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ORIGINAL ARTICLE

Does information on the interdependence of climate adaptation measures stimulate collaboration? A case study analysis

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Abstract
A key issue in implementing adaptation strategies at the landscape level is that landowners take measures on their land collectively. We explored the role of information in collective decision-making in a landscape planning process in the Baakse Beek region, the Netherlands. Information was provided on (a) the degree to which measures contribute to multiple purposes, (b) whether they are beneficial to stakeholders representing different sectors of land use, and (c) the need for landscape-level implementation of adaptation measures. Our analysis suggests that the negotiation process resulted in collective decisions for more collaborative adaptation measures than could be expected from individual preferences previous to the planning session. Based on the results, it is plausible that the provided information enhanced integrative agreements by leading stakeholders to realize that they were mutually interdependent, both in acquiring individual benefits as well as in implementing the measures at the landscape level. Our findings are significant in the context of the emerging insight that targeted information provision for climate adaptation of landscapes can support collaboration between the relevant stakeholders.

Keywords Participative planning · Climate adaptation · Landscape planning · Adaptation measures · Collaboration · Stakeholders

Introduction

Adapting land use systems to reduce projected impacts from climate change often requires that adaptation strategies have to be implemented in multipurpose landscapes at a regional spatial scale. In predominantly agricultural landscapes, for example, farmers deliberate and prioritize various ecosystem services in cooperation with a variety of other landowners,

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responsible authorities, and users of the landscape, and take measures on their land (Adger 2003). The implementation of adaptation strategies is often hampered by opposing views on environmental and economic values, complicated by diverging interests and subject to many uncertainties. Solving these so-called unstructured or wicked problems (Hoppe 2011) requires explorative and iterative design-oriented approaches based on integrated information from a range of science disciplines, in which common learning by scientists and practitioners is a prerequisite (Opdam et al. 2013).

Climate change adaptation anticipates the adverse effects of climate change by taking appropriate action to prevent or minimize the damage it can cause or by taking advantage of opportunities that may arise. As multiple sectors are impacted by climate change, integrated adaptation plans are an important prerequisite for regional sustainability (Caves et al. 2013; Barton et al. 2015). For instance, in the Netherlands, climate change will both increase the probability of summer droughts as well as cause additional water surplus as a consequence of extreme precipitation (Van den Hurk et al. 2014). The increased periods of drought will have negative impacts on natural wetlands as well as on agricultural production, while flooding might cause considerable social and economic damage. The projected loss of value and increased risks of damage are a strong motive for taking adaptation measures. It has been shown that well-planned long-term and short-term adaptation strategies can reduce risk and unnecessary costs later on (Haasnoot 2013).

From a sustainability perspective, ecosystem-based adaptation measures, rather than technical measures, have been advocated because they make use of the natural potential of ecosystems to regulate biophysical and ecological processes and they provide multiple landscape services (Huq et al. 2013; Wamsler et al. 2016). From the spatial scale and nature of landscape processes that provide these services, it follows that implementation of these measures at the landscape level is necessary, which implies an interdependence between landowners and users in the region. Therefore, a key issue in implementing integrated adaptation plans at the landscape level is that the landowners take measures on their land in collaboration. While we are aware that collaboration can be enhanced by building social networks (Tompkins and Adger 2004; Ostrom 2009), for example, in workshops facilitated by scientists or planners, in this paper we explore the potential role of information content in enhancing collective decision-making. In a recent literature review (Opdam et al. 2016), we found indications that collective decisions in landscape planning can be enhanced by providing information on multiple benefits of ecosystem services as well as by emphasizing how these benefits depend on coordinated landscape-level management. Collective action theory predicts that if actors expect that their individual interests will gain from collaboration, they are more willing to collaborate (Ostrom 1998). This was supported by findings in landscape planning studies suggesting that collaboration between stakeholders was enhanced by informing them that landscape elements deliver a multitude of services and benefits (Steingröver et al. 2010; Rathwell and Peterson 2012). Also, it has been suggested that providing information about this interdependence of actors on gaining benefits from landscape services indeed stimulated collaborative action (Southern et al. 2011; Opdam et al. 2015a). However, this evidence was not conclusive, as other factors associated with the organized social process may also have influenced the intensity of collaboration. In their review, Opdam et al. (2016) conclude that "the reported collaboration was rather a by-product of the case studies than an answer to explicit research questions achieved by a transparent method."

In this paper, we aim to contribute to more understanding about the role of information in collective decision-making in landscape adaptation. We do this by exploring how the three types of information suggested by Opdam et al. (2016) might contribute to collective decisions. These types are the degree to which measures contribute to multiple purposes, whether they are beneficial to stakeholders representing different sectors of land use, and the need for implementation of adaptation measures at landscape level (Fig. 1). Our assumption is that these types of information result in more collaboration between stakeholders than might have been expected from the prior attitude of the individual stakeholders regarding these adaptation measures.

Given the explorative character of our research, we have opted for analyzing a real-world case study rather than designing experiments in a somewhat artificial setting. Our case is taken from a planning process aiming at finding effective integrated solutions to climate adaptation, the Baakse Beek case in the Netherlands. This planning process consisted of several steps, all involving stakeholders in a collegiate participation mode (sensu Barreteau et al. 2010) and with an explicit role for scientists in providing information on the implications of adaptation measures. We explored how the provided information on adaptation measures is used in negotiations where the individual preferences of stakeholders are opposite to the adaptation measures they collectively selected in this collaborative landscape planning process. The implication of our choice to analyze an authentic case is that we will not be able to conclusively disentangle the effect of information on collective decision from other possible factors associated with the participative approach.

