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DeveLoP—A Rationale and Toolbox for Democratic Landscape Planning

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Abstract: A rationale for an individuals-oriented landscape approach to sustainable land-use planning based on an analysis of bio-geo-physical components as well as the human components of the landscape is presented. A toolbox for analysing individuals' decision-making and valuations in the landscape is described. The toolbox can provide evidence on the drivers of individuals' decision-making in the landscape and the decision strategies they apply. This evidence can be used to identify communication needs and to design guidelines for effective communication. The tool for value elicitation separates the instrumental values (means) and end values (goals) of individuals with respect to locations in the landscape. This distinction, and knowledge of the end values in the landscape, are critical for the achievement of policy goals and for spatial planning from a democratic point of view. The individuals-oriented landscape approach has roots in geography and draws on behavioural decision research together with a model for integrating "science and proven experience" that is widely used in public decision-making in the Nordic countries. The approach differs from other scholarly disciplines addressing sustainable land-use planning. It is suitable for application on decision-making problems that include trade-offs between values. An overview of empirical studies is provided in which the individuals-oriented landscape rationale is applied to climate change.

Keywords: landscape analysis; local knowledge; effective communication; decision analysis; instrumental value; end value; climate change; subjective attribution; tipping point thinking; blocked beliefs

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1. Introduction

Recent years have seen a growing interest in holistic "landscape" approaches to sustainable land use management and planning. While some authors use the term landscape to describe a focus on ecological understanding of spatial heterogeneity, e.g., [1], holistic approaches to landscape are intended to improve on sectoral approaches, and to address the often interconnected social, environmental and political challenges raised by sustainability, e.g., [2–5]. Based on their review of more than 13,000 peer-reviewed articles and more than 500 grey literature documents, Reed et al. [4] conclude that, in essence, the landscape approach is a way of managing landscapes in which social and economic development is integrated with biodiversity conservation and climate change mitigation. However, they add that a degree of confusion remains over terminology as well as application and utility.

When defining the landscape approach, other authors have emphasised the important role of interactions between people and their environment to achieve social, economic and environmental objectives—for instance, in areas where land-based resource-use competes with environmental and biodiversity goals, see [2,6]. Hence, analysis of the landscape targets the biophysical, social and economic environment, as well as the perceptions of the individual decision-making agent.

The focus on interactions between people and their environment harmonises with the notion of the landscape as an environment as perceived by people—an interpretation first put forth by the Finnish geographer Johannes Gabriel Granö in 1929 [7]. It also captures the way people across seven European languages (Dutch [Netherlands], English [UK], French [France], German [Switzerland], Italian [Italy], Spanish [Mexico] and Swedish [Sweden] understand the term "landscape" [8]. The objects people associate with "landscape" include mountains, rivers, lakes, sky, trees and birds and other objects from the environment, which also suggests that people in the cultures represented by these languages conceptualise "landscape" in a vague but holistic way [8]. In contrast with a pictorial conception of the landscape, the Swedish geographer Torsten Hägerstrand conceptualised the landscape as a dynamic arena in which material and immaterial features interact in time and space, e.g., [9]. Hägerstrand argued that greater scientific attention to the beliefs and behavioural norms of people in the landscape would provide opportunities to identify pathways for sustainable development. In harmony with Hägerstrand's conceptualisation of the landscape, the European Landscape Convention defines a landscape as "a zone or area as perceived by local people or visitors, which evolves through time as a result of being acted upon by natural forces and human beings" [10].

With this in mind, we will argue that the interaction between people and their environment is a critical element of the landscape approach. In other words, we need an *individuals-oriented* landscape approach to sustainable land-use management and planning. Such an approach clearly accords with the sustainable development goals of the United Nations' Agenda 2030—goals that aim to achieve a better and more sustainable future for all [11]—since it provides opportunities for individuals in the landscape to present their perspectives, including the problems they see and where they need help to solve problems, see [12,13]. Moreover, because everyday decision-making is often the root cause of environmental problems, it also identifies lifestyle changes and a capacity to adapt, i.e., a capacity to adjust to changing conditions, as important means for development towards sustainability, see [9].

The individuals-oriented landscape approach is different from anthropological approaches to land-use planning in which people are seen as mainly social beings and primarily learn from each other, e.g., [14] (Figure 1). It also differs from cultural/political approaches, where different valuations and resulting value polarisation act as a starting point [15–18], from traditional environmental science, which focuses on the impacts of human action on the environment, e.g., [19], and from approaches where the focus is on the management and delivery of services and benefits that ecosystems can offer society, such as natural resource science and technology [20,21] and social-ecological systems theory [22,23]. In contrast with an individuals-oriented landscape approach, social-ecological systems theory focuses on interactions between two separate entities—social and ecological—and as such it makes it difficult to incorporate the "local", the arena of individuals' everyday lives.

To overcome the shortcomings of the landscape approach identified by Reed et al. [4], we will draw on empirical results from behavioural decision research, cf. [24], the framework of science and proven experience, cf. [25], and value theory, cf. [26–28]. Our aim is to demonstrate the potential of the individuals-oriented landscape approach, and to show how it can be applied and how its utility can be maximised in pursuit of sustainable development of society. We take it as read that communications need to meet the needs of the receiver to be effective, and that policy makers need to know what people assign value to in order to better target interventions. By "effective communication" we mean communication that is effective for increasing the decision-making capacity of the receiver. By way of illustration, we provide an overview of recent attempts to use landscape analysis to identify communication needs and develop guidelines on effective communications on mitigation of climate change and adaptation to its impacts, and to assess the vulnerability/opportunities of people in the landscape connected with climate change. However, the landscape approach can be applied to support other aspects of sustainable development as well. The guidelines for effective communications are meant to boost the decision-making competence of the individuals in the landscape, in the terminology of Hägerstrand [9] thereby building *spatial competence* of the decision-making agents. Hence, fostering spatial competence can be used as a planning instrument, see [29]. The assessments of vulnerability/opportunities of individuals in the landscape are meant to provide input for authorities' spatial planning, fostering *territorial competence* in the terminology of Hägerstrand [9]). Spatial as well as territorial competence are both important vehicles for sustainable development.

