

Decision making in complex land systems

outline of a holistic theory of agency

Christensen, Andreas Aagaard; Van Eetvelde, Veerle

Published in:
Landscape Ecology

DOI:
[10.1007/s10980-024-01822-2](https://doi.org/10.1007/s10980-024-01822-2)

Publication date:
2024

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Christensen, A. A., & Van Eetvelde, V. (2024). Decision making in complex land systems: outline of a holistic theory of agency. *Landscape Ecology*, 39(3), Article 72. <https://doi.org/10.1007/s10980-024-01822-2>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

Take down policy

If you believe that this document breaches copyright please contact rucforsk@kb.dk providing details, and we will remove access to the work immediately and investigate your claim.



Decision making in complex land systems: outline of a holistic theory of agency

Andreas Aagaard Christensen ·
Veerle Van Eetvelde

Received: 12 March 2023 / Accepted: 26 December 2023
© The Author(s) 2024

Abstract

Context Models of human agency within research on land systems and landscapes do not fully account for social and cultural factors in decision making. Conversely, within social theory, parallel concepts of agency do not fully take biophysical and spatial factors into account. This calls for a synthesis of conceptual models addressing human decision making in land systems.

Objectives The review identifies parallels between social and ecological perspectives on humans as co-constituent parts of complex land systems. On this basis selected models of agency combining insights from social theory and land systems research are outlined and compared, and improved concepts are outlined.

Methods Elements of agency in modern agricultural land systems are reviewed. A case study illustrating the application of agency concepts in an analysis of

decision making among farmers on the Canterbury Plains (New Zealand) is presented. On this basis it is discussed how to improve understandings of human agency in land systems.

Results The review identifies and compares parallel conceptions of agency, practice and holism in landscape ecology and social theory. Taking the agency of farmers in contemporary agricultural landscapes as an example, theories currently used to characterise and interpret the agency of farmers are discussed and improvements considered. Potentials for improvement of current conceptual models are indicated and discussed, and an improved model of agency is suggested.

Conclusions Based on the review, the article presents an improved conceptual model of agency in land systems emphasizing the position of agents in social-ecological contexts of action.

Keywords Agency · Social-ecological systems · Environmental modelling · More than human geographies · Land systems science · Ecology, Landscape management · Social theory · Values and aesthetics · Holism, Natures contribution to people

A. A. Christensen (✉)
Department of People and Technology, Roskilde
University, 4000 Roskilde, Denmark
e-mail: anaach@ruc.dk

A. A. Christensen · V. Van Eetvelde
Department of Geography, Ghent University, 9000 Ghent,
Belgium

V. Van Eetvelde
Department of Geosciences and Natural Resource
Management, University of Copenhagen,
1958 Copenhagen, Denmark

Introduction

Human agency in complex land systems: a double perspective

It is a characteristic feature of living systems that they consist of components interacting within nested hierarchies with aggregate and emergent functionality manifesting at multiple scale levels. These are studied in a wide variety of research fields from earth systems science, environmental geography, landscape ecology, systems biology and ecology to sociology, anthropology, economics and sustainability science (Holling 2001; Rescia et al. 2012; Preiser et al. 2018; Steffen et al. 2020; Petrosillo et al. 2021). These fields essentially deal with instances and types of the same phenomena: complex systems manifesting at various spatial scales and levels of hierarchy, characterised by aggregations or “wholes” with emergent properties that “cannot be predicted from what is known about the parts and their interactions” (Chapman and Batty 2020). In such systems, agency is dispersed spatially and structurally (Gerrits 2023). An example is land use systems where individual farm holdings are embedded within patterns of land use and land cover, constituting wider ecological and economic systems (Zonneveld 1995; Turner et al. 2021). Here agency taking place in one locality is interrelated systemically with agency in other localities (Liu et al. 2019; see also Giddens 2001), for example when land users share a resource, produce outcomes with aggregate ecological effects or engage in the same markets. Individual agents and groups of agents are processing local information and decision conditions adaptively as they interact to co-constitute system-wide confluent, aggregate and emergent effects, which can be analysed from a landscape or land systems perspective (Rescia et al. 2012; Salvati et al. 2015) and from the perspective of social systems (Eidelson 1997; Lansing 2003).

How the local scene is experienced, understood, valued and assessed by agents locally is significant to understanding adaptive system dynamics. The understanding of the world from the agent’s vantage point is important because it is a co-determinant factor of local decision making, action and reaction—and hence wider system dynamics (Kok et al. 2021). One example is the variety of strategies and actions incurred when land users are confronted

with system-wide changes in decision conditions, for example price fluctuations of output products, new regulations and changing climatic conditions, which can inspire highly varied strategies based on the individual agents’ situation, aspiration and character (Arbuckle et al. 2015; Sorvali et al. 2021). This illustrates a need to understand agents from a local, situated perspective, emphasising how individuality and differentiation between varying situations and cultures may explain decision making, while retaining a systems perspective (Sauer 1925; Wu 2010). As such, situational constraints and opportunities present to agents (such as resources, ecologies, technologies etc.) need to be taken into account as independent factors of decision making (making certain actions and effects possible), alongside “beliefs, values and preferences of people who live in the landscape” (Opdam et al. 2018) which co-determine how situations are understood, evaluated and inspire agency.