Collaboration through collective decisions: the role of information

Landscape-level adaptation to climate change usually requires some form of collective decision-making. If the landscape is owned and/or maintained by multiple stakeholders, interventions will need to be implemented on different plots of land,

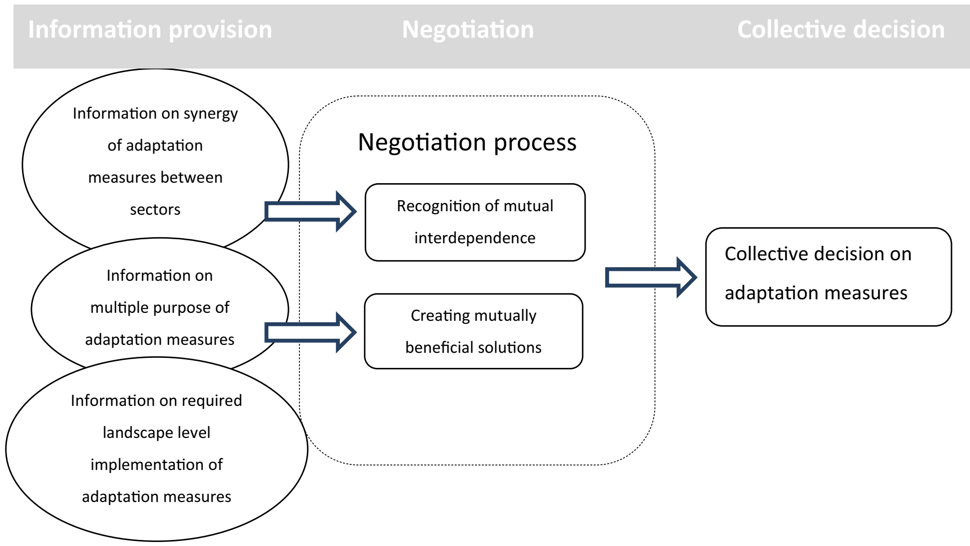


Fig. 1 Analytical framework of the assumed impact of information on collective decision-making. Three types of information (based on Opdam et al. 2016) are provided to a group of stakeholders involved in a participatory process. The potential of this information is to foster collaboration through recognizing mutual interdependence and creating mutually beneficial solutions, which will more likely lead to collective decisions on adaptation measures

and coordinated between the relevant stakeholders. In landscape planning, stakeholders from different sectors, such as agriculture, nature conservation, water management, and recreation, meet each other in a process of vision development, design, and implementation. They will need to converge on (a set of) adaptation measures that is beneficial and desirable for the problems and the geographical location at hand. We will focus our analysis on the collaborative negotiation process leading up to the collective decision, and how different types of information can support this negotiation process (Fig. 1).

Theories on multiactor collaboration (Gray 1989) and collaborative governance (Ansell and Gash 2007; Huxham and Vangen 2000) have identified the *recognition of mutual interdependence*, and integrative negotiation*,* aimed at *creating mutual benefits* for multiple actors, as two important factors in establishing collaboration among stakeholders with diverging interests (Fig. 1, negotiation process). The recognition of mutual interdependence is an important precondition for starting up collaboration (Gray 1989). If stakeholders understand why or how they depend on each other for resolving problems or pursuing opportunities, they will be more inclined to collaborate. Therefore, providing information about the required contribution of different stakeholders to implementing adaptation measures, so that interdependence becomes visible, can be expected to contribute to collaboration and collective decision-making. Integrative negotiated agreements go beyond the initial positions and preferences of the different stakeholders by forging mutually beneficial agreements at the level of underlying interests (Fisher and Ury 1981 in; Leeuwis 2000). This contrasts with distributive negotiation, where parties try to obtain individual benefits at the expense of others. Following these authors, information supporting the identification of actions that are mutually beneficial can be expected to contribute to integrative agreements. Of course, many more factors affect the emergence and success of collaboration, such as social learning (Van der Wal 2015), frame diversity (Gray et al. 2007; Dewulf et al. 2011), and leadership (Prell et al. 2008; Stringer et al. 2006), but in this paper we focus on the role of particular types of information.

In a previous study (Opdam et al. 2016), we found that three types of information can be distinguished that potentially support collective decision-making for landscape-level adaptation to climate change (Fig. 1, information provision). The first type of information concerns the extent to which adaptation measures render mutual benefits between sectors (e.g., water, agriculture, or nature), showing the potential for synergy between these sectors. A second type of information that may stimulate collaboration between sectors is information about the difference between single- and multiple-purpose measures. Single-purpose measures are taken to solve a single climate change impact, for example, either crop damage from storm water or increased impact of habitat fragmentation on a population of a protected species. A multiple-purpose measure is taken to solve the two problems at once. We expect that multiple-purpose measures have higher potential to foster collaboration than single-purpose measures. A third type of information concerns how some measures are more effective if implemented collectively on a landscape level with neighboring landowners and managers. This especially holds for ecosystem-based adaptation measures, which become effective only when implemented on a landscape scale. For instance, re-naturalizing streams will increase the water holding capacity, especially when carried out on a stream valley level (Verburg et al. 2012). We expect that this type of information highlights the interdependence between stakeholders for achieving landscape-level adaptation.

Research questions

We hypothesize that information on the interdependence of adaptation measures results in selection of more adaptation measures requiring collaboration between stakeholders than may be expected from a beforehand assessed attitude of individual stakeholders. The presented framework in Fig. 1 will be used to answer three main questions:

1. When provided with relevant information, do groups select adaptation measures that provide benefits for other sectors, address multiple purposes, and are best implemented through cooperation at landscape level?
2. Does the collective decision taken reflect or go beyond the prior individual preferences?
3. How can differences between collective decision and prior individual preferences be understood by features of the negotiation process?

The answers to these questions will provide us with a further understanding on how information about mutual benefits and interdependence among stakeholders leads to collective decision-making. In the next sections, these questions are explored for the empirical case "*Baakse Beek*."

Methods

The Baakse Beek case study

The Baakse Beek is a watershed with an area of 280 km^2 in the east part of the Netherlands, dominated by dairy farms, arable land, estates, and nature reserves. Issues of water management (preventing drought and water excess) and nature management (improving landscape conditions and connectivity of nature areas) have implications for local ecosystems, agricultural practices, and recreation and living in the area. The regional stakeholder process was initiated by the water board and the provincial government. This planning process intended to anticipate future climate changes such as changing precipitation patterns, temperature increase, and resulting consequences for nature, agriculture, and water, focusing on adaptation options that were acceptable for all stakeholders. Thus, the climate adaptation process was an authentic process initiated by stakeholders in the geographical area. Stakeholders decided to join in on a discussion on integrated adaptation measures that reach beyond individual adaptation options. Stakeholders that participated were the farmers union (LTO), individual farmers, municipalities (local governments), the federation of privately owned estates, nature organizations, a governmental organization for landscape planning and design (DLG), and some local inhabitants. In 2010, the stakeholders joined forces with the research project CARE ("Climate Adaptation for Rural arEas"), a part of the Dutch national research program "Knowledge for Climate." This research program aimed to connect research, public and private sectors, and stakeholders to develop regional and national climate adaptation strategies. Throughout the 4-year project, a series of four stakeholder meetings was organized to involve stakeholders and scientists. This full process is described in Van der Wal (2015). The foci of the CARE project are water management (Witte et al. 2015), nature management (Van Teeffelen et al. 2015), and agricultural practices (Alam et al. 2014). The first three meetings (May 2011, May 2012, and December 2012) concerned dialogue among stakeholders and scientists on central issues of concern and possible future scenarios. The last meeting started with a short plenary meeting presenting the scientific insights from the CARE project, followed by a design workshop, focused on integrated adaptation measures. In this study, we report on the design workshop.

