PERSPECTIVE

Navigating the space between landscape science and collective action for sustainability: identifying key factors in information processing

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Abstract

Context   Transitions to more sustainable landscapes require that actors change their thinking about using the landscape and act collectively to implement a shared view on the future. If landscape ecologists want their knowledge to contribute to such transitions, the information they provide need to stimulate collective decisions and action.

Objective   To identify key factors that determine how scientific information about landscape functioning and benefits influences actors in organizing collective action for landscape sustainability.

Method   I combine a theory of knowledge management with a theory of behavioural change to construct a framework of 4 phases of interpretation and implementation of landscape information.

Results   The 4 phases are: (1) actors accept the information as significant, (2) actors assess the saliency of the information for their case, (3) the information stimulates social network building and collective action, and (4) the information enforces the capacity to organize collaborative change. The extent to which these phases effectively develop in the interaction between scientists and practitioners depends on characteristics of the information, but to a great deal also on the process of interaction and the roles scientist play. I discuss how landscape ecologists can intervene in these phases, by providing the right information and by facilitating an interactive process of knowledge generation.

Conclusions   Whether landscape information is eventually used in organizing the landscape change depends on characteristics of the information and the governance process in which the information is brought in. Knowledge from social sciences is indispensable for landscape ecology with impact.

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Introduction

The existence of a gap between science and practice that prevents a proper use of scientific information by practitioners is widely accepted in science (e.g. Burbridge et al. 2011; Tkachenko et al. 2017), including ecosystem services research (Wright et al. 2017), conservation biology (Toomey et al. 2017), landscape ecology (Opdam et al. 2018) and sustainability science (Miller et al. 2014). More research producing more information is not an effective solution (Fazey et al. 2014). Dominant beliefs about the causes of ineffective knowledge transfer are

shortcomings in the communication by scientists, and a lack of saliency and legitimacy of knowledge as perceived by potential users (Cash et al. 2003; Wright et al. 2017). These shortcomings are consistent with the so-called linear model of information transfer (Bertuol-Garcia et al. 2018), in which scientists inform policy and other societal stakeholders about their findings, but keep a distance to practice.

During several decades of research, an alternative two-way mode emerged, in which scientists and societal actors interact in the production and application of knowledge (Van Kerkhoff and Lebel 2006; Reed et al. 2014). Scientists learn how environmental information can be edited and presented to obtain knowledge that is helpful to practitioners in a particular context. In such collaborative knowledge production, scientific and practical knowledge meet and this generates new insights, including new solutions for future landscapes (Nassauer and Opdam 2008). However, in a recent review of ecology and conservation literature (including landscape ecology), Bertuol-Garcia et al. (2018) concluded that among environmental scientists the linear mode of information transfer is still prevailing. Examples based on this linear mode are the "evidence-based approach" (Pullin et al. 2004) and the analysis of 59 ecosystem service assessment methods by Wright et al. (2017). Examples of applying the two-way mode in environmental science are growing, though, and can be found in (among others) landscape science (Castella 2009; Bohnet et al. 2011; Opdam 2019), sustainability science (Brandt et al. 2013), natural resource management (Shackleton et al. 2009), and adaptive governance (Wyborn 2015).

In the context of this special issue on sustainability through the lens of the landscape, the implicit assumption is that landscape ecologists wish to have a positive impact on the transition towards a more sustainable landscape. To learn more about what landscape ecologists need to do to have this impact, it is useful to know what determines success in attempts to move towards a more sustainable land use practice. In an empirical analysis of 46 case studies, Raquez and Lambin (2006) suggested three groups of factors associated with having such an impact: information of the state of the environment, motivation to manage the land in a sustainable way, and capacity to implement the required change. In stimulating motivation, the most important factors were local attitudes and values