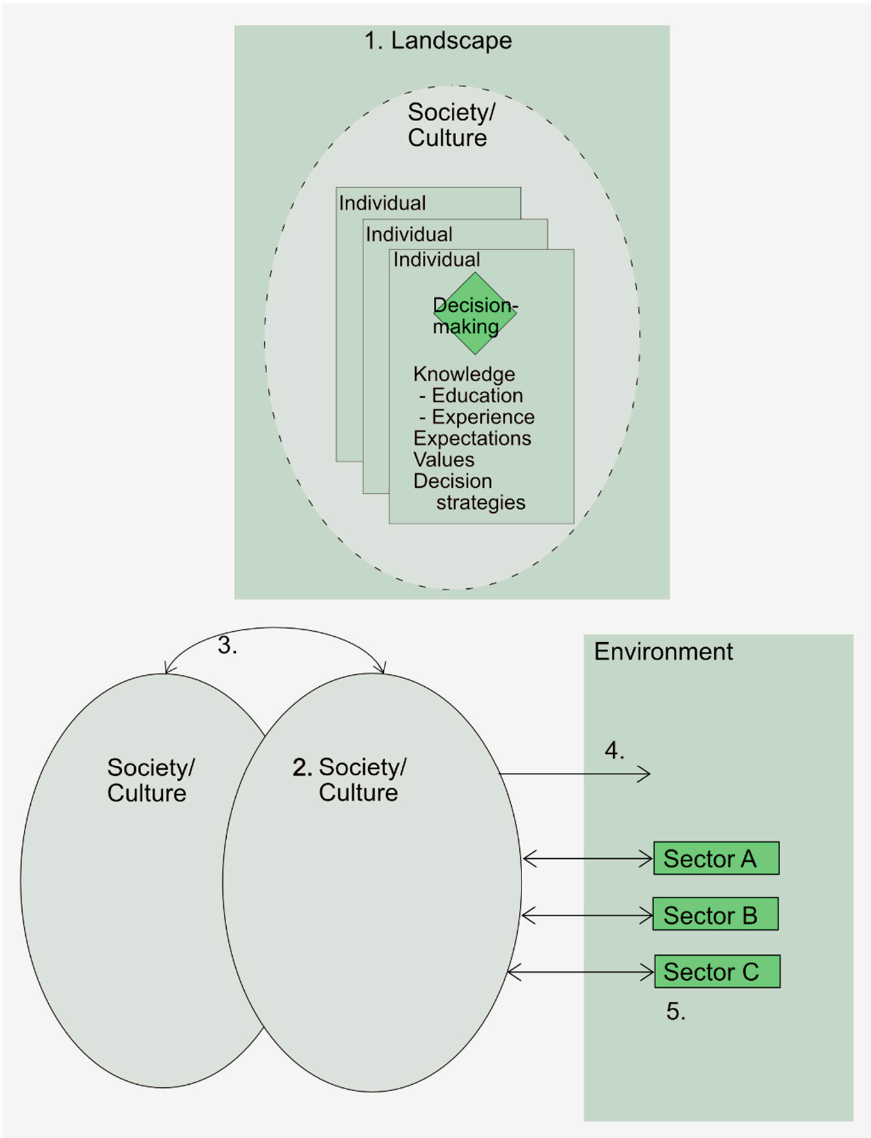


Figure 1. Approaches to sustainable land-use planning. Holistic landscape analysis (1) contrasted with anthropological approaches (2), cultural/political approaches (3), traditional environmental science (4) and natural resource science and technology, including social-ecological systems theory (5).

2. Democratic Landscape Planning Rationale

Democratic landscape planning supports decision-making by proposing policies such as two-way communication between people, experts and planners. Strategies based on behavioural decision research typically aim to involve the decision-making agents' decision-making ability as far as possible, e.g., [30]. Hence, it is critical, on this approach, to provide people with facts in a credible, comprehensive form, and to judge the decisions by the decision-making agents' own goals so that they gain control over themselves and their environment, see [30]. Sometimes interventions are best carried out collectively. For society to know what to protect, and what to exploit, knowledge on what is, and what is not, at risk, as well as the opportunities that arise, is a necessary first step that also provides an opportunity to balance risks and benefits between groups. Indeed, we argue that to be sustainable, a democratic society depends on its ability to create these conditions.

2.1. Guidelines for Effective Communications to Foster Spatial Knowledge

For behavioural change to occur, methods that make it possible to tap into the decision-making agents' experiential knowledge are needed. From a normative point of view, this insight connects with the core of the idea of action in accordance with science and proven experience [25]. Science and proven experience ("vetenskap och beprövad erfarenhet") is a long-standing Swedish concept that has recently attracted international attention and helps us to understand the ways in which scientific evidence and practical experience can (and cannot) be integrated [13,25]. Rooted in geography, the individuals-oriented landscape approach draws on both science and proven experience and behavioural decision research. According to Hägerstrand [9], p. 55), "*What we need to look at is not just objective knowledge in the restricted sense, but rather the whole set of items making up people's mental picture of the world*". Hence, science and proven experience and behavioural decision research together help to explain, and refine our understanding of, the way in which the landscape approach can be used to reduce environmental problems while concurrently, through its focus on the individual, strengthening democracy and contributing to sustainable development in multiple ways.

Behavioural decision research identifies three main types of research that are needed to support decision-making: normative research, which seeks to find the best solution to a choice, descriptive research, which describes the decisions being made and their drivers, and research that exploits the results from both normative and descriptive research to suggest effective prescriptions [24].

2.1.1. Norms

To secure sound decision-making along the above lines, communication needs to include expert knowledge as well as people's local knowledge and expectations, see [31]. For instance, people may have local knowledge that is of importance to decision-making and which the experts do not share. Moreover, local "proven experience" sometimes plays a role similar to scientific evidence and connects with people´s experiential knowledge to form their worldview. By contrasting this with the norms established by experts, we can identify the gap between "what decision-making agents know" and "what they need to know". This gap needs to be well understood if communication is to be effective [32]. This refers to any decision-making agent—to residents and policy-makers alike.

While in science it is important not to imply a causal link when there is none (to minimise type I error), for a decision maker, it is often more important not to miss a causal link when there is one (to minimise type II error) [33,34]. Presenting evidence in terms of assessments of probability, rather than categorical judgements based on the evidence, can make it more useful in a decision situation. A decision-making agent may need answers to questions such as: What can be expected about the probability of coastal flooding, see e.g., [35]? By how much could adapted forest management reduce the probability of wind damage on my forest property, see e.g., [36]? In addition to communications about particular facts, the person making a decision often needs to know something about the knowledge-map of causes and effects from which these facts were extracted [37].

2.1.2. Descriptions

Descriptive research is needed to identify the drivers of decision-making and the decision strategies actually employed. Based on a belief-desire model of decision-making [38], recent research on the drivers of adaptation to changing climate has revealed that strong belief in the local impacts of climate change is a necessary yet insufficient requirement for decision-making that favours adaptation [39–42].

Several researchers have suggested that direct experience of a phenomenon can affect adaptation, e.g., [43]. However, it must be noted that for adaptation to climate change to occur, the individual decision-making agent needs not only be exposed to the phenomenon in question, but to believe that it was caused by climate change [40] (to *subjectively attribute* the causes of an event to climate change, in the terminology of Ogunbode [44]). If the agent does not attribute the phenomenon, such as damage caused by flooding or drought, to the process of climate change, (s)he will not see any need to take measures to adapt to changing climate. Arguably, belief that one has experienced the impacts of climate change can fortify a belief in future local impacts of climate change.

The results of Blennow et al. [40] provide an explanation of why, in 2010, Swedish private forest owners had adopted fewer measures to adapt to climate change than their German and Portuguese counterparts (Figure 2): they believed less strongly in the local effects of climate change and/or believed less strongly that they had witnessed the effects of climate change. The results differ from results based on a general model where structural factors, such as infrastructure and wealth, are taken to determine the capacity to adapt and drive adaptation decisions (Figure 1), e.g., [20,21]. The structural model, in which small and fragmented privately owned forests in southern Europe are expected often to be a barrier to adaptive management practices [20], does not explain the adaptation activity that was taking place among Portuguese private forest owners in 2010. Nor does it explain the differences in adaptation activity observed between Swedish and German private forest owners (Figure 2) [40].