The ex-ante survey

Three weeks prior to the design workshop, all stakeholders received an interactive PDF report (Vos et al. 2014; available online: http://library.wur.nl/WebQuery/wurpubs/fulltext/351019) describing 46 different adaptation measures for the Baakse Beek region. The report included information on the number of climate problems that each adaptation measure addressed and possible implications (positive, negative, or neutral) for each sector involved (agriculture, water management, and nature). At the same time, stakeholders received an invitation to an online survey where they were asked to indicate their view on the 46 adaptation measures on a scale from 1 (highly positive) to 5 (highly negative). The survey was sent to a group of 40 stakeholders that had been involved in some stage of the Baakse Beek process. With 18 filled-in questionnaires, the overall response rate was 45%. In this study however, we refer to the survey results of the eight stakeholders who were present in the design workshop (see supplementary material).

The design workshop

Prior to the workshop, one of the coordinating scientists provided a plenary presentation of the assignment, describing the present land use and the (future) climate problems following from the previous stakeholders meetings, for the three sections (see Table 1). After this plenary explanation, three groups were formed, each focusing on one geographical section of the Baakse Beek (see supplementary material). The upper, middle, and lower parts of the Baakse Beek stream valley are considered as three sections, each with a different dominant land use, and therefore characterized by their own climate adaptation issues and challenges. The groups were composed by the scientists, based on the background of the participants making sure that each sector was well represented in the section(s) most relevant for that sector. For example, section 1 is characterized by nature areas dealing with water issues; therefore, this group consisted of the stakeholders from nature organization, estate owners, and water board. In sections 2 and 3

Table 1 Overview of the presented climate problems. At the beginning of each workshop, the group had the opportunity to accept or adjust the climate problems

Presented climate problems for group 1
1. Increasing risk of flooding of agricultural areas
2. Droughts increasingly threaten groundwater-dependent nature types.
3. Drying out of Baakse Beek stream earlier in the season
Presented climate problems for group 2
1. Increasing droughts will sometimes cause problems for agriculture and nature.
2. Flooding is already a problem for agriculture, and this will increase.
3. Nature is fragmented: there are no natural elements except for a connectivity zone along the *Veengoot* stream.
Presented climate problems for group 3
1. Increasing droughts will cause problems for agriculture.
2. Flooding is already a problem for agriculture, and this will increase.
3. Nature is fragmented in this predominantly agricultural area.
4. Flooding of the village is already a problem after heavy rains and will increase.

on the other hand, land use is much more characterized by agriculture. Therefore, the two farmers who were present during the workshop were each placed in one of these groups. Furthermore, three scientists chaired the groups. Chairing meant that they (a) kept track of time, (b) reminded the participants to fill in the poster per assignment explained in the plenary setting, and (c) pointed out the available resources as answers to questions from the stakeholders. The scientists did not participate in decision-making during the workshops. In total, the group sizes varied from four to five stakeholders, and two to three scientists (see supplementary material for the exact stakeholder composition per group). The conclusions of each group were summarized on a poster, and adaptation measures were located on a map by the reporter (assisting MSc/PhD students), who also kept notes on conditions or additional requirements for the selected adaptation measures. The scientists chairing the groups had attended and contributed to the previous stakeholder meetings as experts, while the reporters had no previous involvement in the process.

Provided information and workshop assignment

Seven adaptation options were presented in the plenary presentation (Table 2). These seven adaptation measures were selected by the scientists based on their suitability to solve climate problems in the sections and because they potentially enable, to a greater or lesser extent, synergy between stakeholders, solve multiple climate problems, and require landscape level cooperation. It was explained that, even though the measure focuses on one sector (water, nature, or agriculture), these measures were selected because they have spatial impacts on the land use in the region *and* would require cooperation between stakeholders to have effect. In other words, adaptation measures that can be implemented by individual stakeholders were excluded because the participatory process of this study was not required for stakeholders to implement such measures. For instance, changing to crop types that are better adjusted to the future climate can be done by an individual farmer without consulting other stakeholders. However, to ensure all adaptation options that the group thought relevant could be selected, the participants were encouraged to discuss and select additional adaptation options.

The general assignment for the workshop was: "How can we, based on expected changes, develop a climate-robust landscape in the Baakse Beek? Please consider history, inhabitants, economic activities, nature and physical characteristics or the area. Also, pay attention to integration between stakeholders and between adaptation measures." The three groups were asked to first discuss whether they recognized the climate problems as presented for their section and if they wanted to add additional climate problems. Then, the groups were asked to discuss the seven adaptation measures, whether they thought the measures to be suitable for solving the climate problems, and under which conditions the measures would be acceptable. In this phase, the group was invited to add additional adaptation measures, including the adaptation measures overview (Vos et al. 2014), which was available during the workshop. Each group had access to a number of maps of the total area, showing the current and future situation of, e.g., groundwater levels, types of land use, and biodiversity maps. Subsequently, the group was asked to come to a collective decision about which adaptation measures to select for their section and where the measures should be taken by placing them on a 1:10,000 map.

Data analysis

We analyzed various data sources from this case study to assess the impact of information on collaboration:

- *Individual preference*: assessment of individual participants' attitude regarding adaptation measures from the ex-ante survey on preferred adaptation measures. This survey provides information on the individual attitude towards the adaptation measures. In each group, we have individual preference data from the survey: for two of the four stakeholders in group 1 (50%), three of the five stakeholders in group 2 (60%), and three of the five stakeholders in group 3 (60%). The supplementary material gives an overview which type of stakeholders per group has taken the survey.
- *Collective decision*: The posters of the workshop results give information on the selected adaptation measures, the arguments and conditions for choosing these measures, and the placement of adaptation measures on a map.