As such, human agency in complex land systems requires conceptual models that take the empirical world into account both from the inside perspective of agents conducting action sequences in ways they experience as meaningful in situ, and from the outside perspective of observers recording resources, infrastructures, mechanisms, limits, potentials and conditions for actions. Such a model of agency would support analysis recognising the deeply entangled yet incongruent natures of human subjects (understood from a situated, local perspective) and objects (understood from a desituated, systemic perspective). A strong concept of agency needs to encompass both in order to deliver coherent accounts of anthropocene ecologies where humans play a major role, given that both are important factors for processes of human cognition, decision making and action driving land use. In this context, to “understand the ‘point’, the meaning or purpose of what is said or done is distinct from being able to explain it as a quasi-natural process” (Outhwaite 2000). These two components of human agency are commonly understood to reflect the immersion of agents in social systems and land systems respectively (Angelstam et al. 2021; Turner et al. 2021). However, despite increasing recognition of the fact that human societies generally incorporate and depend on land systems (Diaz et al. 2019) and the fact that most land systems today are managed by people and thus fall into both of the above categories (Ellis 2021), an integrated conceptualization of the

combined immersion of agents in social *and* ecological wholes has yet to be developed.

This article identifies and reviews outlets for an improved definition of human agency in the current literature on land systems and social systems, emphasising parallels and linkages between social and ecological perspectives on how humans may be understood as a co-constituent part of complex land systems. The review outlines similarities between social and ecological holisms—i.e. theories of agency stressing how humans are part of larger wholes with emergent functionality. Selected elements of agency in modern agricultural land systems are reviewed. A case study illustrates the application of agency concepts in an analysis of decision making among farmers on the Canterbury Plains (New Zealand). On this basis, it is discussed how concepts identified in the literature may inform the improvement of concepts of human agency in modern agricultural land systems and what perspectives this hold for the wider field of research dealing with complex land systems managed by humans.

Outlets for a new approach to agency in land systems: challenges and potentials

Recent research within landscape ecology, land systems science, environmental geography and cognate fields has emphasised ways to overcome the conceptual discrepancies outlined above by merging conceptual models of social and physical systems into joint domains of research, for example under the heading of social-ecological systems and integrated land systems research (Guerrero et al. 2018; Meyfroidt et al. 2022). However, progress is hampered by the fact that conceptual dualisms between human and non-human components of land systems continue to be reproduced, also in research explicitly challenging such ontological delineations. Paradoxically, the very concepts proposed to overcome dualisms by joining together social and ecological ontologies appear to reproduce those same distinctions, given that “dominant metaphors—cultural landscapes, social-ecological systems, human impacts, human interaction with the environment, anthropogenic climate change—all contain within them a dualistic construction of humans and the non-human world” (Head 2012). As such, it is becoming increasingly clear that a fundamental shift in theoretical vocabulary

may be necessary to escape the many unproductive binaries previously thought of as sources of agency, with conceptual pairs such as nature and culture, environment and society, wild and managed, original and designed, pristine and disturbed, physical and social, situated and desituated being the most prevalent (Cronon 1996; Wu 2010; Pawson and Christensen 2014; Ellis 2015; Lorimer 2015; Head 2017; Guerrero et al. 2018; Dudley and Stolton 2020). This insight, combined with observations demonstrating a lack of ability by simpler models to predict land change dynamics (Verburg et al. 2019; Angelstam et al. 2021; Meyfroidt et al. 2022), have increased interest in overcoming dualisms by reinterpreting and expanding definitions of what human agents are. This is done by taking culture and subjectivity into account to a larger extent than previously thought relevant in the sciences (Wu 2010, 2019; Verburg et al. 2019; le Polain de Waroux et al. 2021), and by taking physical, ecological and spatial facets of society more systematically into account, than previously thought relevant in the social sciences (Descola 2012; Duineveld et al. 2017; Brown et al. 2019; Pearson 2020; Adams 2021; Kok et al. 2021). Such developments, now becoming widespread, hold a promise for the establishment of more integrated, holistic understandings of human agents and agency. In the review below we take point of departure in these advancements, most notably the aspiration for a new theory to: (1) accommodate a shift away from binary explanatory devices and concepts, (2) take the subjectivity and situatedness of agents into account as constituent parts of systems, and (3) take ecological, systemic factors into account as part of human agency and lifeworlds.

Potentials and limitations of adopting a relational perspective on agency

A possible solution to the outlined challenges would be a relational, situated and realist approach to agency, shifting attention from essences or ontologies to relations, assemblages and networks (Whatmore 2000; Stenseke 2018; Glückler and Panitz 2021). This is a widely held view, which is anchored within actor network theory and similar traditions of thought (Latour 2004; Cressman 2018). Agency is here recast as distributed phenomena, arising not only from intentional human action but from the assemblage of humans, objects, animals, plants etc. that

make up a system or context of mutual implication in activities—a landscape, or a series of situations in a landscape. Applied, replicable methods for implementing such a modelling approach are feasible, as has been demonstrated for example in the context of modelling relational networks of beings in water management (Raffn et al. 2023) and in the context of geographies of energy distribution and consumption (Hui and Walker 2018). A given culture would then be understood as a historically contingent constellation “of elements which are defined and differentiated in a particular society as representing reality—the total reality of life within which human beings live and die” (Schneider 1976). This would allow research in land systems to align with contemporary anthropological and geographical perspectives emphasising the plurality, diversity and contingency of culture, with a view to analyse “living, experiencing, thinking, affectively engaged human beings who follow (in varying degrees and a myriad of manners) particular lifeways.” (Rapport and Overing 2007). This promising line of investigation for including culture in land system modelling may in our view be facilitated further by shifting the attention of theory-building from a priori categorisations and ontologies to processes of exploration where culturally contingent ontologies may be allowed to appear empirically (Raffn et al. 2023). As such, we take point of departure in a perspective emphasizing empirically grounded and theoretically inclusive approaches to the configuration of subject-object relationships (Christensen et al. 2017), which we argue could take precedence over entrenched ontological and metaphysical positions, thereby contributing to opening up new options for conceptualizing the interplay between people and environments.

