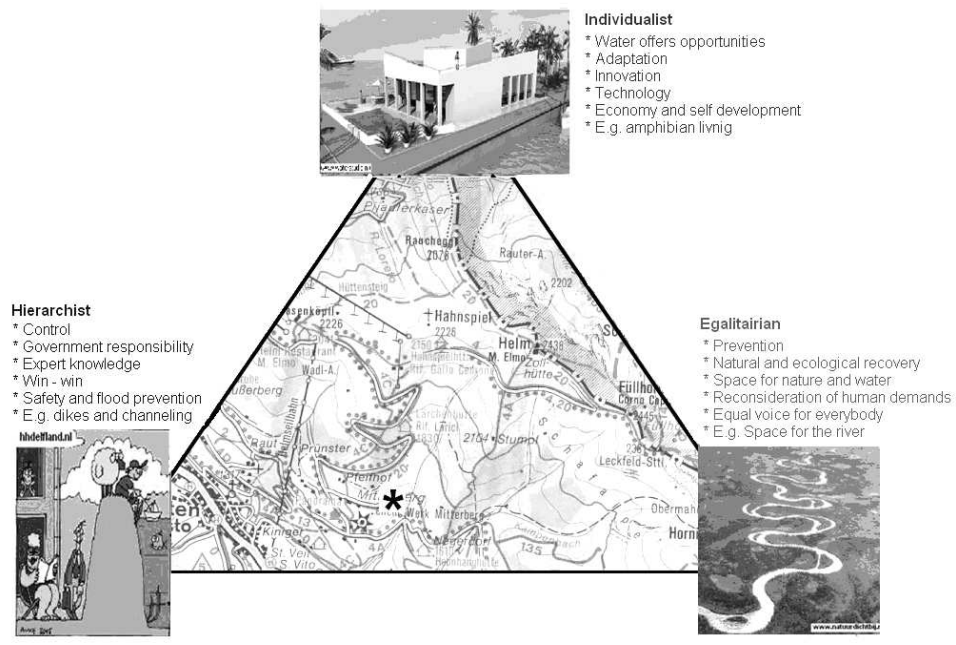


Figure 2. The perspective triangle with a short description of every perspective (Valkering et al. 2008b). * refers to the present, average perspective of Dutch water professionals (see paragraph 3.2)

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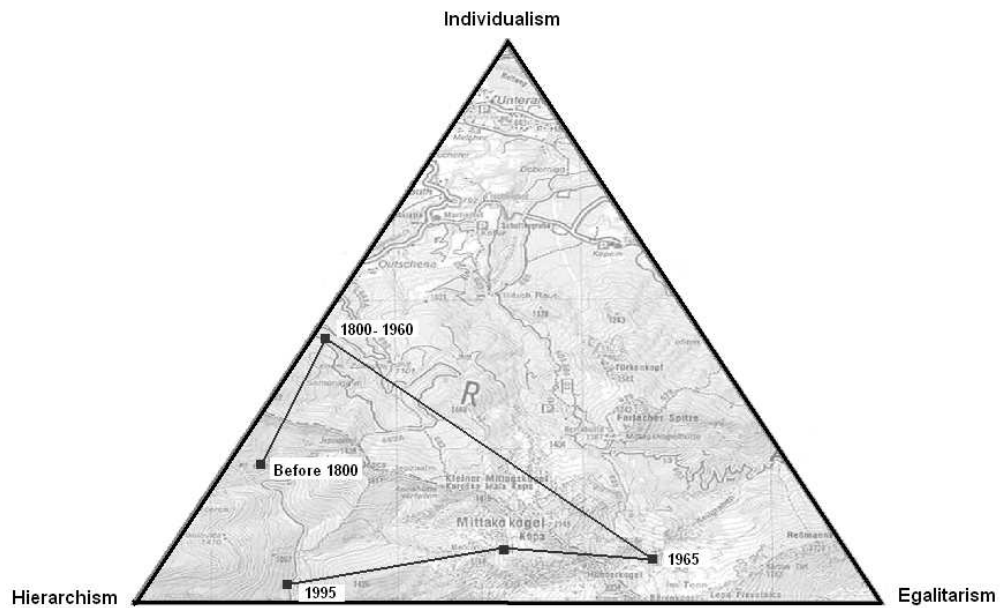


Figure 3. Visualization of the historical transition path for perspective change in the Dutch Meuse valley from 1800 till 2007 (Valkering et al. 2008b).
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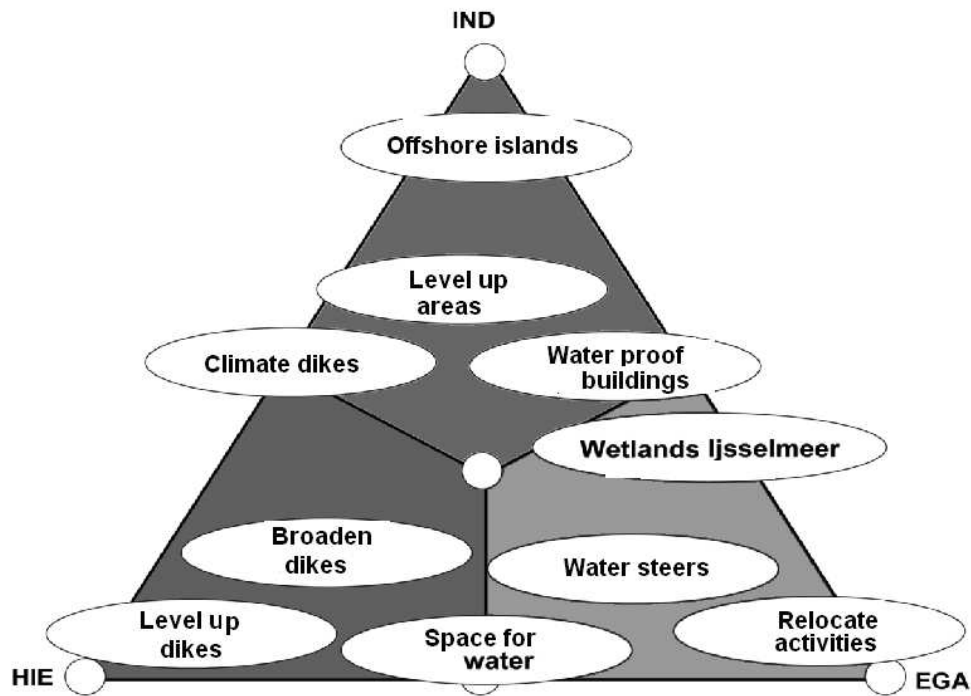


Figure 4. The perspectives triangle and possible measures categorized by perspective (Valkering et al. 2008c).
210x150mm (96 x 96 DPI)

review



Figure 5. Examples of headlines in the IAMM tool. The left one is a surprise for the Hierarchist (and a reproduction mechanism for the Individualist and Egalitarian). The right one is a reproduction mechanism for the Individualist and a surprise for the Hierarchist and –to a lesser extent because of the space given to the water- the Egalitarian.

175x127mm (96 x 96 DPI)