Comparing the individual preferences and the collective decisions gives insight in discrepancies between the

Table 2 The individual attitudes of group members towards the selected adaptation measures

Adaptation measures presented to the groups		Group 1			Group2				Group 3			
		Selected	Respondent 1	Respondent 2	Selected	Respondent 1	Respondent 2	Respondent 3	Selected	Respondent 1	Respondent 2	Respondent 3
W1	Storing water in nature areas	X	1	2	X	1	2	2	X	1	3	1
W2	Re-meandering streams	X	1	1	–				–			
W3	Adjusting dimensions of waterways	X	1	1	X	4	2	1	X	2	5	2
N1	Creating green infrastructure: wet elements	X	1	1	X	3	1	1	X	1	4	2
N2	Creating green infrastructure: hedgerows	–			X	2	1	1	X	1	4	2
N3	Enlarging nature areas	–			–				X	2	5	2
N4	Reducing surface discharge nature areas	–			–				–			
Added adaptation measures												
W4	Changing nature type	X	5	1	–				–			
L3	Diversifying farmers' income	X	1	1	–				–			
L1	Changing to climate adjusted crops	–			X	2	2	1	–			
L2	Improving organic matter in soil	–			X	1	1	1	–			

Explanation of codes: selected (X) and not selected (−) adaptation measures during the design workshop. Attitude of the respondent towards the measures prior to the design workshop: highly positive (1), positive (2), neutral (3), negative (4), and highly negative (5) towards the adaptation measure individual decisions and the collective decision resulting from the groups' negotiation. To understand why and how these discrepancies occur, information on the negotiation process is required:

- *Negotiation process:* transcripts of group discussions, concerning discussed issues, choices, and motivations. The analysis of the transcripts of group 1 (33% of the total qualitative data) was done separately by scientists 1 and 2. This resulted in an inter-rater agreement of 95%. Based on this result, the remaining two groups were analyzed by one scientist, and checked and discussed with the other scientist. Both scientists were present at the stakeholder workshops.

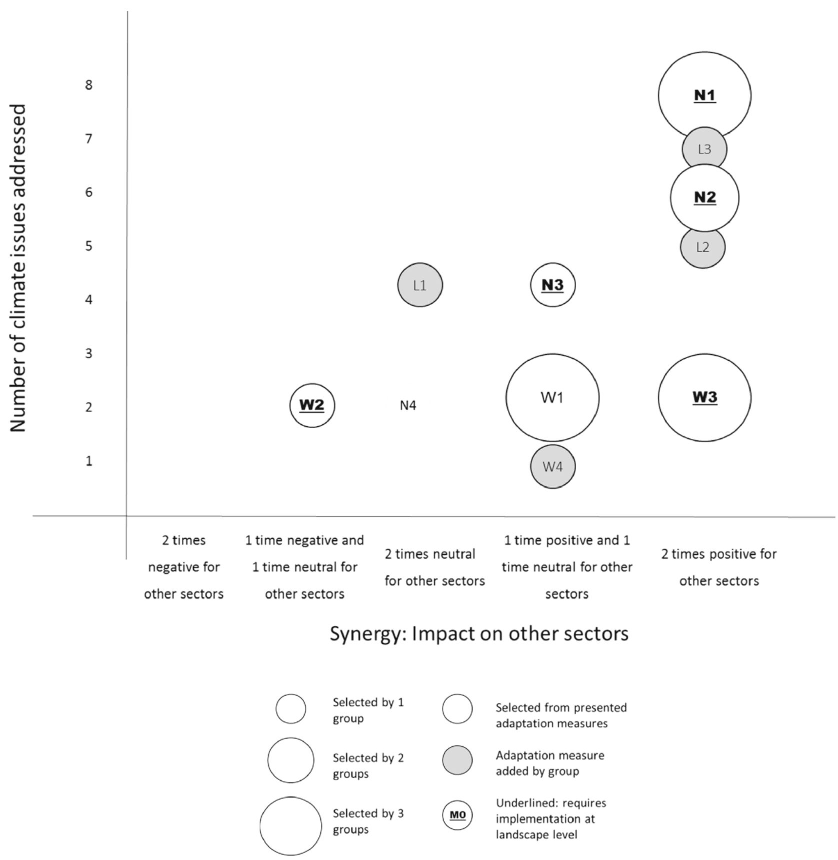
Data analysis was done by comparing the individual preferences of the group members with the collective decision. Where we found discrepancies, we zoomed in on the negotiation that led up to the collective decision. By using such a pre-structured or template-based content analysis of the verbatim transcripts of the meetings (Robson 2002), we were able to clarify the mechanisms that led from individual preferences to collective decisions. This approach fits our focus on exploring the types of information that were brought forward by the stakeholders and which provisions were mentioned for an adaptation measure to be selected against an individual preference.

Results

Which adaptation measures were selected?

The selected measures by the three groups are summarized in Fig. 2.

Fig. 2 The adaptation measures selected by the three groups and their position along two axes. The horizontal axis describes the synergy between sectors. An adaptation measure which is positive for the focus sector can be negative, neutral, or positive for the other two sectors, resulting in measures with high synergy at the right (positive for both other sectors). The vertical axis shows the number of climate problems solved by an adaptation measure from one to a maximum of eight climate-related problems. Underlined measures require implementation at landscape level



Adaptation measures Water	Adaptation measures Nature	Adaptation measures Agriculture
W1 Water storage in nature areas	N1 Green infrastructure: wet elements	L1 Changing to climate adjusted crops
W2 Re-meandering streams	N2 Green infrastructure: hedgerows	L2 Improving organic matter in soil;
W3 Adjusted dimensions of waterways	N3 Enlarging nature areas	L3 Diversifying farmers' income.
W4 Changing nature type	N4 Reducing surface discharge nature areas	

Measures that provide benefits for other sectors

The groups preferred adaptation measures that were beneficial to all sectors, which is the highest level of synergy. As illustrated in Fig. 2, mostly adaptation measures with a positive impact for one or both sectors were selected or added, while hardly any measures were selected or added that had negative impacts for the other sectors. An exception formed the selection of *Re-meandering streams* (W2) in group 1, which has negative impacts for farmers (see Table 2 for an overview of the selected measures per group). However, the group suggested an additional adaptation measure *diversifying famers' income* (L3), paying farmers for blue services, as a way to compensate farmers for the loss of production area. The groups mentioned further opportunities for integration by stressing adaptation measures that could be combined. Both groups 1 and 3 proposed adaptation measures that combine the *wet green infrastructure along water ways* (N1) with *adjustments of the waterway dimensions* (W3). Group 2 proposed an even further integration of adaptation measures by stressing that N1 and W3 could be combined with water storage in the natural elements along streams (W1).