However, while a broadly based perspective represents an important step towards a more empirically relevant understanding of human agency in local situations and networks, important questions about how it may coexist and merge with ecological understandings of agency, have so far gone unanswered. Key questions include if and how modelling of local, scene-dependent decision making with relational theory can be understood to capture constituent parts of larger patterns of aggregate and emergent functionality characteristic of ecosystems, landscapes and land systems. This is unclear, because ecological thinking and evidence within the

sciences tend to emphasize the nature and character of objects and beings involved in relational encounters, rather than the relations and networks alone. Research within landscape ecology, for example, does not concern itself with relations and networks as such, but with the life forms, species, populations, ecosystems, biotopes, geotopes, humans and land units taking part in relational exchanges (Forman 1995; Antrop 2021; Van Eetvelde and Christensen 2023). These are identified with certain characteristics such as genes, strata and energy fluxes on the basis of which they are differentiated and analysed, without which their ecological situation and functionality could not be grasped. Ecology, in essence, does not concern itself purely with relations. Rather, it stresses the relation to other things and beings—which are understood to have functionally important, persistent characteristics and histories (deLaplante 2008). This conflicts with fundamental notions of anti-essentialism in relational theory, and it is most likely one explanation why actor network theory and cognate traditions of thought have had limited impact on theory development in the natural sciences. It also highlights an apparent need for a more inclusive conception of land systems, able to account for both the phenomena seen as primary to relational theory, and the phenomena encountered in ecological and object oriented research on the environment.

What the above analysis indicates is (among other things) the presence of several, competing notions of human agency, modelled in a similar way: emphasizing individuals engaging with contextual factors encountered as a result of their immersion within wider wholes or systems. Building on this common denominator, it may be possible to balance the relational perspective with an understanding of the ontology of systems or wholes within which agents take part. This would involve an understanding of agents as situated within semi-variable system contexts, which they co-create and which also condition their options and actions. A pervasive way to conceptualise and investigate this has been to use concepts of *holism*, which have been applied both with respect to land systems and social systems. In the review below we build on this parallel, seeking to uncover potential outlets for a holistic theory of agency.

Parallel conceptions of agency and holism in the social and environmental sciences

As has been outlined, one of the key challenges to understanding agency from a relational perspective is to account for how agents are situated in wider social and ecological systems. Within social theory, the main challenge in this respect has been to operationalise and nuance understandings of *structuration*—the mutual processes by which practices performed by agents can be understood to constitute continuous social structures that in turn co-constitute agents through their practices (Bourdieu 1977; Giddens 1986). Within landscape research, parallel lines of reasoning have emphasised spatially explicit modes of structuration under the heading of “pattern and process”, seeking to understand the mutual relationship between landscape patterns co-constituting ecological processes taking place within them, which in turn co-constitute the same patterns (Forman and Godron 1986). The challenge that these two remarkably similar conceptualisations of agency-structure relationships pose for environmental research is to nuance and concretise *how* agents form part of larger systems.

Understanding how agency is situated and constituted within systems has also been the topic of recent conceptualisations of land systems as complex systems, through which researchers have sought to combine social and ecological modes of structuration in a common framework (Rescia et al. 2012; Preiser et al. 2018). However, such research tends to let biophysical ontologies overrule social ones rather than combining them, rendering meaning, intent and creativity secondary to objects and physicality—leading to loss of complexity and understanding of the social side of the systems under study. Therefore, a broader look at the parallel terminologies used to describe and model phenomena exhibiting emergent behaviour stemming from distributed adaptive agency is needed. The most widespread within both landscape research and social theory is holism.

Holisms of human agency in landscape and land systems research

Holism was first applied in the context of landscapes and land systems inspired by Smuts (1926) who defined it broadly as “the tendency of nature