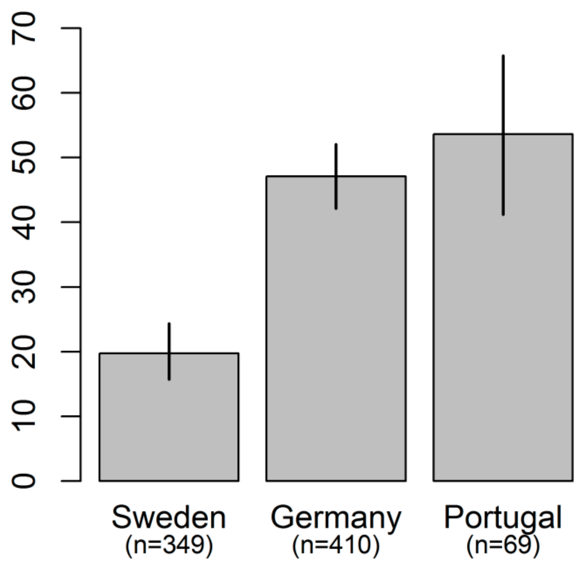


Figure 2. Private forest owners' adaptation of forest management to climate change in 2010 by country. Proportions of respondents in Sweden, Germany and Portugal who stated that they had adapted their forest management practices to climate change. Bars denote 95% confidence intervals. Reproduced from [40].

The study by Blennow et al. [40] illustrates how critical components of the capacity to adapt can be identified by analysing decision-making of the target group. A change in adaptive behaviour will require a change in one or both of the two personal factors. These, in turn, are correlated with the level of education [45]. Hence, appropriate formation and updating of beliefs in relation to climate change can result from the decision-making agent's education, but the decision is also affected by experiences and the strategies the decision-making agent employs, and those strategies may or may not be substantially affected by education [46,47]. As an example of the latter, a strategy by which information that readily comes to mind is employed (availability heuristic: [48]) explains why belief in the local effects of global warming among Swedish private forest owners was stronger in

2004 than it was after the cold winter in 2010 [40]. The decision strategies at play therefore need to be identified. For an overview of decision strategies, see [49].

In a survey of forest professionals' adaptation of forest management to climate change in 10 different countries across Europe in 2016, it emerged that belief in local impacts of climate change was stronger than in previous studies. More than four in five respondents definitely or probably believed in local climate change impacts on the forest, but not all of these had taken measures in favour of adaptation to the impacts of climate change, and spatial variation in adaptation was observed across Europe (Figure 3) [41].

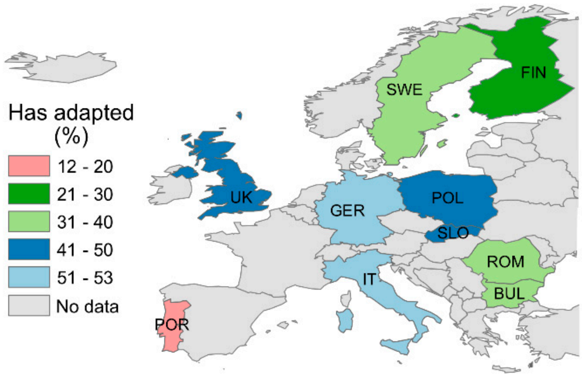


Figure 3. Percentage of forest professionals who have adapted to climate change by country. BUL = Bulgaria; FIN = Finland; GER = Germany (only Thuringia surveyed); IT = Italy; POL = Poland; POR = Portugal; ROM = Romania; SLO = Slovakia; SWE = Sweden; UK = United Kingdom. Base map modified from GISCO Eurostat (European Commission) with Administrative boundaries: ©EuroGeographics ©Food and Agriculture Organization of the United Nations ©Turkstat. Reproduced from [41].

According to expected utility theory of von Neumann and Morgenstern [50], a rational decision-making agent seeks to maximise expected utility. Drawing on expected utility theory, Persson et al. [51] developed a measure of an equivalent of expected utility called net value of expected impacts (NVEI), see [41]. NVEI measures the net of negative and positive values of expected specific impacts of change, in this case climate change on the forest, by each individual [51]. To calculate the NVEI of forest professionals, each respondent's NVEI of climate change was taken as the net of their expected values of several specific impacts of climate change on the forest.

While a clear spatial pattern of negative NVEI for forest professionals in the south-west and south of Europe and a more neutral NVEI in the north and north-east was discerned, no spatial pattern could be discerned in relation to the commonest value objects expected to be impacted by climate change [51]. This indicates that trade-offs made by the forest professionals on expected values of climate change impacts are a stronger driver of decision-making for adaptation to the impacts of climate change than the specific value objects they expect to be affected. Hence the results indicate that NVEI is a stronger driver of decision-making for adaptation to the impacts of climate change than cultural or political values, cf. [15–18].

The use of NVEI as the equivalent of expected utility implies that the probability of a rational decision-making agent deciding in favour of adaptation increases with the absolute value of NVEI (Figure 4). Indeed, NVEI was found to be significantly correlated with forest professionals' decisions for adaptation but in a highly non-linear way [41]. The shape of the NVEI function, and the way it interacted with covariates, revealed insights into drivers of decisions for adaptation among forest professionals as well as the decision strategies they had employed. For example, although the probability of having taken measures to adapt to climate change increased with increasing absolute value of NVEI, overall the probability of having taken measures to adapt was higher for those with negative NVEI than it was for those with positive NVEI. This asymmetry might have arisen because the respondents were satisficing, rather than maximising, the utility of their decision-making (Figure 4a) [52]. This would imply that when the expected result is an improvement even without adaptation measures being taken, the respondents thought the result was good enough, and that there was no need for further adaptation decisions. When the expected outcome was negative, the expected result was always worse without adaptation, and perhaps not good enough, and motivated decision-making for adaptation.

In some cases, decisions for adaptation were not taken in spite of values of NVEI close to the negative or positive extreme (Figure 4b). This behaviour was interpreted as a result of "tipping point thinking", i.e., the agent thinking that a relevant part of the climate system has passed a tipping point and that taking measures to adapt would make no difference [51]. Two different kinds of tipping point behaviour have been identified: "decision-maker's tipping point behaviour" and "systemic tipping point behaviour" [42]. The first of these occurs when the decision maker believes that his or her own actions would be inadequate to make any substantial difference and so (s)he abstains from taking measures for adaptation (Figure 4b). Systemic tipping point behaviour also inhibits actions but for a different reason. Here the person believes that the relevant parts of the system have reached a tipping point at which no action can make any difference. Systemic tipping point behaviour was frequently observed in both Portuguese and Finnish forest professionals [41]. In some of the Portuguese forest professionals tipping point behaviour was associated with negative NVEI, while in some of the Finnish forest professionals it was associated with positive NVEI (Figure 3). Moreover, Blennow et al. [41] found that for moderately negative values of NVEI, advice on effective adaptation measures inhibits adaptation when the receiver is aware of effective adaptation measures unless the advice is balanced with information on how climate change leads to negative impacts.