Measures that address multiple purposes

The results did not show a preference of multiple-purpose measures over measures that address one or a few climate problems. Figure 2 shows that measures solving multiple climate problems were selected, but also measures that solve two to three problems only. However, all groups explicitly mentioned that, additional to benefits of adapting to climate change, certain measures created other co-benefits for sectors not involved in the planning process. The groups agreed that these adaptation measures created opportunities for extending the cooperation with these sectors. For instance, group 1 mentioned water purification as an additional ecosystem service not related to climate change that could be enhanced by the adaptation measures. In group 2, many co-benefits were put forward that could be provided by the selected adaptation measures: stimulating pollination by wild insects, water purification, attractive landscapes, biomass production, CO_2 sequestration, and soil fertility. Group 3 mentioned recreation as an additional ecosystem service not related to climate change that could be enhanced by the selected adaptation measures.

Measures that require landscape-level cooperation

The groups mainly selected measures that become effective on a landscape level and therefore require collaboration between neighbors (10 selected measures, Fig. 2). The adaptation measures that were added by the groups however did not require collaboration between neighbors (see the gray circles in Fig. 2). The focus on landscape-level cooperation was further expanded in groups 1 and 2, who explicitly reported that the selected adaptation measures would only be effective if they were adopted in the whole Baakse Beek stream valley and not only in their particular section. In group 3, there was no specific reference to landscape-level cooperation or implementation in the whole stream valley.

Does the collective decision taken reflect or go beyond the prior individual preferences?

We tested how the group decisions related to the attitudes of the individual group members towards the selected adaptation measures. The individual attitudes were measured in a survey sent prior to the landscape design workshop.

In Table 2, it is shown that in group 1 the attitudes of individual group members were supportive towards all selected adaptation measures, except for measure W4 *Changing nature type*. Based on the survey results, we expected to see a debate in group 1 concerning adaptation measure W4, since initially the respondents did not agree on the desirability of this adaptation measure. Similarly, in group 2 we see that respondent 1 disagrees with the other respondents on adaptation measure W3 *Adjusting dimensions of waterways*, and in group 3 we expected a conflict in preference between respondent 2 and its group members on most of the selected measures.

How can differences between collective decision and prior individual preferences be understood by features of the negotiation process?

In group 1, the members actively explored conditions under which the measure would be acceptable or even beneficial to this stakeholder with a negative attitude. Prior to the negotiation process, the nature conservationist (stakeholder A) rejected *Changing nature types* (W4) as a measure to cope with changing climatic conditions. However, during the negotiations, it became clear that *Changing nature types* would imply replacing coniferous forests by wet deciduous forests that is able to cope with regular flooding. The conservationist then recognized that by accepting this adaptation measure, unnatural coniferous forests would be replaced by natural wet forests, changed his attitude, and became an enthusiastic promoter of this measure:

In group 2, one group member was negative about one of the selected adaptation measures: W3 *Adjusting dimensions waterways*. However, this negative attitude towards the measure was not expressed during the group discussion.

[group discussion on changing nature type]

Stakeholder A: But what type of nature? I can imagine that [some changes] are not considered a problem, but there is hardly a nature type that prefers runoff water from agriculture.

[discussion on ground water quality vs. surface water: Other stakeholders: "we can assist certain species in surviving by retaining more water in some nature types / We have some A-status forests, and that's quality. Still, the water from the Baakse Beek is not a problem for those forests"]

Stakeholder A: The same goes for ponds. If you have put clay edging on ponds, we agree that agricultural water is better than no water. But that more cultural historically correct.

Chair: But that is isolated from the rest of your system.

[discussion continues on exact geographical locations]

[discussion on characteristics of types of grassland and forests]

Stakeholder A: You are right, for those types of nature that is perfectly acceptable.

Stakeholder A: That means less evaporation. If you take into account the natural potential of vegetation and forests, then you can change some pine to leaf forests in the long term. If you have water available, than it's a possibility. Even though it is a small change to a bigger problem.

In group 3, one group member was very negative about four of the five selected measures and neutral towards the 5th selected measure. This stakeholder (B) made various attempts to stop or reduce the impact of these measures. This group member expressed his skepticism regarding the adaptation measure to add hedgerows to the landscape to reduce habitat fragmentation (N2 *Creating green Infrastructure: hedgerows*). Also, he tried to reduce the number of hedgerows that were planned on the map with the argument: "we do not need all species everywhere, do we?" The adaptation measure to *enlarge existing nature areas* N3 was acceptable for this group member, as he observed that the suggested location was not very valuable for agriculture. During the negotiations, some additional arguments were given how to minimize the required area for this adaptation measure, thus making the measure more acceptable for him (stakeholder B):

[Comments on measure W3, Adjusting dimensions of water ways]

Stakeholder B: So, the effect is the same as I saw in the previous study. You can change the width and depth, but eventually it will run dry anyway.

[Comments on measure N1, Hedgerows]

Stakeholder B: Personally, I don't think that's useful. Wait a minute! That would mean doing the same for all species, but we don't need the same animal on each square km, right?

We all keep throwing these cards around [adaptation measures, ed.], we all want something different than the agricultural sector. We need a central aim. We are not just putting up hedgerows for fun and all. We need some more specific goal.

Other stakeholders: But the underlying choice for hedgerows is the connection between nature areas. A climate robust landscape is what we want for all those purposes.

Stakeholder B: No, I don't think the agricultural sector disagrees if you use more land [for hedgerows]. But you need a pretty – if a nice agricultural area remains, then the agricultural sector will not object to such ideas as much… I don't know that area that well, so if you want to do something like that we need to discuss this from our bikes, riding the landscape and seeing the lines in the landscape. [all stakeholders agree]

[Comment on measure W1, Storing water in nature areas]

Stakeholder B: First we said no. We could retain more water in this area, but that is already taken care of. But if we can do even more than we do now, then start storing water to compensate for water level differences. If this is too hard, then create something here to discharge water from the streams, because you can't store it all. And in case of extremities it needs to be able to flow away [gives examples]. [Group accepts measure W1]

Conclusion and outlook

We have investigated how the outcome of negotiation in a participatory planning group was affected by informing the group about mutual benefits and the dependency on landscape-level adaptations for achieving these benefits. We studied responses of the group to three categories of information: whether measures were simultaneously beneficial to actors from different sectors (synergy), whether or not adaptation measures contributed to solving several climate-related problems at the same time (multiple purpose), and whether these benefits increased through coordinated implementation at the landscape level. Our first research question was focused on the selection of adaptation measures when provided with these three types of information.