to form wholes that are greater than the sum of the parts through creative evolution”. As such, it refers to both the hierarchical organisation of systems and their evolution over time (Zonneveld 1995). Holism has become a fundamental concept in landscape research (Antrop and Van Eetvelde 2017), where it is applied in two complementary ways. The first is epistemological as a specific way of recognising and understanding the ordering of landscapes, whereby observations are directed by *gestalts*—meaningful relational pattern-constructs in the eye of the beholder—which are afforded by the pattern of the landscape, thus reflecting the combined presence of a real, actual pattern and the ability of a beholder to recognise it (Wagemans 2015). Here holism is used to emphasise how specific configurations of interacting parts of the landscape form wholes that are more than the sum of their composing parts, and how the meaning of such complex patterns is observed and analysed. Applications in landscape research include holistic interpretation of landscape patterns in remote sensed imagery (Antrop and Van Eetvelde 2000) and experiential in situ perceptions of order, pattern and its opposites in landscapes by human agents (Troll 1939; Granö et al. 1997; Bell 2012). The second way is ontological, where holism is used as a descriptor of landscapes as hierarchical and complex systems constituted of interdependent components. Holistic landscape entities are referred to as *holons* constituted by interacting parts reproducing forms and/or functionality across a series of nested scale levels, each consisting of smaller holons at a lower level and embedded in holons on a higher level. Examples of this type of multi-scale hierarchy of land units with emergent functionality at different scale levels are widespread, as demonstrated by Zonneveld (1995) and Naveh and Lieberman (1994) (see also Antrop and Van Eetvelde 2017). Holism is applied within geography, the earth sciences and environmental research to land units distributed over a surface, giving rise to systemic (i.e. emergent) functionality arising from patterns and neighbourhood relationships within wholes in the form of geographical regions or landscape systems. The same line of reasoning can be recognised within broader contexts of ecological research at various scales (Trepl and Voigt 2011). A classic example is the way cell organelles interact to exhibit emergent cellular functionality, while cells in turn co-constitute organs interacting to form organisms, which again

interact in ecosystems forming landscapes, forming part of the larger earth system. In accounts of the type given here, holism aids in defining agency within complex land systems by pointing out how such agency is conditioned by (1) the position of agents within spatial configurations of biophysical objects in environments encompassing other beings, with effects manifesting across scales, and (2) the ability of agents to interpret and encompass system-wide patterns cognitively, empowering engagement with systemic as well as local processes and patterns.

Holisms of human agency in social theory

Within social theory, parallel notions of holism are being employed, albeit within another framework of concepts. Emergent behaviour within societies and cultures is referred to as “holisms of meaning”, building on the view that “beliefs depend on systems of language-use in social practices, which involve communities of people and worldly objects” (Piiroinen 2018). This seemingly simple observation has wide-ranging consequences for how human societies can be understood, because it implies that the meaningfulness of practices conducted by individuals arise from and add to a concerted effort within social wholes, i.e. societies (see also Watkins 1957; Jackman 2014). The way money constitutes economies is an example. Take a physical coin, which is an object invested with a “holism of meaning”, allowing the coin emergent behaviour to set social events in motion. Unlike other pieces of metal, it can be exchanged for goods and services by force of summative agreement among individual agents as to its value and role. If the coin leaves its social context, for example by being brought outside the territory of its market or jurisdiction, it turns into just a piece of metal (List and Spiekermann 2013). In this view, a distinction is made between practices conducted by agents and how those practices *count* in the social context—the way they are seen to be meaningful. So agents immersed in a society are concerned with that which is meaningful in their culture. Potential objects, actions, events and processes that are not meaningful do not figure in contemplation and practice unless they are made to appear meaningful in the context, by an expansive and/or creative process of cultural transformation (Malpas 2002). Likewise, the same objects, persons and events may have different, shifting meanings.

The same stand of trees can be a habitat, a piece of scenery or a timber resource, depending on the context (Meinig 1979). Similarly, the same person can be a resident in a landscape, the director of a company managing the land and/or the owner of a piece of land, depending on the context of meaning holism (Cronon 2000). Each of these roles are contingent social positions that are meaningful only as a consequence of agreement by agents within the relational context (social field of practice) where they appear (Bourdieu 1977; Atkinson 2020). Taking up and practising land use within roles like these entail engagement with constraints, options and expectations constituted by the cultural whole of many individuals. As such, seen through the lens of meaning holism, it is the culture of a society that constitutes its objects, land units and agents as well as the relations between them, even while the culture(s) involved are subject to continuous structuration through social exchange and communication. This type of holism aids in defining agency within complex land systems, by pointing out how such agency is conditioned by (1) the position of agents within societies where persons, things, relationships, events and actions are constituted as objects of cognition and action through meaningfulness pertaining to cultural and social wholes, and (2) the ability of agents to continuously reconstitute and redefine roles and meanings through social exchange, potentially involving multiple cultures and a plurality of ontologies. Conditions and modalities of agency identified in the review are outlined in Table 1 below.

Redefining the object of study: several sciences— one land system

Since one of the primary purposes of land systems research and landscape research more broadly is to understand how land users contribute to changing and maintaining the wider landscape, the apparent similarities and overlaps between the two contextualisations of human agency outlined above give food for thought. On the one hand, agents take part in ecological structuration processes within biophysical systems. On the other hand, the same agents take part in social structuration processes within societies and cultures. Both contexts for agency are constituted by processes initiated by agents under the influence of existing structural conditions evolving over time

Table 1 Conditions and modalities of human agency identified within the ecological and social theories of holism that were reviewed (“Holisms of human agency in landscape and land systems research” and “Holisms of human agency in social theory”).