with respect to the local environment, the balance between monetary and non-monetary benefits, and to what extent divergent interests among actors could be reconciled. To enhance capacity, the most prominent factors were inspirational leaders, a high level of social capital and well-developed skills and technologies to manage natural resources. What this study shows is that the impact of scientific information on transitions towards sustainability is mediated by a range of factors. As sustainability is a normative concept (Opdam et al. 2018), actors discussing landscape change trajectories have diverging opinions about which benefits should be obtained from the future landscapes. Landscape information on sustainable use should therefore help to bridge these differences. A way to do this is by providing information about the range of services a landscape area has to offer and how these services are connected to the functioning of landscapes (Termorshuizen and Opdam 2009). Westerink et al. (2017) have shown that such information may help actors with diverging views to converge towards a common goal and develop collective action. So scientific information should eventually result in collective behavioural change, in human communities making other decisions about using and managing the landscape than they did before (Miller et al. 2014). To achieve this impact, providing scientific evidence alone is not sufficient (Palmer 2012), but requires knowledge brokering (Turnhout et al. 2013).

So this view shifts the focus on the science-practice gap from a one-way "scientists provide information to society" towards a two-way effort to "navigate the space between research and implementation" (Toomey et al. 2017). By navigating, scientists learn to understand how people respond to scientific information, and how they transform such information in a collaborative landscape change process. With this essay I seek to contribute to this insight among landscape ecology scholars. My aim is to identify key factors that determine how scientific information about landscape functioning and the resulting benefits influences behavioural change towards landscape sustainability. I recognize that information is only one of many factors that determine decision making for sustainable action. To limit the scope of this essay I will only briefly refer to those other factors, for example policy incentives, economic conditions and regulations based on national and international law. In

identifying the key factors I will draw firstly on several theories concerning the processing of information and its impact on behavioural change. Then I will consider how scientists may use these factors as reference points to navigate the space between science and practice. The main message is that to have an impact, landscape ecological evidence needs to be presented in a two-way approach in cooperation with practitioners.

Constructing the conceptual framework

The context of this essay is collaborative adaptation of cultural landscapes for sustainability (Opdam et al. 2018). Cultural landscapes combine private interest (people have properties, farmers generate income) and public interest (water retention, health, clean air etc.). Because of these multiple interests, landscape adaptation is a collaborative endeavour (Lefebvre et al. 2014). Collaboration is also required because many landscape benefits depend on landscape level processes. Therefore, a transition towards a sustainable landscape requires a common view on which future landscape is most desirable and which coordinated interventions make the landscape future-proof.

In this line of thinking, I will explore how information brought in by scientists in a collaborative landscape adaptation process interacts with the actors (I prefer this term over the more passive "stakeholder"). Collaboration refers to interactions between scientists and practitioners as well as to interactions between actors. I use the term scientific information to describe data, insights and tools produced by scientists, while knowledge refers to the interpreted and transformed information as generated in the collaborative process. Landscape ecological information is limited here as information about how landscapes produce benefits. Such information should inform actors in the local landscape about how the physical landscape can be adapted to generate a desired value. For example, if a better pollination service is desired, the management of road banks and field margins can be optimized to achieve more flowery plant species. Termorshuizen and Opdam (2009) have coined the form-function-value knowledge chain to connect the physical conditions of the landscape to the benefits as perceived by the actors in the local community. I will draw on this idea.

For landscape services information to cause a behavioural change, it first needs to be accepted as significant and relevant: significant with respect to the challenge that is faced; relevant with respect to its appropriateness in the local situation. A useful model for acceptance of environmental information by actors in a collaborative process was proposed by Cash et al. (2003). This is based on a thorough analysis of information transference in 5 cases. Apart from the fact that the paper is cited nearly 3000 times, I have chosen this model here for its simplicity. Cash et al. proposed that three factors determine whether knowledge is accepted by actors who are engaged in a complex decision processes. These three factors are: credibility, saliency and legitimacy. Credibility is related to the adequacy of the evidence and the arguments, saliency is related to the appropriateness of the knowledge to apply in the particular case at hand, and legitimacy comes with the perception that the knowledge is produced with respect to the values and beliefs of the actors. Apart from characteristics of the information itself, these factors depend on what is called boundary management: activities in the interspace between scientists and practitioners with the aim to bridge different views and interests. Examples are two-way communication processes to increase transparency, trust and mutual understanding, and also the inclusion of local data and insights in knowledge tools.