The decision-analytical approach presented here has also been applied to explain why people tend to prefer taking measures mitigating climate change than measures adapting to it [42]. While approximately four in five citizens of Malmö, Sweden, had taken measures to mitigate climate change in 2018, only approximately one in five had taken measures to adapt to its impacts. In agreement with [53], it was found not only that those who had made mitigation decisions outnumbered those who had made adaptation decisions, but that even though both mitigation and adaptation decisions are made in response to climate change they have different drivers. While decision-making favouring adaptation to the impacts of climate change can be driven by negative NVEI (risk perception) or positive NVEI, mitigation is driven by risk perception alone (Figure 5) [42].

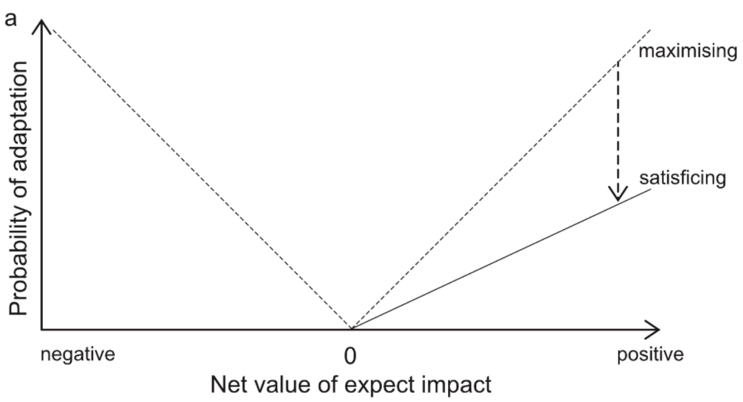


Figure 4. *Cont*.

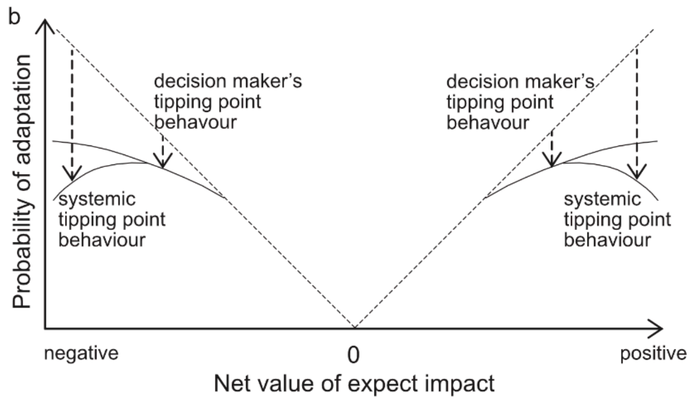


Figure 4. Stylised impacts of decision rules and decision strategies when applied to decision-making in favour of adaptation in a population. (**a**) The impact of the decision rule of maximising the expected utility (dashed line) and the decision rule of satisficing (solid line) on adaptation along the range of net value of expected impacts (NVEI). (**b**) The impact of two types of tipping point behaviour (solid lines) on adaptation along the range of NVEI. Individuals displaying tipping point behaviour had not decided in favour of adaptation in spite of NVEI close to the negative or positive extreme. Based on [41,42,51].

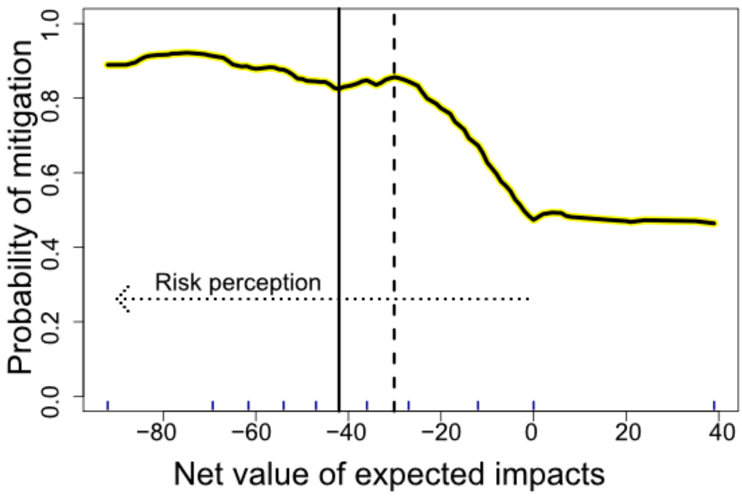


Figure 5. Risk perception (dotted line) drives decision-making in favour of mitigation in a population. A model of the probability of decision-making promoting climate change mitigation fitted to the net value of expected climate change impacts and based on data from citizens of Malmö, Sweden. Start of systemic tipping point behaviour (solid line) and decision maker's tipping point behaviour (dashed line) with increasing negative net values of expected impacts. Modified from [42].

Moreover, the strength of the subjective attribution of the causes of events to climate change was positively correlated with adaptation to climate change for negative as well as positive experiences (Figure 6) [42]. However, whereas decision-making favouring mitigation of climate change was also positively correlated with negative experiences attributed to climate change, strength of belief in positive experiences subjectively attributed to climate change was negatively correlated with climate change [42]. This means that positive experiences attributed to climate change can inhibit decision-making in favour of mitigation of climate change.

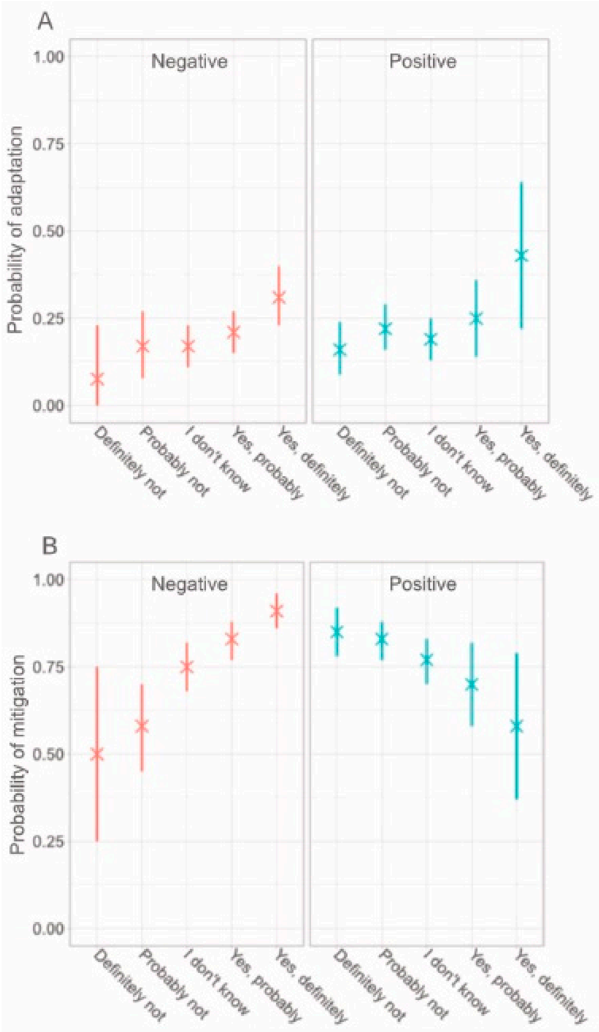


Figure 6. Response to climate change and strength of attribution of positive and negative experience to climate change. (**A**) The probability of decision-making in favour of adaptation to climate change was positively correlated with the strength of attributing negative and positive experiences to climate change. (**B**) The probability of decision-making in favour of mitigation of climate change was positively correlated with the strength of attributing negative experiences to climate change and negatively correlated with the strength of attributing positive experiences to climate change. Tests were conducted on data collected among citizens of Malmö in 2018 and used Bayesian robust correlation at a credibility >0.9. Modified from [42].