	1. Ecological holism	2. Meaning holism
Conditions for human agency:	Positions and situations within landscapes where objects and beings have functionality as a consequence of the configuration and composition of ecosystems pertaining to ecological and spatial wholes	Positions and situations within societies where persons, things, relationships, events and actions are constituted as objects of cognition and action through meaningfulness pertaining to cultural and social wholes
Modalities of human agency:	The capacity of agents to understand, act upon and affect spatial land units and the patterns they form, constituting engagement with local and systemic landscape processes and patterns	The capacity of agents to understand, act upon and affect roles and meanings through social exchange, constituting productive engagement with social structures and cultures

While spatial holisms and ecological conceptions of agency have traditionally been dominant in land systems and landscape research, studies dealing with landscapes including human agents may profit from combining the two perspectives. In particular when analysing relationships between individual agents and the landscapes they inhabit

through the same processes (structuration). Many researchers analyse this as two systems, a social and an ecological (Petrosillo et al. 2015; Verburg et al. 2015, 2019; Meyfroidt et al. 2018; Opdam 2018; Preiser et al. 2018; Angelstam et al. 2019; Turner et al. 2021). Common to this research is a definition of distinct “interactive social and environmental subsystems” understood to be functionally related through various “links”, “couplings”, “feedbacks”, “impacts”, “relationships”, “exchanges” and other processes which are the topic of integrative research (Turner et al. 2020). In contrast to this definition of two interacting spheres of reality, research focusing on social-ecological systems stress a perspective seeing “delineation between society and the environment as artificial” (Guerrero et al. 2018). In this view, the conceptualisation of two distinct ontological spheres of reality (social and ecological) is seen as irrelevant. However, this is not reflected widely in research practice, where the same conceptual delineations tend to be reproduced through the employment of classes of processes and objects, subsystems, interactions and feedbacks assuming a distinction between social and ecological ontological domains (see f.x. Reed et al. 2021; Meyfroidt et al. 2022). This is surprising, since most environments brought under investigation clearly do not conform to such definitions. Human dominated landscapes are geographically the most prevalent today, taking up an estimated 75 percent of the ice-free terrestrial surface area in the year 2000, having been transformed historically “into predominantly anthropogenic ecological patterns combining

lands used for agriculture and urban settlements and their legacy; the remnant, recovering and other managed novel ecosystems embedded within anthromes” (Ellis et al. 2010; see also Ellis 2021). Even areas not directly influenced by human land use are affected deeply by anthropogenic changes to global biogeochemical cycles (Ciais et al. 2013). So there are no ecological and no social systems. Not in parallel that is, as the most widespread conceptual models today still presuppose, but in unity.

For any subsection of the planetary surface, there is evidently only one system, made of a single set of molecules, agents, cognitions etc.—a nature including humans and a society including natures. Consequently distinctions between social and ecological realities and wholes (holisms) (such as in Table 1) are likely to obscure empirical observation and analysis rather than aid it. Such concepts do not reflect discreet groups of empirical phenomena but appear to reify a tradition of definitions pertaining to disciplinary histories for subdivision of knowledge, imposing upon the world an a priori mode of organising scholarship. Bringing applied ontologies in line with this insight—the realization that both the natural and social sciences have lost their traditional subject matter to history—is a major task and opportunity for land systems and landscape research. It demands of researchers that they break down and rebuild existing conceptualisations of structuration and holism in order to expand and recombine these. In this article we discuss how this could be done by outlining a theory of agency emphasising an inclusive

non-dualistic vocabulary exploring how people exist on the land as social and ecological beings. To do so, we employ a case study to exemplify overlaps and relationships between notions of agency in practice. We start by reviewing specific factors and components of agency found in modern agricultural land system, which is the context of the case study, to identify how the broader notions of agency reviewed can be operationalised with respect to a concrete landscape context.

Specific components of agency in the context of agricultural land systems

Making a relational and integrative theory of human agency operational will depend on identifying types of relationships/factors to include and prioritise in conceptual models. At the outset of any action, agents involved in land use practices are situated in a context including: (1) Practical conditions for their actions, such as ecologies, technologies and infrastructures etc. and (2) Meaningful conditions for their actions, such as cultures, aspirations, dreams, priorities, values, ethics etc. As has been reviewed above, these two contexts of action are intertwined and overlap (see Table 1). But what factors are essential to include in their description to conceptualise them?

Taking modern, industrialised, capitalist agricultural landscapes as an example, factors identified as important for understanding human agency in landscapes in selected parts of the literature are outlined below. The review focuses on factors addressing and informing observational choices regarding the challenge of integrating ecological and social holisms identified above. Three clusters of theory currently used to characterise and interpret the agency of farmers in industrial agricultural landscapes are included: (1) farming style research, (2) research on agricultural regimes; and (3) role theories of agricultural land use.

Farming style research

Farming style research seeks an integrated understanding of farmers as persons forming opinions and making land use decisions based on a combination of cultural, social and physical factors. A farming style is “a coherent pattern that brings the organization and development of the farm in line with the strategic

repertoire of the actors involved” (van der Ploeg et al. 2019). They represent “a specific unity of farming discourse and practice, a specific unity of mental and manual labour” resulting in a particular physical and social structuration of farm, landscape, lifestyle and land use practices over time (van der Ploeg 1994). By emphasizing the combined effect of economic, social, political, ecological and technological dimensions in farming, farming style research directly address the relationships between cultural meaningfulness and ecological functionality. Farming style research understands human agents as cultural beings with shared values and lifestyles that are integrated with their land use and links individuals with cultures and helps to grasp and theorise meaning holism and attitudinal heterogeneity (Schmitzberger et al. 2005). By combining normative and material dimensions of farming, understood as variation in modes for “patterning the social and the material world” (van der Ploeg 2012), farming styles research addresses the meaningfulness of land use processes, while maintaining an integrated understanding of their social and material dimensions (Burton et al. 2020) as well as structural, contextual conditions and forcings (Vanclay et al. 2006). This broad, integrative perspective resting on an inclusive understanding of structuration processes is a key strength of farming style research. Weaknesses include the idiographic, non-comparative character of the knowledge produced. The theory aids in explaining and recording meaningfulness on a case by case basis, in ways similar to ethnographic methods within anthropology. However, the theoretical approach lacks a clear method to aggregate specific understandings into types of farming styles and eventually to general concepts describing broader patterns of empirical variation. The emphasis is rather on historical, contingent and contextual aspects of human behaviour in farmed landscapes, wherefore knowledge developed through farming style research often stays at the level of middle-range theory, rarely providing general concepts that can be used across contexts, except as an inspiration for methodological experimentation.