If the knowledge is accepted as significant and relevant, what determines its impact on behavioural change? For a theoretical model describing the impact of information on behavioural change I will draw on Ajzen's (1991) theory of planned behaviour. The basic proposition is that the response of an individual can be predicted by the intention to perform the behaviour and the belief that the individual is able to do so (control belief). Intention emerges from an interaction between the individual's attitude (with respect to values) and dominant normative beliefs in the individual's social network. Based on these propositions, Ajzen suggested three factors to influence individuals to change their behaviour: values and attitude, normative beliefs and control beliefs. (1) Values correspond to very general normative ideas about what is desirable and good. Attitude refers to opinions and behaviours based on these values. For example, a person who cares about a sustainable future will be more receptive to information about landscape services than one who primarily cares about making fast

money. Legitimacy of information as proposed by Cash et al. (2003) is related to these attitudes and values. (2) Normative beliefs determine the degree to which the individual perceives that significant people or groups in his or her network approve the change of behaviour. For example, farmers are more inclined to create flowery strips in their fields for enhancing natural pest control if their neighbours do the same (Grashof-Bokdam et al. 2017). (3) Control belief is related to the availability of resources (knowledge, finances) and the socio-economic limitations.

The theory of planned behaviour was born in the field of social psychology, but has been widely applied in multiple fields of science. Examples of topics investigated are the dissemination and implementation of evidence-based practices in human health (Burgess et al. 2016), the homebuyer's willingness to purchase a dwelling with a sustainability certification (Judge et al. 2019), and consumer intentions to buy food in short food-supply chains (Giampietri et al. 2018). In the landscape ecology domain, Opdam and Steingröver (2018) applied the theory to explore how companies could be engaged in landscape-inclusive solutions to sustainability.

Based on the combination of the two theories I identify 4 steps in the interpretation and implementation of information that are conditional to induce behavioural change.

1 The actors accept the information as being significant to their interests, because it aligns with their values and is perceived as credible and legitimate (based on Azjen and Cash).
2 The actors accept the information as salient and therefore useful to apply in their case (based on Cash).
3 The information enforces social network building and influences subjective group norms about the common interest of collective action for sustainability (based on normative beliefs proposed by Azjen).
4 The information contributes to the capacity to organize change and thereby fosters the belief that action for change is feasible (based on Azjen).

These In the following paragraphs I illustrate each of these four conditions with reference to information about landscape services.

When do actors accept landscape services information as significant?

When actors are told about the advantages of landscape services as a goal to improve sustainability, people's values determine how the information is processed. Actors differ in their values with respect to landscapes (Swanwick 2009). While some people support the historic-cultural narrative, others lay their finger on the natural character and still others see the landscape as a socio-economic arena. Steg (2016) distinguishes 4 types of values: hedonic values (related to enjoyment and reducing effort), egoistic values (related to personal wealth such as money and status), altruistic values (related to other people's benefits) and biospheric values (related to consequences of choices for nature and the environment). Actors who rank these values differently also differ in how they receive information. An example is the experiment by Bolderdijk et al. (2013). They showed a film on the environmental impact of bottled water to two groups which differed in their ranking of biospheric values. Seeing the film led to the intention to decrease the consumption of bottled water, but only in the group with strong biospheric values. In another experiment, Opdam et al. (2015b) told three groups of students different storylines about the future of a landscape, and asked them to add landscape elements to a map consistent with a more effective provisioning of preferred landscape services. One storyline emphasized an economic scenario based on production services, a second one followed a sustainability frame highlighting water regulation, and the third one focussed on social services including recreation and biodiversity. Also the students were asked to allocate a budget. Both the social and sustainability group predominantly decided for measures that were consistent with the storyline they had been told, but the group that listened to the economic narrative did not, probably because biomass production did not align with the values of students who had chosen for an environmental education. These experiments illustrate that information is accepted as potentially significant if it aligns with the values of the recipient.

When do actors accept the information as being useful to apply in their case?