2.1.3. Prescriptions

When it comes to policy prescriptions, with the drivers of decision-making and the decision strategies identified, there are now opportunities to identify communication needs, and to tailor guidelines effectively to groups of people that differ in their NVEIs and decision strategies (Figure 4). Scientific knowledge is often presented at a generalised level. Robust knowledge of what works in the particular landscape where the decision is to be made is needed as well [25]. Hence, the two—scientific knowledge and local knowledge—need to be integrated if adaptation is to be taken up. For example, the results of one study [40] lead the authors to conclude that gathering and disseminating evidence of climate change and its effects might increase people's perceptions of having experienced it and therefore motivate them to consider the need for adaptive measures. Blennow et al. [41] were able to formulate a range of guidelines on effective communications (denoted guidelines for adequate communications in Blennow et al. [41]) with European forest professionals about adaptation to climate change (Figure 4) (Table 1). The guidelines reflect geographical patterns which in turn reflect the critical role of local knowledge driving decisions for adaptation to climate change among the forest professionals (Figure 4) (Table 1).

Table 1. Guidelines for effective communications (denoted adequate communications in [41]) derived for European forest professionals in a study by Blennow et al. [41] with the additional identification of decision-maker's tipping point thinking [42]. Map modified and reproduced from [41].

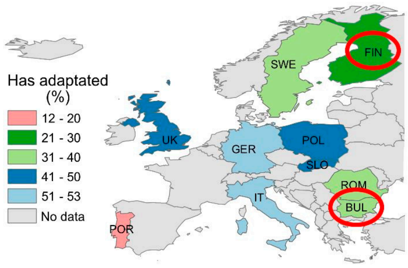
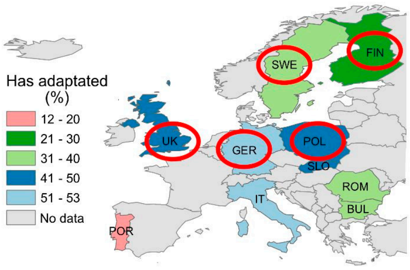
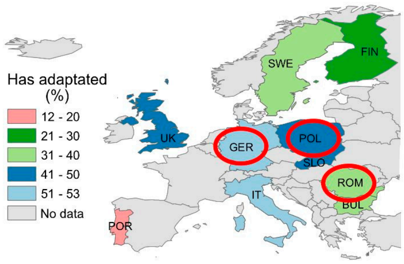
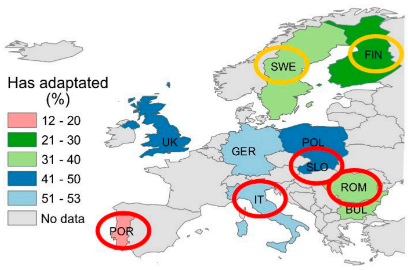
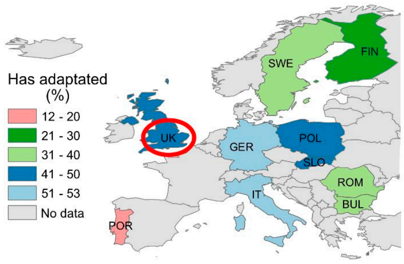
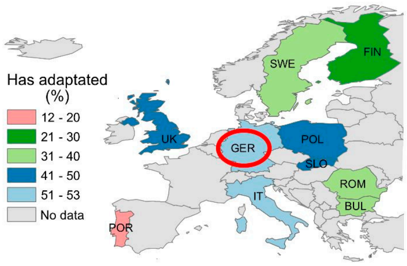
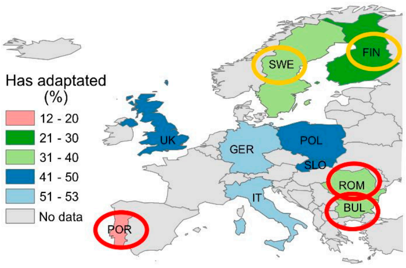
Individual's State of Knowledge/Expectation	*Distribution*	*Communications Recommended . . .*
Weak or uncertain belief in the local impacts of climate change on forests		. . . on climate change per se and its impacts on the forest
Weak belief in having experienced the impacts of climate change		. . . that fortify the subjective attribution of experiences to climate change
No or very weak impacts of climate change on the forest expected		. . . on climate change impacts on any forest value object
Positive and negative values of specific expected impacts of climate change on the forest that cancelled each other out		. . . on the impacts of climate change on all objects for which the expected values are weak
Low strength of values of climate change impacts on the forest expected on"Rural livelihood development", "regulatory ecosystem services", "biodiversity", "recreation", "carbon storage", "non-timber production" and "hunting" (in yellow) and "return-", "pulp-", "timber-" and "energy production" (in red)		. . . on how climate change affects value objects for which the value strength of expected impacts is low
High absolute expected net value of specific climate change impacts		. . . on specific negative impacts of climate change on forests. N.B. These are more likely to instigateforest adaptation of forest professionals across Europe than communications on specific positive climate change impacts

Table 1. *Cont.*

Individual's State of Knowledge/Expectation	*Distribution*	*Communications Recommended . . .*
Decision-maker's tipping point thinking. Moderately negative net values of climate change impacts on forests expected and few effective adaptation measures perceived to be available		. . . on effective measures for climate change adaptation that the decision-making agent can take him- or herself.
Moderately negative net values of climate change impacts on forests expected and several effective adaptation measures perceived to be available		. . . on the causal connections between climate change and negative impacts. N.B. Communications on even more effective measures unnecessary as this would reduce the utility the recipients expect from adaptation and thereby reduce their decision-making for climate change adaptation
Systemic tipping point thinking		. . . on whether or not relevant parts of the earth's climate system have passed a tipping point. Positive (in yellow) and negative (in red) tipping point thinking

In their study, Persson et al. [51] were unable to identify value polarisation in the NVEIs of forest professionals. However, when they asked forest professionals how strongly they believed in the overall positive and overall negative local impacts of climate change, Blennow et al. [41] found that approximately 50% of their respondents displayed "blocked beliefs" where their beliefs about opposite valences were concerned. People with blocked beliefs who had answered that they definitely believed in the negative local impacts of climate change had also answered that they equally strongly do not believe in the positive local impacts of climate change. This pattern was consistent for different strengths of belief in the local impacts of climate change, and it resulted in value polarisation of the population. Importantly, the value polarisation observed was not correlated with decision-making in favour of adaptation to climate change [41]. Indeed, the frequency of value polarisation depended on the level of generalisation of the question asked. A general question seeks a generalised answer which, in some individuals, invokes blocking of beliefs. This is consistent with, and may be explained by, the theory of psychological distance [54]. The blocked belief phenomenon offers a mechanism that could explain the correlation between climate change adaptation, on the one hand, and cultural or political value polarisation, on the other, theorised in the literature [15–18]. This underlines the need to empirically identify the drivers and decision strategies employed in responses to climate change by analysing real decisions.