Our analysis in the "Which adaptation measures were selected?" section suggests that information on the synergy of adaptation measures between sectoral interests stimulated finding mutually beneficial solutions, while information on the required landscape-level implementation of adaptation measures may have contributed to the recognition of mutual interdependence. Our results are not in line with the expected role of information on the multiple purposes of adaptation measures. In fact, multiple-purpose effects of measures were considered in second instance, after selecting adaptation measures when stakeholders were further discussing conditions and expectations.

The second research question aimed at understanding the selection of adaptation measures in the light of ex-ante survey data. This analysis is described in the "Does the collective decision taken reflect or go beyond the prior individual preferences?" section, where selected adaptation measures were related to the ex-ante survey data. Our results are in line with the expectation that following a negotiation process based on these types of information, more integrative agreements occurred than expected from individual attitudes as apparent from the survey that was taken prior to the workshop. Stakeholders preferred measures that were beneficial to all three sectors involved (Fig. 2). Also, when they proposed additional adaptation measures (not preselected by the researchers), these measures showed the same preference for synergy with other sectors.

We found that the groups preferred measures which provided benefits to all three sectors. In the third research question, we zoomed in on the group discussions to understand differences between the collective decision and individual preferences ("How can differences between collective decision and prior individual preferences be understood by features of the negotiation process?" section) The discussions during the negotiation process showed that stakeholders actively explored the conditions under which an adaptation measure is associated with benefits to all stakeholders at once. Furthermore, the analysis of the group discussions demonstrated that group 1 and group 2, but not group 3, explicitly included landscape-level cooperation in their interpretation of the adaptation measures. Not only did they select adaptation measures that require landscape-level implementation, but they explicitly scaled up the application of these measures to the whole Baakse Beek area, arguing that this would increase their effectiveness. Finally, we could not find a preference for solutions that address several climate-related problems at the same time; whether or not this was the case was not a topic during the discussions. Apparently, the groups' first focus was on solving the specific climate problems that were identified in their group. However, after selecting adaptation measures that solved the identified climate problems, all groups recognized that some measures could be physically combined in the landscape, and therefore acknowledged multiple-purpose benefits on second thought. Stakeholders also mentioned additional benefits of a selected measure relevant to environmental issues outside the scope of climate change adaptation. For instance, the contribution of green infrastructure to recreation, pollination, CO_2 sequestration, and natural pest control were additional arguments for the uptake of this measure, emphasizing the opportunities for cooperation with additional sectors.

Overall, we found that all groups eventually presented a collective decision about implementing adaptation measures which was beyond the prior individual preferences. Although all groups were provided with the same information, the collective decision process showed individuals following different strategies to deal with incongruent individual perspectives. One strategy was to start discussing the conditions under which the adaptation measures would be acceptable (groups 1 and 3), illustrating that a conflict can be constructive by triggering dialogue directed at the recognition of mutual interdependence and interest. Constructive conflicts are understood to increase the collaborative process (Cuppen 2012; Franco et al. 2015). In both groups, the dialogue created a new, shared perspective, which can be labeled as a "third space" (Ikas and Wagner 2009), where a new, integrated perspective is created based on the group's individual stakeholders' perspectives.

Another strategy was followed by one actor in group 2. We expected this stakeholder to disagree with the others, but no conflict took place. One possible explanation is that the stakeholder misunderstood the adaptation measures when s/he filled in the survey, and matters were placed in a context during the workshop. Therefore, the survey results may not reflect his/her views at the time of the workshops. This effect has also been noted by Becu et al. (2008), who claim that each assessment of perspective is a temporary assessment. Another explanation is the stakeholder's position in the group's power dynamics. This phenomenon, mentioned by Prell et al. (2008), describes power relations where stakeholders who place themselves hierarchically above or below other stakeholders do not equally participate in dialogue. Given the interdependence in finding solutions for climate adaptations, and the explorative and non-binding character of the workshop, we did not find evidence for such behavior in the analysis of the discussion. The way the groups were facilitated was aiming at an equal discussion among the co-dependent stakeholders. Additionally, the stakeholders and scientists had a working relation for the 4 years leading up to this final workshop. During this process, the stakeholders were considered the experts on the local area and their sector, whereas the scientists were considered experts in exploring the impact of adaptation measures under various climate scenarios. Facilitating a group can influence power relations between the stakeholders (Becu et al. 2008; Leeuwis and Aarts 2011). Any mistrust or suspicion among stakeholders and/or scientists is likely to have been discussed and addressed in a previous meeting during the 4-year cooperation and did not show in the analysis of the discussion. In our analysis, we therefore focused on the dialogue rather than on the effect of such power relations.

In our approach, based on a real-world case study, we presented the information as part of a facilitation process. As discussed, we think it is plausible that the impact of the information depended on or was augmented by the facilitation. It is well known that the transfer of scientific knowledge to stakeholders becomes more effective when the relevance of the knowledge is discussed in the stakeholder group and transformed to fit the local context (e.g., Cash et al. 2003). Therefore, a necessary follow-up to our exploration would be to investigate what the information does for collective decision-making without researchers organizing a participatory process. For example, following the logic of Fig. 1, one could investigate preferences of stakeholders if they get a choice between measures that can be implemented individually but with no opportunity for synergy with other stakeholders, versus measures that need landscape-level cooperation but with high value because of synergy. Such an investigation can be organized as a choice experiment with (for example) groups of students (see, for an example, Opdam et al. 2015b), and also could inquire about motivations behind the preferences.