Research on agricultural regimes

Research on agricultural regimes contributes with an understanding of humans as economic and productive beings. It highlights and critically assesses polarities

between humans as economic, physical producers and caretakers on the one hand and as partakers in social processes having non-productive goals on the other hand. In this research, change and persistence in agricultural land use systems are conceptualised as instances of reproduction and/or transition between regimes, understood as complexes of practices, values, technologies, infrastructures and ideologies motivating agricultural activity (Wilson 2001). For example, a distinction is made between “productivist” agricultural regimes organised mainly around an ethos of efficient production with high farming intensities and productivity, and other regime types including so-called pre-productivist, post-productivist or non-productivist and neo-productivist regimes as well as various types of multifunctional agriculture, where other ethics and motivations permeate land use practices, making other patterns of decision making and resulting land use meaningful to farmers (Marsden et al. 1993; Marsden 2013; Rogers et al. 2013; Wilson and Burton 2015). The aim of post-productivism is to integrate agriculture within broader rural economic and environmental objectives (Ilbery and Bowler 1998; Wilson 2007; Burton et al. 2020). This means a reduced emphasis on food production and on the intensity of farming through extensification and diversification, as well as an increased emphasis on the countryside as a place of ‘consumption’ with high environmental sustainability (Burton and Wilson 2006). Research on agricultural regimes contribute with an understanding of established frameworks of action, infrastructures, assumptions and lock-ins affecting human agency in farmed landscapes. It identifies commonalities, expectations and norms within regimes. This perspective on land use is rooted in political economy, with “a focus on the role of macro-scalar, institutional, and policy-driven processes” (Wilson and Burton 2015). It emphasises wholes rather than individuals, continuity rather than breaks and focusses on characterising periods of stability of practice and their eventual reform or replacement by new regimes representing a new order. The main weakness of this perspective is an inability to account for individuality, creativity, disruption and innovation. Agents are understood not as individuals per se, but as partakers in regimes. The strength of this interpretation is that regimes are understood as both cultural, meaningful, technological and physical

wholes at once, emphasising the multifaceted character of decision making observed in agriculture.

Research on social roles

Role theory employs an understanding of agents as role-takers in social systems “to explain how individuals who occupy particular social positions are expected to behave and how they expect others to behave” (Hindin 2007). The theory developed as an explanation of social ordering processes (Linton 1936; Mead 1938) and later found use more broadly as a way to conceptualise observed predictability of human agents. Within landscape research, Primdahl and Kristensen (2011), Primdahl et al. (2013, 2018) differentiate a range of roles among land users, whereby socially legitimate “competences to physically use and alter the land and its resources” are understood as constituting relationships between individuals and larger social wholes (Primdahl et al. 2018). Landscape managers such as farmers are understood to practice three social roles, which may overlap and may be distributed between agents: the roles of producer, owner and citizen (Primdahl and Kristensen 2011). As producers of food, fibre, energy and other ecosystem services, farmers make decisions in the context of markets, production technologies and business leadership. In the role of owners of farm properties, farmers make decisions linked to the property, in the context of financial opportunities and spatial regulations. As citizens, farmers participate in community life, making decisions in the context of place attachment, community, and rights and duties of citizenship. The three roles reflect parallel engagement by agents in key contemporary social institutions including capitalist markets, tenure systems and nation states (Christensen 2016) mediated as competences to act in society (Hägerstrand 2001). This links individuals with larger-scale societies and their social organisation, informing theories of stewardship (Raymond et al. 2016; Bieling and Plieninger 2017) and theories of framing and meaningfulness in resource management (Carnahan et al. 2019; Graversgaard et al. 2023). The strength of these theories is that they provide a comprehensive account of individual decision making conditions on the basis of collectively experienced, contextual parameters, linking

agency to wider social contexts of perceived meaningfulness, lawfulness, legitimacy, purpose, status and worth. Weaknesses of role theory include an inability to account for counter-cultures and alternative ideologies within societies. When seen as role-takers, agents are interpreted relative to the macroscopic social roles they inhabit, challenge, co-define, maintain, enforce or otherwise relate to (i.e. with reference to social institutions permeating societies). Role theory tends to explain agency mainly as idiographic variation within wider social structures framing the lifeworld of agents, land use practices and landscapes. Also, due to its strong focus on social roles, the theory treats material factors largely as an implicit aspect of social practice rather than as the subject of explicit modelling and analysis in its own right.

The review indicates a need to improve understandings of the relationship between two sides of decision making that is consistently voiced in parallel: meaning and motivation on the one side and resources, economies and possibilities on the other. There is a need for a theory within landscape ecology and land systems science more broadly explaining how these two parallel outlets

for landscape management combine to inform and inspire decision making in practice. This is further explored using a case study of agricultural land management histories on the Canterbury Plains, New Zealand.