Like the forest professionals studied by Blennow et al. [41], citizens who lack strong belief in the local impacts of climate change, or who lack strong belief that they have experienced the impacts of climate change, need communications that fortify those beliefs [42]. It should be noted, however, that mitigation decision-making is promoted by communications strengthening only negative (and not positive) beliefs in local impacts and only negative (and not positive) experiences of climate change (Figure 6). Decision-makers exhibiting tipping point thinking require communications on effective measures for climate change response. But while communications on such effective measures initiated in response to negative as well as positive impacts of climate change tend to favour adaptation decisions, only communications on effective measures initiated in response to negative impacts of climate change can favour mitigation decisions [42]. Notwithstanding the enormous importance of the mitigation of climate change, the fact that decision-making in favour of mitigation outnumbers decision-making in favour of adaptation shows that 'attention needs to be paid to the balance between decisions solving problems "here and now" and those focusing on the "there and then"' ([42], p. 1), (Figure 6).

2.2. Assessment of Vulnerability and Benefit to Foster Territorial Competence

The everyday decisions people make affect their ability to achieve their goals, but they often have an impact on the ability of others to achieve their goals as well. For example, a forest owner's decision to improve the drainage of water-logged forest soil to enhance tree growth, and a city dweller's choice of whether to use impermeable flagstones for a garden terrace, may both affect the probability of flooding downstream, e.g., [55]. To prevent negative effects of such tele-connections, a society might want to implement policies enabling trade-offs of benefits and risks for citizens in upstream and downstream areas, respectively. This could be particularly valuable if flood-mitigation measures turn out not to have been adequate up-stream, or if adequate measures for adaptation have not been put in place downstream. The elicitation of citizens' values provides an opportunity to discover any value conflicts and target planning to help citizens achieve their goals. Access to such information is necessary for planners if they are to make properly informed trade-offs between values and between groups of people with different value profiles.

How the trade-offs between values are to be made at a societal level is a political issue. There is currently little debate about what is at risk and what the adaptation measures should protect. Such debate could generate conflicts between individuals and groups as well as between individuals and society. Information on citizens' values will be needed if we are to assess vulnerability and benefits, and if we are to make suitable trade-offs. For instance, in order to know what to protect, policy makers and municipality officers planning adaptation to climate change need information about the values citizens have. They need to know whether, and if so how, those values are associated with locations in the landscape.

Tools designed for valuation of non-market services and commodities, such as ecosystem services, in monetary terms are popular, e.g., [56]. The main aim of assigning monetary value to such services and commodities is to enable the comparison of their values with other values, potentially in cost-benefit analyses and other decision tools. Using the market, or market simulation schemes such as contingent valuation schemes, to assign value is undoubtedly very useful, but it also has drawbacks. It tends to create a bias against certain value objects as well as against those who are less active in the market place and therefore also most vulnerable, see e.g., [56–59]. Democratic landscape planning requires a means of valuation that steers clear of this sort of bias.

Recent progress in value theory points to the importance of distinguishing between instrumental values (means) and end values (goals), e.g., [26–28,60,61]. Traditional polls tend to be misleading in that they do not distinguish these two types of value. The distinction is crucial, since it is only what is valued as an end, or goal, that has value in itself to respondents (we here assume that end value is individual and subjective). To value something instrumentally, or as a means, is strictly speaking to assign it value on the basis that it is useful for promoting end value. Typically, neither those who construct the questions nor those who answer them pay very much attention to this distinction, which makes it impossible to know what is of real value to the respondent, as opposed to being merely, so to speak, useful. This means we run the risk of providing what the respondent asks for rather than what (s)he really values.

This distinction between instrumental and end value—which is recommended by the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services [62]—implies that the two different kinds of value need to be identified and handled in different ways. An entity has end value (is a goal) if it has value in its own right, while it has instrumental value (is a means) if it is useful for the achievement of something else. Goals might differ from one stakeholder to another, and therefore they need to be identified in communication with stakeholders. By contrast, assigning value to means requires a knowledge of the ecosystem functions that is acquired through review of the relevant literature and/or by consulting experts. Together with assessments of the probability of events ("Assessment of the probability of an event" in Figure 2), knowledge of stakeholder end values can be used to assess both vulnerability and benefit in a spatially informed way (Figure 7), see [35].

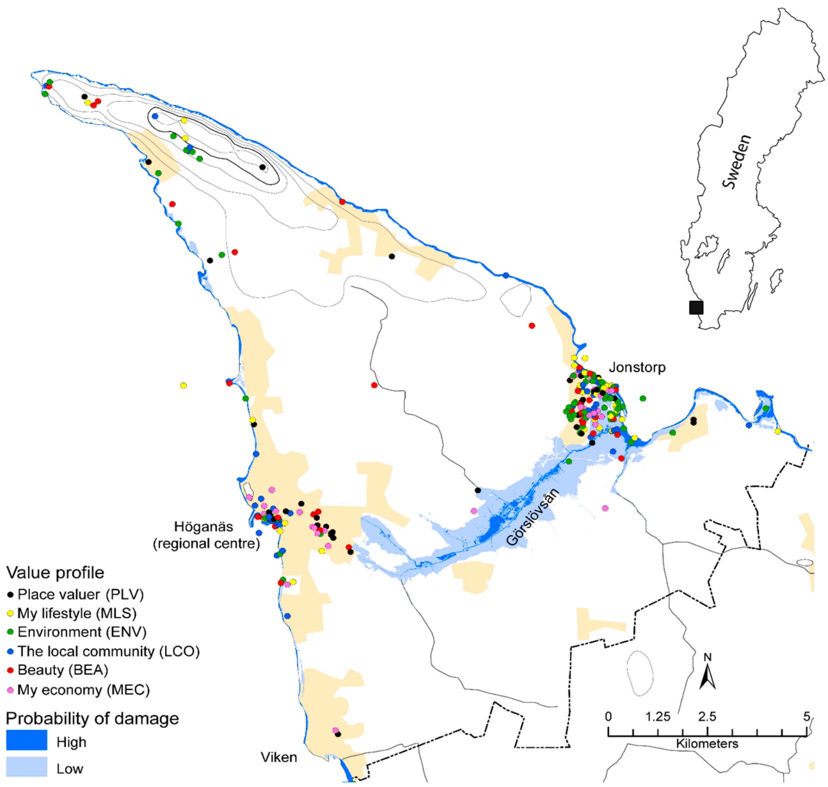


Figure 7. Value profiles and the probability of flooding in a landscape. Individuals´ value profiles in locations in Höganäs municipality, Sweden, displayed together with expert assessment of the probability of damage from coastal flooding. From Blennow et al. [35].

For example, a location that is chosen because it is used for walks might provide instrumental value to a respondent who values fitness as an end. The distinction has implications for spatial planning. Perhaps the respondent can go walking somewhere else and still get fit. However, if walking has instrumental value because it enables the walker to experience historical sites, which is what (s)he values as an end, the opportunities to substitute the location with another are likely to be considerably fewer.

Naturally, to collect and analyse relevant data we require appropriate tools. We shall now present a toolbox for collecting and analysing data that is relevant for Democratic Landscape Planning—a toolbox that produces new knowledge that can be used to organise and foster democratic and sustainable development.