Discussions in scientific literature about the science-practice gap often refer to the importance of the saliency of information (Cash et al. 2003). Saliency refers to the degree the characteristics of the information allow its application in a particular case. Saliency is limited when the information cannot be linked to the local landscape or the right spatial scale, or when the information does not match the type of decision making, for example when an assessment tool is forwarded while the decision making process is in a phase of creating solutions (Opdam et al. 2018). An analysis of priority questions for the sustainable management of cultural landscapes in Europe by Hernández-Morcillo et al. (2017) suggests that scientists have not the right picture of what practitioners need. While policy makers were more interested in questions about the local application of landscape services, scientists preferred to investigate abstract issues such as integrating landscape service values. To increase the saliency of ecosystem service assessment models, Olander et al. (2017) advocate the use of Benefit Relevant Indicators (BRI's) that link "ecosystem functions and measures of natural values that people value" (p. 180). By organizing collective activities to discuss and apply scientific tools, researchers can learn what makes their information more salient. The use of BRI-like criteria could be further advanced in the two-way approach allowing scientists to learn from the application in practice. Pouwels et al. (2011) discussed maps created by spatially explicit models that describe the interaction between recreation use and bird conservation aims in the New Forest area in the UK. This resulted in adjustments of the model that improved its applicability in the local context, and resulted in actors accepting the model as an adequate description of the relationship between recreation patterns and breeding bird distribution in the area. This example illustrates that actors accept landscape information as salient if they recognize how it helps them to understand the functioning of their local landscape from the point of view of their interests, and how it helps them to create improvements of their local landscape.

When does the information enforce social network building and insight that collective action is of common interest?

Ajzen (1991) argued that the intention to change is partly determined by subjective norms in the social network of the individual. Individuals let their decisions depend on what people who are important to them think, for example friends, relatives and neighbours. Subjective norms develop within social networks. Information by scientists can help to extend the social network and can influence group thinking. Informing actors about how they depend on each other for implementing landscape improvements stimulates their willingness to collaborate (Opdam et al. 2016). In a collaborative workshop about adapting a landscape to Vos et al. (2018) provided information about how landscape adaptation measures lead to shared values. The increased level of collaboration made people change their mind and adopt a positive intention to take measures. This case illustrates that by building stronger relationships in landscape actor groups through information about the common benefits of landscape services, individuals feel more support and approval by group members, which increases their willingness to engage in the adaptation of the landscape. It also shows that for information to play this role, it needs to be provided in a collaborative process.

When does the information enforce the capacity to organize change?

What if actors in a landscape transition process have become aware of the need to change, and found their friends and peers approving the chosen solution, will they then act accordingly? Ajzen (1991) proposed that the intention to change a behaviour could turn into action if individuals believe that they are in control of the implementation. Variables associated with control include certainty about the finances and the power required to move forward, certainty that suggested measures are effective and feasible, certainty that the required support will be provided or that policy regulations are not limiting. Some of these aspects of control belief can be supported by scientific information about landscape services. For example, collective mapping methods and design rules for green infrastructure were helpful to farmers in locating the best

places for adding landscape elements for natural pest control (Steingrover et al. 2010). Other types of information are also pivotal. Farmers who are willing to change may improve their control belief by discussing cost-benefit ratios. Also, informing them about successful cases may strengthen the control belief. More than in the previous steps, landscape information is only one of the building blocks. Whether landscape information contributes to a behavioural change depends on the combination with information from other fields of science, for example with economic parameters. Also, this impact depends on trust building, social learning and the creation of new relationships (Horlick-Jones and Sime 2004; Armitage et al. 2009). One of the advantages of using landscape services is that the concept leads to distinguishing actors who demand a particular service and actors who are able to supply the service on their land. The creation of such roles have facilitated negotiations between a group of farmers and regional governmental bodies, resulting in arrangements for payments of landscape services (Westerink et al. 2017). These examples show that, if presented in a well-organized collaborative process, landscape information may contribute to the capacity to change.