Case study: agricultural land management on the Canterbury Plains, New Zealand

The Canterbury Plains is a highly developed agricultural region on an outwash plain formed by two braided rivers extending seawards from the foothills of the Southern Alps on the South Island of New Zealand (Fig. 1). The plains constitute a gradient of ecological conditions affecting variation in land use, from high alpine valleys in the West to wetlands and fertile irrigated cropland near the Eastern coastline (Pawson and Holland 2008). Along this regional ecotone, farm properties in three landscapes were selected for interview surveys using a maximum variation sampling strategy (Patton 2015), aiming to identify common factors affecting farmer decision making regarding landscape management.

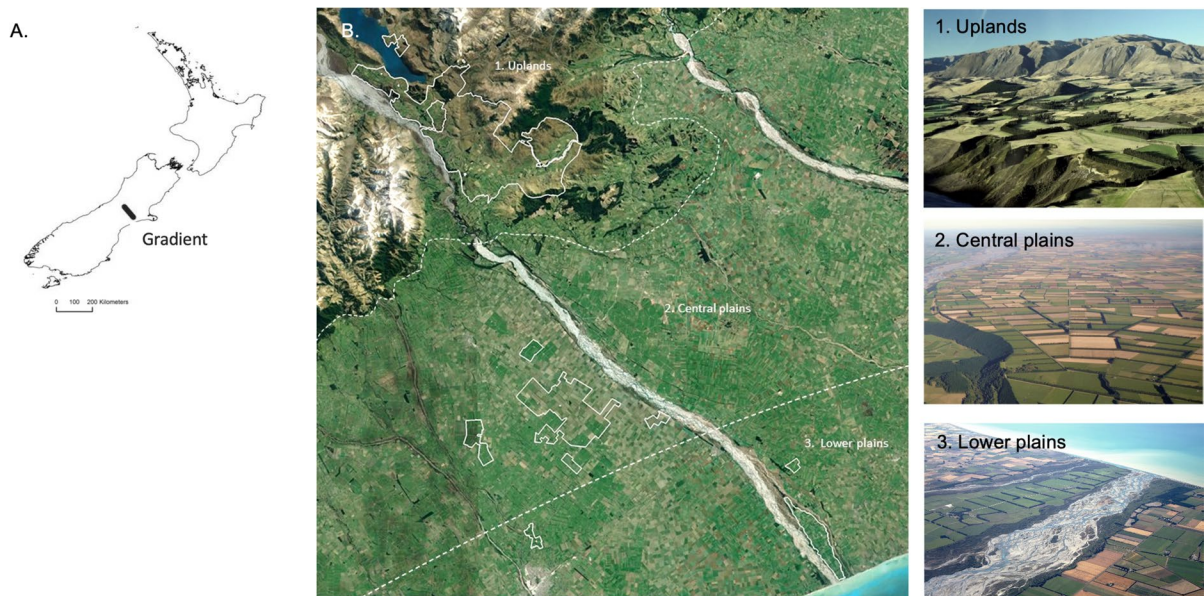


Fig. 1 Location, extent and landscape context of farm properties included in the interview survey. Farmers were sampled from three landscapes (1–3) along an ecotone **A** along the Rakaia River located on the South Island of New Zealand.

Pane **B** indicates the location of properties included in the survey. Aerial oblique photographs of landscape structure (1–3) by the authors

Context

Land use on the Canterbury plains is characterised by “conversion” processes from one dominant land use to another interspersed by periods of more continuous development (Brooking and Pawson 2010; Christensen 2013). These developments are mediated and motivated by the introduction of new technologies, skills and capital, and by changes in infrastructure, market access and patterns of global demand for agricultural products. Currently, rural properties on the Canterbury Plains are being converted from dryland sheep farming and multi-cropping systems relying on flood irrigation (river water) to milk production systems relying on pressurized irrigation with groundwater delivered through automated boom- and pivot systems (Dynes et al. 2010). Also fields and holdings are aggregated into larger units. These processes are leading to widespread loss of interstitial habitats on properties under conversion (Meurk 2008), making the extent of semi-natural habitats (patches with permanent vegetation) per hectare on farm properties a useful indicator of changes in land management practices. But not all farms are being converted to the same degree or at the same time.

Interview survey and farm property habitat inventories

To investigate the different decision strategies of the farmers (indicated by changes in habitat cover), an interview survey was conducted including a sample of farmers operating land distributed along the Rakaia river intersecting the Canterbury plains from west to east (Fig. 1). A total of 25 interviews were conducted with farmers operating 132 properties. A habitat inventory for each property was developed for the years 2006 and 2017 based on aerial image interpretation. Farmers were interviewed in the growing seasons of 2013/14 and 2017/18. A broad range of qualitative and quantitative questions were used to uncover past and present land use, future plans and expectations, management roles, production regimes, farming styles, motivations, aspirations, values, lifestyle, family situation, sense of purpose, place attachment, agroecological factors, demographic and economic conditions and reasons for operating the

property. Questionnaires were designed to cover the main factors indicated in the review (“[Specific components of agency in the context of agricultural land systems](#)”). These possible explanatory variables modelling aspects of the landscape managers’ lifestyle and productive practices were compared with the data on habitat and land use changes.