3. The Democratic Landscape Planning Toolbox—DeveLoP

The Democratic Landscape Planning rationale we have presented focuses on the delivery of effective, democratic landscape planning that meets sustainability objectives by inviting citizens to participate in the planning process in an effort to identify and bridge the gaps between science, practice and policy. DeveLoP (Figure 8), the state-of-the-art Landscape Planning toolbox, provides a means of collecting and analysing information from a large number of people.

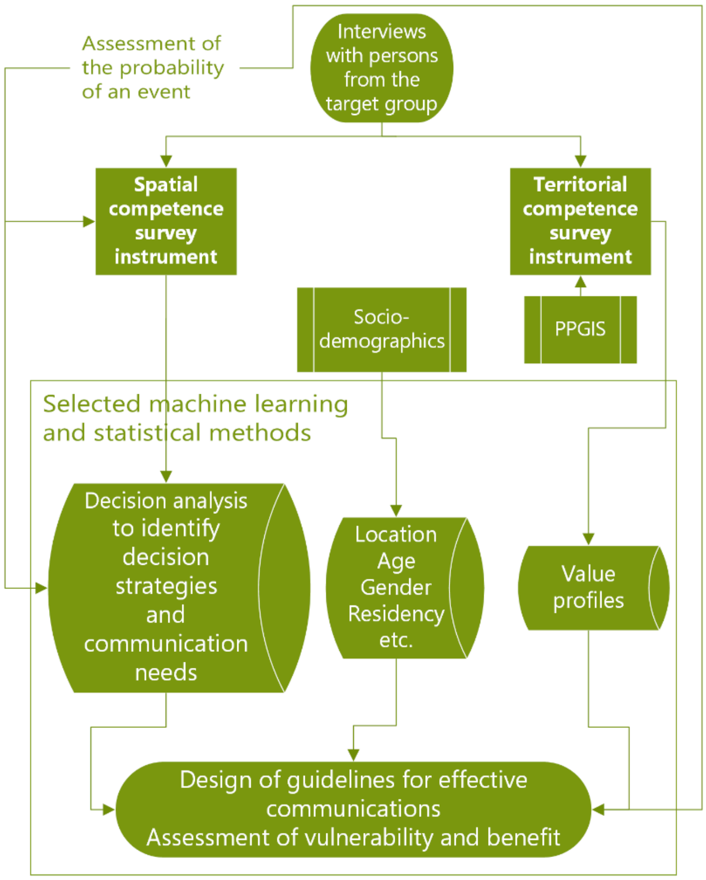


Figure 8. Flow chart of the democratic landscape planning toolbox.

It has been designed with two main objectives: (a) the design of guidelines for effective communications fostering spatial competence, and (b) the assessment of vulnerability and benefit fostering territorial competence. It includes two survey instruments and various tools that can be used in the analysis of the data these can be used to collect. In the following, we shall explain how DeveLoP can be used in relation to adaptation to climate change, but the tool can also be applied to decisions favouring mitigation of climate change, see [43], and indeed in relation to other spheres involving trade-offs, such as land-use change and biodiversity loss, which may or may not be being examined with climate change in mind.

It is often difficult for respondents to report on their values. They may not know exactly what their values are, and people's values are of course likely to change as they learn new things. Hence, at best we can expect to a snapshot of an individual's general value orientation and state of local knowledge at a particular time. Given this, data collection needs to be repeated over time.

3.1. Survey Instruments

The questions in the survey instruments (Figure 8) are shaped by the results of expert assessment of exposure to the impacts of changing conditions. Preferably, they are also informed by previous interviews with a sub-sample of decision-making agents in the target audience, e.g., [32,63]. Such interviews aim to provide mental maps showing how the interviewees understand the situation [64]. Following a useful published interview protocol, see [65], they also help to ensure that important aspects are covered, and that the questions are formulated clearly.

3.1.1. Decision Analysis

The survey instrument on decisions, beliefs and expectations (see Figure 8) provides data for analysing stakeholder decisions. The data are based on elicited beliefs about the Earth's system functioning, and on stakeholders' local expectations in a changing environment, see [41,51]. The survey instrument includes the questions below (for examples of questionnaires, see the supplements included by Persson et al. [51] and Blennow and Persson [42]). The responses to these questions have been found to be important in the identification of the drivers of decision-making in favour of acting in response to climate change:

(a) Have you decided in favour of mitigation/adaptation to (the impacts of) climate change? (Response options "Yes" and "No".)

(b) Do you believe in local impacts of climate change? (Response options arranged in a five or seven tier range from "Definitely not", through "I don't know", to "Yes, definitely".)

If a respondent does not strongly enough believe in the local impacts of climate change (s)he will not take measures to respond to climate change [39,40]. Here it is important not to ask separately about the strength of the respondent's belief in positive and negative local impacts of climate change. This is because people sometimes display "blocked beliefs" (described above in Section 2.1.3). Thus, the respondent's response to a question about one of the valences blocks his or her response to another question about the other valence, see [41]. When blocked beliefs occur, as may happen when questions on both negative and positive beliefs are asked, the responses are uncorrelated with adaptation decisions, and thus they are less useful for identification of communication needs.

(c) Do you believe that you have experienced local impacts of climate change? (Response options arranged in a five or seven tier range from "Definitely not", through "I don't know", to "Yes, definitely".)

Strong attribution of the causes of events to climate change of the sort observed when an individual attributes the experience of extreme weather events to climate change can fortify belief in the local impacts of climate change. It is useful to ask questions about how strongly negative as well as positive experiences are subjectively attributed to climate change, see [40].

(d) In your opinion, does climate change in your country lead to increasingly positive (negative) impacts on the following value objects? (Response options: "Yes, always", "Often", "Rarely", "No, never" and "I don't know".)

The assumption that the value objects selected, 1...n, may be impacted by climate change is based on scientific knowledge or the beliefs of the interviewees. By asking each sub-question about both negative and positive values of the expected impacts of climate change, the net value of those expected impacts (NVEI) and the value strength of expected impacts of climate change (VSEI) can be calculated, see [40]. For each sub-question, the respondent can choose between the response options: "Yes, always", "Often", "Rarely", "No, never" and "I don't know". The net value of expected impacts measure, introduced in [51] as the homogeneity of expected value, is calculated according to:

$$\textit{net value of expected impacts } = \sum_{n=1}^{n}\left(-a_{Negative} + a_{Positive}\right) \tag{1}$$

with the sub-questions 1...*n*, with "a = 4 if the response is "Yes, always" and a = 3 if it is "Often". Thus, negative and positive scores" are "assigned to negative and positive values of expected impacts, respectively. For any other response to these questions, a = 0. The values used to convert valuations expressed in words to numbers were chosen to reflect the number of alternative pre-defined answers to each question" Supplemental Text 3 of [41].

As described in [51], the homogeneity of expected values (i.e., NVEI, or net value of expected impacts), is thus a measure of how strongly climate change is expected to have determinately negative or positive impacts on all objects. An individual with a homogeneous set of expected values will expect that climate changes always, or often, lead to either a negative (net value of expected impacts << zero) or a positive (net value of expected impacts >> zero) impact on the objects. A person with inhomogeneous values, on the other hand, will expect that the impacts are sometimes determinately negative and sometimes determinately positive, or neither determinately negative nor determinately positive (net value of expected impacts = zero). For example, a person might expect positive impacts of climate change on" one value object "and concurrently expect negative impacts of climate change on another value object" Supplemental Text 3 of [41].