Opdam et al. (2016) observed that there is hardly any empirical evidence that information about the interdependence of individual and common interests in landscape management does stimulate collaboration between stakeholders, and concluded that more systematic empirical studies are required. Although our analysis is based on a limited number of stakeholders, our study is one of the first case studies attempting to explore how information on mutual interdependence may enhance collaboration through negotiation in landscape management. The provided information in our case study stressed the interdependence of the stakeholders in terms of creating synergy between sectoral interests, creating multiple purposes with one measure and the need for landscape-level implementation (Fig. 1). The recognition of these interdependencies and the opportunities for mutually beneficial solutions during negotiation may have contributed to the groups' collective decisions. However, in this authentic case study, we provided the information in the course of a social facilitation process which itself aimed to foster negotiation as well. Therefore, the influences of the provided information and of the facilitation are tightly interwoven and cannot be regarded separately. Studies separating these effects would require a more experimental setting, which is difficult to combine with the aims of a real-world planning process.

Considering the modest group size and the specific, authentic context of this case study, our conclusions are primarily relevant for this study and its context as reported in this paper. Nonetheless, our findings are significant in the context of the emerging insight that climate adaptation of landscapes needs to be organized as a community-based planning process. The too limited role of stakeholders in translating the generic recommendations of climate adaptation into site-specific solutions has been identified as one of the key barriers for effective implementation (Brown 2002; Biesbroek et al. 2013). To bridge this gap between science and practice, it has been proposed to consider adaptation measures in the context of social-ecological systems (Turner et al. 2010; Adger et al. 2011). Olsson et al. (2010) stressed that a lack of understanding of the functioning of the natural system will result in inadequate management of natural resources. Our study illustrates that knowledge about how ecological and social components interact can be a key element in the development of social-ecological systems. In this study, we used information about the link between functioning of the landscape and mutual benefits and interdependencies. This elicited integrative negotiation and collective decision-making, which ultimately can increase the common benefits of adapting landscapes to climate change.

The regional adaptation process in the Baakse Beek area is still ongoing and has reached the implementation phase (see website https://www.baaksebeek.nl/). Although we do not want to imply that the successful implementation of adaptation measures is the sole result of the presented study, many of the measures are in accordance with the collective decisions made during the design workshop. Some examples of the measures that are being implemented are improved water retention in nature areas, avoidance of flooding of a village during extreme precipitation by creating water storage on agricultural land, creation of wet green-infrastructure elements along streams, adjusting dimensions of water ways, and re-meandering of stream sections on estates.

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References

Adger WN (2003) Social capital, collective action, and adaptation to climate change. Econ Geogr 79:387–404. https://doi.org/10.1111/j.1944-8287.2003.tb00220.x

Adger WN, Brown K, Nelson DR, Berkes F, Eakin H, Folke C, Galvin K, Gunderson L, Goulden M, O'Brien K, Ruitenbeek J, Tompkins EL (2011) Resilience implications of policy responses to climate change. Wiley Interdiscip Rev Clim Chang 2:757–766. https://doi.org/10.1002/wcc.133

Alam S, Bakker M, Karali E, Van Dijk J, Rounsevell M (2014) Simulating the expansion of large-sized farms in rural Netherlands: a land exchange model. In: Alam SJ, Parunak HVD (eds) Multi-agent-based simulation XIV. Springer, Berlin-Heidelberg, pp 115–128. https://doi.org/10.1007/978-3-642-54783-6_8

Ansell C, Gash A (2007) Collaborative governance in theory and practice. J Public Adm Res Theory 8:543–571. https://doi.org/10.1093/jopart/mum032

Barreteau O, Bots PWG, Daniell KA (2010) A framework for clarifying 'participation' in participatory research to prevent its rejection for the wrong reasons. Ecol Soc 15:1 https://www.ecologyandsociety.org/vol15/iss2/art1/

Barton JR, Krellenberg K, Harris M (2015) Collaborative governance and the challenges of participatory climate change adaptation planning in Santiago de Chile. Clim Dev 7:175–184. https://doi.org/10.1080/17565529.2014.934773

Becu N, Neef A, Schreinemachers P, Sangkapitux C (2008) Participatory computer simulation to support collective decision-making: potential and limits of stakeholder involvement. Land Use Policy 25:498–509. https://doi.org/10.1016/j.landusepol.2007.11.002

Biesbroek GR, Klostermann JE, Termeer CJAM, Kabat P (2013) On the nature of barriers to climate change adaptation. Reg Environ Chang 13:1119–1129. https://doi.org/10.1007/s10113-013-0421-y

Brown K (2002) Innovations for conservation and development. Geogr J 168:6–17. https://doi.org/10.1111/1475-4959.00034

Cash DW, Clark WC, Alcock F, Dickson NM, Eckley N, Guston DH, Jaeger J, Mitchell RB (2003) Knowledge systems for sustainable environment. PNAS 100:8086–8091. https://doi.org/10.1073/pnas.1231332100

Caves JK, Bodner GS, Simms K, Fisher LA, Robertson T (2013) Integrating collaboration, adaptive management, and scenario-planning: experiences at Las Cienegas National Conservation Area. Ecol Soc 18:43. https://www.ecologyandsociety.org/vol18/iss3/art43/. https://doi.org/10.5751/ES-05749-180343

Cuppen E (2012) Diversity and constructive conflict in stakeholder dialogue: considerations for design and methods. Policy Sci 45:23–46. https://doi.org/10.1007/s11077-011-9141-7

Dewulf A, Mancero M, Cardenas G, Sucozhanay D (2011) Fragmentation and connection of frames in collaborative water governance: a case study of river catchment management in Southern Ecuador. Int Rev Adm Sci 77:50–75. https://doi.org/10.1177/0020852310390108

Fisher R, Ury W (1981) Getting to yes: negotiationg agreement without giving in. Penguin Books Ltd., Harmondsworth

Franco LA, Rouwette EAJA, Korzilius H (2015) Different paths to consensus? The impact of need for closure on model-supported group conflict management. Eur J Oper Res 249:878–889. https://doi.org/10.1016/j.ejor.2015.06.056

Gray B (1989) Collaborating: Finding common ground for multi-party problems. Jossey-Bass, San Francisco

Gray B, Hanke R, Putnam LL (2007) The discourse of environmental conflicts: how stakeholders construct their claims, their opponents and themselves. MOPAN 2007, 28-29 June, Leuven (Belgium), pp 28–29

Haasnoot M (2013) Anticipating change: sustainable water policy pathways for an uncertain future. Dissertation, University of Twente

Hoppe R (2011) Institutional constraints and practical problems in deliberative and participatory policy making. Policy Polit 39:163–186. https://doi.org/10.1332/030557310X519650