Key factors for navigating the science-practice space

In the previous chapter I argued that for landscape scientists to have an impact on a collective landscape adaptation process, information about landscape benefits need to comply to 4 conditions. The information needs (1) to make a connection to the values of the actors and (2) to be salient in the context of the case. Furthermore, the information must (3) stimulate social network relationships and influence subjective group norms about sustainability (4) and must enforce the capacity of the group of actors to organize change. These conditions are based on the assumption that the information is provided by scientists and that actors believe it comes from a trustworthy source. I have also argued that the impact of landscape information is enforced if it is provided as part of a collaborative and interactive process, particularly with respect to condition (3) and (4). These insights are depicted in Fig. 1.

To ensure that the information is considered trustworthy, researchers need to be transparent about data collection, interpretation and Cravens and Ardoin (2016) concluded that trust in scientific information is not so much a characteristic of the information itself or of the way it has been generated, but rather the outcome of a process of discussion and social learning in which scientists and practitioners take part. To improve the level of trust in spatial information, actors in a workshop can be asked whether they recognize the information on a map being consistent with their own experience. Steingrover et al. (2010), facilitating a group of farmers who aimed for natural pest control on their arable fields, shared the uncertainty in the design rules for green infrastructure with the farmers, and asked them how to deal with it, thereby making it possible for the farmers to take responsibility for the risk of pest outbreaks after implementation.

What can landscape ecologists do to improve their performance? In Table 1 I propose 4 key activities based on the 4 conditions and illustrate these with two examples of possible action by scientists: one example is about the information, the other one about an organized activity in which scientists and practitioners work together to create trust, understanding and shared knowledge. These examples are taken from my own experience. *The first activity* aims to get the information about landscape benefits accepted by actors with variable values. To this aim landscape benefits should be connected to the assumed personal interests of the actors. For example, the information about landscape services could be expressed in terms of both the egoistic and biospheric values (Steg 2016), as in the experiment by Opdam et al. (2015b). Climate change impacts on the water system in a landscape can be framed in terms of costs to households caused by flooding, and in terms of dying trees and loss of biodiversity due to extensive drought. Another way of connecting information to personal interests is to ask actors at a round table what the information means to them personally. In a recent community-based process to adapt a landscape to climate change-related weather extremes (unpublished data), the actors were first given information about the expected risks and predicted changes, including the effects on biodiversity and the risk of damage to their houses due to extended dry periods. Then, in round table discussions, they were asked to tell each other about what these changes would mean to them personally. I suggest that
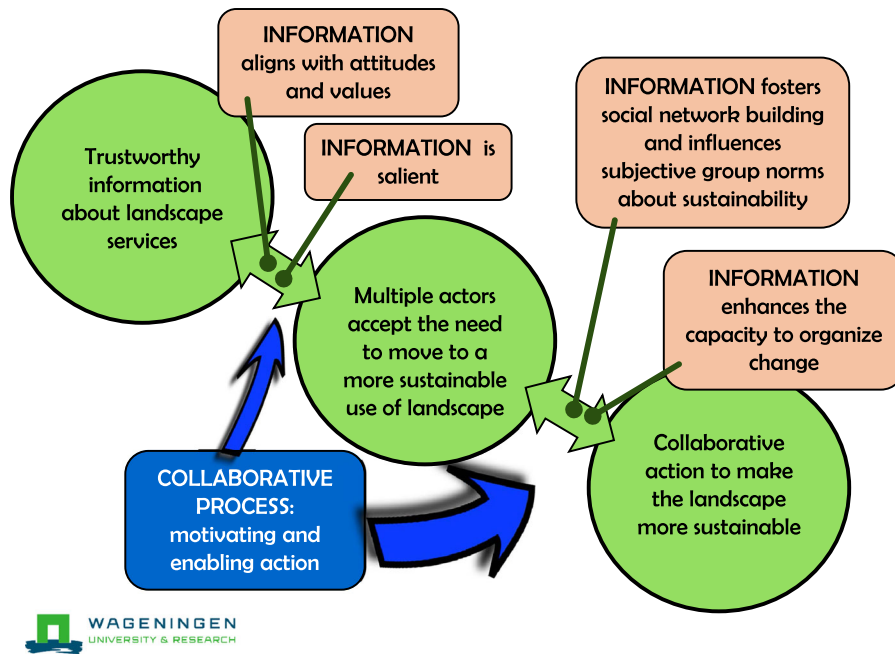
Fig. 1 Information provided by scientists in a collaborative landscape adaptation process contributes to action to create a more sustainable use of the landscape in two steps. Each step is enhanced by information in two ways. Organizing a collaborative and interactive process in which the information, provided by scientists, is collectively developed, increases the impact of information on creating change for sustainability