The VSEI (i.e., value strength of expected impacts) measure, introduced as strength of expected values by Persson et al. [51], was used to measure the value strength of the climate change impacts on the forest expected by the respondents:

$$\textit{value strength of expected impacts} = \sum_{n=1}^{n} \left(a_{Negative} + a_{Positive} \right) \tag{2}$$

with the sub-questions 1...*n*, with "a = 4 if the response is "Yes, always" and a = 3 if it is "Often". In this way, positive scores were assigned to negative as well as positive expected values. For any other response to these questions, a = 0" [41], supplemental Text 3. VSEI is the sum of the absolute values of strongly held positive and negative values of expected impacts of climate change.

Questions that enable calculation of how many effective measures for adaptation to climate change the respondent sees is needed. This includes presenting the respondent with a list of potential climate change adaptation measures and asking him or her how effective (s)he believes each to be, and then counting how many of the measures each respondent finds highly effective [41].

With Bayesian machine learning modelling, e.g., [63], the drivers and interactions of decision-making in favour of adaptation to the impacts of climate change can be identified. This is useful for linear as well as non-linear relationships, see [41,42]. By analysing the resulting model of NVEI, and making use of VSEI, information on the communication needs of the respondents can now be identified, see [41]. For example, respondents who do not expect the value of an object to be affected by the impacts of climate change may require communications on how climate change can affect the value object in question. Responses to additional questions on socio-demography can be used to extrapolate the results to groups of people sharing similar communication needs, see [41]. The results can be used to inform the design of guidelines on effective communications on, in this case, climate change, with the target group being that from which the respondents to the survey belong, see [41]. The effect of the guidelines can be evaluated by interviewing the relevant individuals, and asking them about their beliefs and decision-making, before and after being presented with the communications designed in accordance with the guidelines.

3.1.2. Value Elicitation

The survey instrument for value elicitation identifies end values and relates these to geographic locations to inform land-use management and planning (Figure 8), see [35]. This instrument can provide insights into what places are valued by the respondents and why. Together with the results of external assessments of exposure to the impacts of, for instance, climate change, this information can serve as useful input in connection with questions about societal trade-offs in protection from, or exploitation of, the impacts of climate change (Figure 6) [35].

The survey instrument procedure begins with a request, to the respondent, to identify the location that he or she finds most important in the area by marking it on an interactive map. Public participation geographic information system methodology (PPGIS), e.g., [66], is used. In Blennow et al. [35] each respondent was restricted to choosing just one location in order to minimise the time needed to respond to the questionnaire (2–15 min, depending on the number of end values chosen and the number of iterations required to reach the end values). However, this restriction can be relaxed: two or more locations can be chosen if preferred. The response options in the value elicitation module had been classified beforehand as instrumental or end values. After selecting the most important location, the respondent was asked a set of questions about why that location is important. The set was composed conditionally on responses to preceding questions until one or several end values were reached. In this way, the classification determines how a response is used in the tool. In Blennow et al. [35] the maximum number of answers (value objects) that could be selected in response to a specific question had been set to three in order to limit the time needed to complete the questionnaire.

Importantly, a procedure in which questions about why a location is important are repeated can reveal that the end value is quite different from what it appeared to be after the first iteration. For instance, applying this procedure, Blennow et al. [35] report that some respondents had chosen a location as the most important one because of its beauty (Figure 9). However, when several iterations of the question why the location was important had been completed it emerged that the beauty of the location was of instrumental value to the respondents because it benefited them personally financially (the end value). Perhaps the respondents ran businesses and had taken advantage of a beautiful location that helped to attract customers.

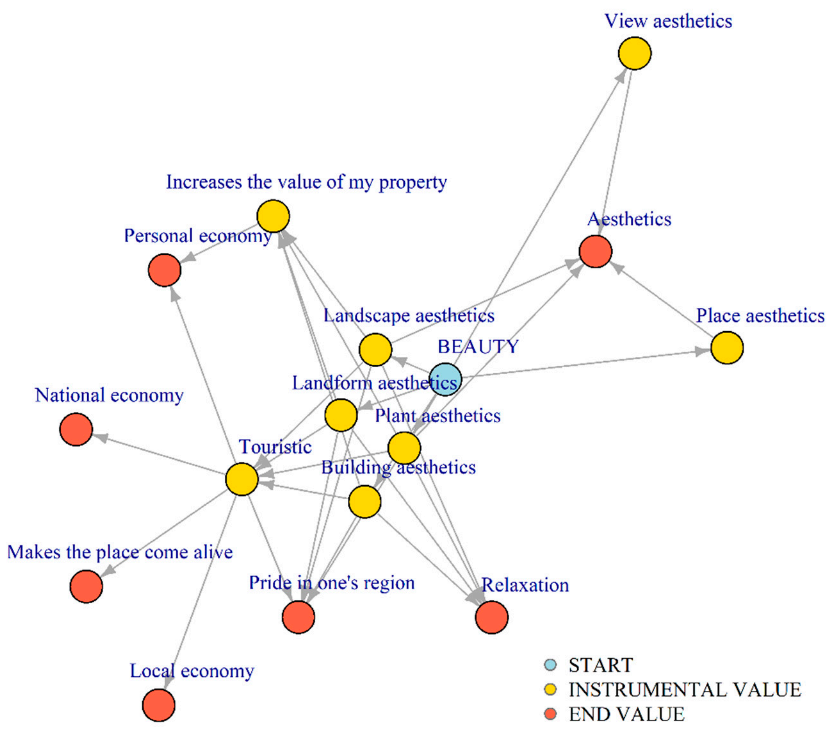


Figure 9. Principle for survey instrument to elicit end values. From Blennow et al. [35].

Once an end value has been identified, the respondent is asked to rate it on a scale of 1 to 7. Because respondents are known to use scales of measurement that are often non-linear, and which often differ between individuals [67], optimal scaling of the ratings can be useful, see [45]. The resulting relative interpersonal scale can help to compare the valuations of different respondents. The optimally scaled transformations can then be used to co-cluster the values and respondents. Value clusters can then be identified, and it can be shown how the respondents' valuations are loaded on these, see [45]. By clustering the individuals' loadings on the identified clusters of values, value profiles of groups of respondents can also be identified, see [45] (Figure 7).

4. Conclusions

The obvious weaknesses in sectoral conceptions of the often interconnected social, environmental and political challenges of landscape planning call for a holistic approach capable of providing effective communications that support local (and global) landscape-related decision-making. We have argued for an individuals-oriented landscape approach to sustainable land-use management and planning, highlighting its democratic strengths. Such an approach needs to find ways to take both scientific knowledge and the local knowledge of individuals, and indeed aggregates of them, into account. In addition, it must identify what is valuable to the different individuals involved and determine whether some of the values held by individuals are end values.

The DeveLoP rationale and toolbox we have presented here was designed to meet this need. It was developed using empirical evidence relating to a range of landscape types. It can be used to improve our understanding of individuals' trade-offs and decision-making in relation to specific decision problems. With that improved understanding, we can identify communication needs, and having done this design guidelines on effective communications to foster spatial competence of the individuals in a landscape. The elicited values provide territorial competence that will also help authorities to improve policies on spatial planning in a way that supports sustainable, democratic development.

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