Huq N, Renaud F, Sebesvari Z (2013) Ecosystem based adaptation (EBA) to climate change—integrating actions to sustainable adaptation. United Nations University, Institute for Environment and Human Security (UNU-EHS), Bonn

Huxham C, Vangen S (2000) Ambiguity, complexity and dynamics in the membership of collaboration. Hum Relat 53:771–806. https://doi.org/10.1177/0018726700536002

Ikas K, Wagner G (eds) (2009) Communicating in the third space. Routledge, New York

Leeuwis C (2000) Reconceptualizing participation for sustainable rural development: towards a negotiation approach. Dev Chang 31:931–959. https://doi.org/10.1111/1467-7660.00184

Leeuwis C, Aarts N (2011) Rethinking communication in innovation processes: creating space for change in complex systems. J Agric Educ Ext 17:21–36. https://doi.org/10.1080/1389224X.2011.536344

Olsson P, Bodin Ö, Folke C (2010) Building transformative capacity for ecosystem stewardship in social-ecological systems. In: Armitage D, Plummer R (eds) Adaptive capacity and environmental governance. Springer Verlag, Berlin-Heidelberg

Opdam P, Nassauer J, Wang Z, Albert C, Bentrup G, Castella J-C, McAlpine C, Liu J, Sheppard S, Swaffield S (2013) Science for action at the local landscape scale. Landsc Ecol 28:1439–1445. https://doi.org/10.1007/s10980-013-9925-6

Opdam P, Westerink J, Vos CC, De Vries B (2015a) The role and evolution of boundary concepts in transdisciplinary landscape planning. Plan Theory Pract 16:63–78. https://doi.org/10.1080/14649357.2014.997786

Opdam P, Conincx I, Dewulf A, Steingrover E, Vos CC, Van der Wal M (2015b) Framing ecosystem services: a way to affect behaviour of actors in collaborative landscape planning. Land Use Policy 46:223–231. https://doi.org/10.1016/j.landusepol.2015.02.008

Opdam P, Coninx I, Dewulf A, Steingröver E, Vos CC, Van der Wal M (2016) Does information on landscape benefits influence collective action in landscape governance? Curr Opin Environ Sustain 18:107–114. https://doi.org/10.1016/j.cosust.2015.12.006

Ostrom E (1998) A behavioral approach to the rational choice theory of collective action. Am Polit Sci Rev 92:1–22. https://doi.org/10.2307/2585925

Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. Science 325:419–422. https://doi.org/10.1126/science.1172133

Prell C, Hubacek K, Quinn C, Reed M (2008) 'Who's in the network?' When stakeholders influence data analysis. Syst Pract Action Res 21:443–458. https://doi.org/10.1007/s11213-008-9105-9

Rathwell KJ, Peterson GD (2012) Connecting social networks with ecosystem services for watershed governance: a social-ecological network perspective highlights the critical role of bridging organizations. Ecol Soc 17:24 https://www.ecologyandsociety.org/vol17/iss2/art24/. https://doi.org/10.5751/ES-04810-170224

Robson C (2002) Real world research. A resource for social scientists and practitioner-researchers, 2nd edn. Blackwell Publishing, Oxford

Southern A, Lovett A, O'Riordan T, Watkinson A (2011) Sustainable landscape governance: lessons from a catchment based study in whole landscape design. Landsc Urban Plan 101:179–189. https://doi.org/10.1016/j.landurbplan.2011.02.010

Steingröver EG, Geertsema W, Van Wingerden WKRE (2010) Designing agricultural landscapes for natural pest control: a transdisciplinary approach in the Hoeksche Waard (The Netherlands). Landsc Ecol 25:825–838. https://doi.org/10.1007/s10980-010-9489-7

Stringer L, Dougill A, Fraser E, Hubacek K, Prell C, Reed MS (2006) Unpacking "participation" in the adaptive management of social–ecological systems: a critical review. Ecol Soc 11:39 https://www.ecologyandsociety.org/vol11/iss2/art39/

Tompkins EL, Adger WN (2004) Does adaptive management of natural resources enhance resilience to climate change? Ecol Soc 9:10 https://www.ecologyandsociety.org/vol9/iss2/art10

Turner WR, Bradley BA, Estes LD, Hole DG, Oppenheimer M, Wilcove DS (2010) Climate change: helping nature survive the human response. Conserv Lett 3:304–312. https://doi.org/10.1111/j.1755-263X.2010.00128.x

Van den Hurk B, Siegmund P, Klein Tank A (eds) (2014) KNMI'14: Climate change scenarios for the 21st Century—a Netherlands perspective. Scientific Report WR2014-01. KNMI, De Bilt

Van der Wal MM (2015) The role of computer models in social learning for participatory natural resource management. Dissertation, Open University The Netherlands

Van Teeffelen AJA, Vos CC, Jochem R, Baveco JM, Meeuwsen H, Hilbers JP (2015) Is green infrastructure an effective climate adaptation strategy for conserving biodiversity? A case study with the great crested newt. Landsc Ecol 30:937–954. https://doi.org/10.1007/s10980-015-0187-3

Verburg PH, Koomen E, Hilferink M, Pérez-Soba M, Lesschen JP (2012) An assessment of the impact of climate adaptation measures to reduce flood risk on ecosystem services. Landsc Ecol 27:473–486. https://doi.org/10.1007/s10980-012-9715-6

Vos CC, Grashof-Bokdam CJ, Stremke S, Oudes D (eds) (2014) Factsheet report Adaptation measures. [In Dutch] http://library.wur.nl/WebQuery/wurpubs/fulltext/351019. Accessed 11 August 2017

Wamsler C, Niven L, Beery TH, Bramryd T, Ekelund N, Jönsson KI, Osmani A, Palo T, Stålhammar S (2016) Operationalizing ecosystem-based adaptation: harnessing ecosystem services to buffer communities against climate change. Ecol Soc 21:31. https://www.ecologyandsociety.org/vol21/iss1/art31/. https://doi.org/10.5751/ES-08266-210131

Witte JPM, Bartholomeus RP, Van Bodegom PM, Cirkel DG, Van Ek R, Fujita Y, Janssen G, Spek TJ, Runhaar H (2015) A probabilistic ecohydrological model to predict the effects of climate change on natural vegetation at a regional scale. Landsc Ecol 30:835–854. https://doi.org/10.1007/s10980-014-0086-z