Table 1 Key activities associated with the 4 conditions for information processing as distinguished in the text

	Key activity scientist	What to do? (examples)	References
1	Frame information to address the variation of values	Select indicators that connect to the variety of values	Opdam et al. (2015b)
		Organize a workshop to ask: what does the information mean to you?	
2	Create saliency of information during interactive process	Use the form-function-value chain for linking aimed value to concrete measures in the landscape	Westerink et al. (2017) and Pouwels et al. (2011)
		Organize sessions to interpret the information in the local context, e.g. collaborative mapping of Landscape services.	
3	Stimulate cooperation and social network building	Inform about links between individual and common interests.	Opdam (2019) and Vos et al. (2018)
		Organize workshop in which actors discover that to reach their goals they are interdependent and have shared benefits.	
4	Enforce the capacity to implement the change during interactive process	Provide design rules for actors to determine which measures in which locations are most effective.	Steingrover et al. (2010) and Westerink et al. (2017)
		Facilitate workshop in which actors develop a common vision.	

such activities help the actors to connect the information to their personal interest and thereby foster that the information is recognized as significant.

The *second key activity* is about creating salient information. One aspect of saliency is that the preferred added value of improved services can be translated into feasible physical changes, such as

adding landscape elements or adapting a water course. Ideally this relationship could be presented in the form of a cause and effect curve that relates value to measure (Termorshuizen and Opdam 2009). Such a curve facilitates negotiations between actors about how much should be done in the landscape. Alternatively, one could inform about the minimum required conditions for sustainable provision of the preferred landscape services (examples in Steingrover et al. 2010; and Westerink et al. 2017). Interactive tools can be made more salient during a cooperative process with actors who reflect on how the information connects to the local case (e.g. Pouwels et al. 2011).

In *the third key activity* bonds between the actors and collaborative actions are stimulated. This can be done by information that shows that a personal interests can only be achieved by collaborative action, for example that improving water management at a catchment level requires collective measures (review by Opdam et al. 2016). Obviously, collaboration is also fostered by workshops in which actors get to know each other and are facilitated to perform collective actions, such as drawing green infrastructure elements on a map. For example, collaborative mapping of landscape services (Raymond et al. 2009; Fagerholm et al. 2012) is a promising way to strengthen the social interactions in a local community.

The *fourth key activity* entails facilitating action to move to a more sustainable landscape. In my experience, creating a common vision on the long term future of the landscape area effectively stimulates common understanding of shared interests; motivates to turn into action, and enforces collaboration. It is easier and more energizing to agree on long term goals than to solve short term problems. This insight is incorporated in process facilitation techniques based on appreciative enquiry (discussed by Liu and Opdam 2014 in the context of landscape services) and GIS-based back casting approaches (Haslauer et al. 2012). The use of landscape services as a boundary concept (Opdam et al. 2015a; Westerink et al. 2017) creates a level playing field for negotiations. Obviously, economic incentives, for example provided by the government, bear an improved willingness to invest in landscapes for added value. A well-known example is the payment for biodiversity in the agri-environmental schemes (Prager et al. 2012).

Discussion and conclusions

This perspective essay starts from the notion that a key aspect of landscape sustainability science is the involvement of practitioners from a landscape area in a collaborative process, in which sustainable solutions for future challenges are created. In this collaboration, scientists and practitioners generate salient knowledge that recognizes the values of interest groups in the local community (Lang et al. 2012). In this essay I have identified key activities that may be helpful for landscape ecologists to navigate the space between science and practice in moving towards landscape sustainability. By combining theories of knowledge management and behavioural change with insights from literature and my own experience, I found the following four key factors to determine the impact of landscape service information in a collaborative landscape adaptation process:

1 The degree to which the provided information aligns with personal attitudes and values of the actors,
2 The perceived saliency of the provided information with respect to the problem to be solved and the landscape area of the case,
3 Whether the information stimulates collaboration between the actors,
4 The degree to which the information improves the capacity of the actors to organize the landscape change.

I have shown that these factors depend on characteristics of the information as well as on the social process in which the information is interpreted and transformed. These insights are corroborated by the work done by Raquez and Lambin (2006), who analysed 46 case studies in which sustainable land use practices were adopted or land use had been sustainable over a long period of time. These cases come from all rural regions all over the world and range from local to national spatial scale levels. Although this study does not specifically focus on the contribution of scientific information in these land use transitions, the results are relevant in the context of this essay. The authors suggested three groups of key factors that determine whether the land use was sustainable: factors making people aware of the need to change, factors that increase the motivation to change and factors that enhance the capacity to

implement the change. Cultural factors are associated with 87% of the cases, showing the importance of attitudes and values. The authors also emphasize the importance of social capital and collaboration as part of the capacity to organize change (78% of the cases). In addition, economic incentives play a key role (87% of the cases).

With cultural factors being of such a great importance, it is obvious that the insights generated in this essay cannot be generalized at this stage. I have heavily leaned on my personal experience accumulated in more than 20 years of cooperation with practitioners, predominantly in The Netherlands. This view leads to assumptions about the willingness of actors in a landscape process to cooperate that may not apply to other countries. Arguably Dutch people have built a culture of cooperation and are possibly more than average inclined to work towards a shared solution. So there is a need for studies in other countries. An analysis of five Swiss case studies (Menzel and Buchecker 2013) found support for the effect of discussing the benefits of landscape measures on collective learning, but also pointed to the huge time investments necessary for people to accept paradigms changes. Shirk et al. (2012) gave an American perspective on the added value of collaborative approaches, particularly in "natural resource management where actions must respond to integrated social-ecological needs with diverse understandings and knowledges". They concluded that as a new branch in science, this type of approach is just at the beginning of building a scientific basis. Thus, my proposition for the 4 key factors in navigating the science-practice space is offered here for further learning and research in landscape science and practice.

One possible approach is using the theory of planned behaviour to analyse behavioural change in landscape case studies, as examples in other disciplines of science show. Qi and Ploeger (2019) created a statistical model that explained 83% of the variation in perceived consumer intentions to buy green food. To achieve this result, the researchers extended the basic model proposed by Ajzen with two factors: personal characteristics (such as gender, education level, age) and a person's confidence in green food. Opdam et al. (2015b) adapted the theory of planned behaviour to study the impact of information about landscape services on actor's decisions to change the

landscape. Other social science theories may be helpful to landscape ecologists as well. For example, Schuttenberg and Guth (2015) used the theory of change in combination with the theory by Cash et al. (2003) to specify the capacities and mechanisms in knowledge co-Meyfroidt (2013) gives an overview of social theories that could be useful for landscape ecologists. Clearly, there is a merit in building cooperative relations with social scientists.

Next to gaining more insight into the processing of landscape ecological information, landscape ecologists could improve their capacity to organize knowledge co-production processes. During a collaboration of scientists and practitioners the scientific information evolves due to the interaction with knowledge of the local landscape and values of local actors. This evolution of information can be an interesting subject of study, for example to learn about possible misinterpretations and to study the impact of information on social Opdam (2019) discussed how during such sessions scientific information about landscape services played a role in building collaborative relationships. Innes and Booher (2016) gave a very useful set of conditions under which such a science-practice coproduction process can be rational.

The aim of this essay is to make landscape ecologists more aware that to increase the impact of their science, they should develop more insight in what the evidence of their science does in social processes at the local landscape scale. The 4 key factors may help to ask questions about this role. Landscape scientists who want to contribute to sustainability may improve their performance by gaining more insight in attitudes and values of actors, and in the various meanings these actors give to the concept of landscape sustainability. They may also benefit by developing methods to integrate scientific and local information to increase the saliency of scientific information. And finally, there is a need for methods and competencies to interact with actor groups in a variety of circumstances. I hope this essay may be helpful in developing a greater impact of landscape science in developing more sustainable landscapes.

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