Sources of farmer decision making: complexity and holism in practice

Results show that a diverse array of factors had some influence on the decision making of the farmers across the gradient. The farmer’s age is a factor because younger landscape managers typically introduce new priorities and redesign the landscape to fit new lifestyles and/or production paradigms (i.e. regimes). Removed habitats per hectare fall sharply with increasing landholder age. As for the duration of ownership, there is a rise in habitat creation with the duration of ownership until 17–25 years (with a peak at 9–16 years) of ownership, after which it falls. Other groups remove habitats rapidly, reflecting large-scale conversion processes when farm properties are first acquired or when they are being prepared for sale. Property size plays an essential role in landscape management because it correlates with farming style, production intensity, and reliance on agriculture as an income source. The largest farms are relatively stable because they are efficient, and trees and hedges have already been removed. In contrast, landscape managers with medium-sized properties tend to remove the most habitats or create the least because they are in a yet unfinished or continuous process of rescaling and optimising their production. As such, individual variables such as age, duration of ownership and property size are essential in explaining variations in landscape managers’ decision-making with respect to habitats, but with dissimilar and/or conflicting effects in terms of habitat change. The same factors can affect the decision making process of people in different ways. This indicates that even though the same general drivers apply, they lead to different outcomes depending on local conditions.

The only factor correlated uniformly with land use changes across properties and landscapes was the long-term strategy of the farmers involved, which is an expression of expected and desired futures and life situations of the farmers. When asked how they saw

their property in 20 years, farmers identified futures correlating consistently with past landscape management practices on their properties. When specifying a pathway forward, they revealed much about how they make decisions in general. In considering the future, farmers evaluate all the variables they believe to be relevant such as expectations for market prices in coming years, financial limitations and opportunities, their ability to conform with or challenge such conditions, their desires and needs, their ambitions and preferences as residents in the landscape, as parents, producers and members of a community (i.e. social roles and farming styles). In effect, they provide a situated analysis, summarized as a set of *expected futures*, which they have thought through as part of daily management practices. These included, in order of decreasing habitat loss, properties with the following expected futures: (1) Investment in enlargement and conversion; (2) Transfer to heir without conversion of land use system; (3) Focus on niche production or high value products; (4) Hobby/part-time agriculture with land sold off; (5) Use as recreational property. In selecting a trajectory to follow, the whole totality of the subjectivity of the farmers—from their values, aspirations and lifestyle to their family situation—are brought to bear on what they consider to be relevant decision conditions, limited and constituted by the knowledge and experience they hold with respect to the social and ecological structural conditions they are attempting to navigate (Fig. 2). This demonstrates the prospects of an analytic approach emphasizing situated, aggregate accounts of decision conditions such as the landscape futures farmers identify as possible and desirable, towards which they direct their agency.

Conceptualising agency in modern land systems

The case study illustrates that expected and desired land management futures indicate the combined, emergent effect of a wide range of factors encompassing a holistic account of the position of agents in land systems. When landscape managers decide to change landscape elements on their properties, they do so based on an appraisal of the present situation in comparison with a desired future (Fig. 3). From a situated standpoint in the present (t_1), agents review the current situation on their property and take stock of the

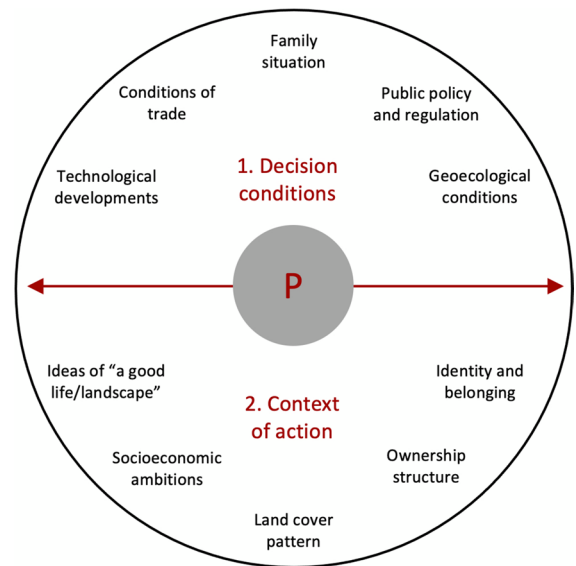


Fig. 2 Experienced conditions for decision making described by farmers in the interview survey. A clear distinction was made, by each farmer individually, between (1) factors believed to be outside his/her control, towards which adaptation was appropriate; and (2) factors considered within reach of his/her agency, which could be adapted and changed as part of strategies for the future. Interestingly, all farmers diverged somewhat with respect to what factors were included, and what factors were considered outside their agency. Distinction between (1) and (2) is relative to the position and situation of the farmer / person in question (P). As such, how agency is constituted varies with beliefs, outlook and the position of agents (P) as well as with their skills and resources available, even within a relatively small sample of farmers

resources at their disposal to change it, taking account of the limited ecological, financial, technological and social resources they are aware can be mobilised seen from their position. On this basis a better yet still realistic future can be visualised (t_2), which renders change meaningful, profitable and/or necessary. Such visions, bounded by the continuous enactment of distinctions between subjective and objective features of the environment and situation, are reconstructed and deliberated upon continuously as part of the daily practice through which the landscape is maintained and changed. A key observation here is that the distinction between (1) Decision conditions and (2) Contexts for action, is fluent and varies greatly. This deeply affects agency. For example, some agents believe themselves to be close to powerless as a result of globalisation processes and technological development, while others see themselves as having a wide

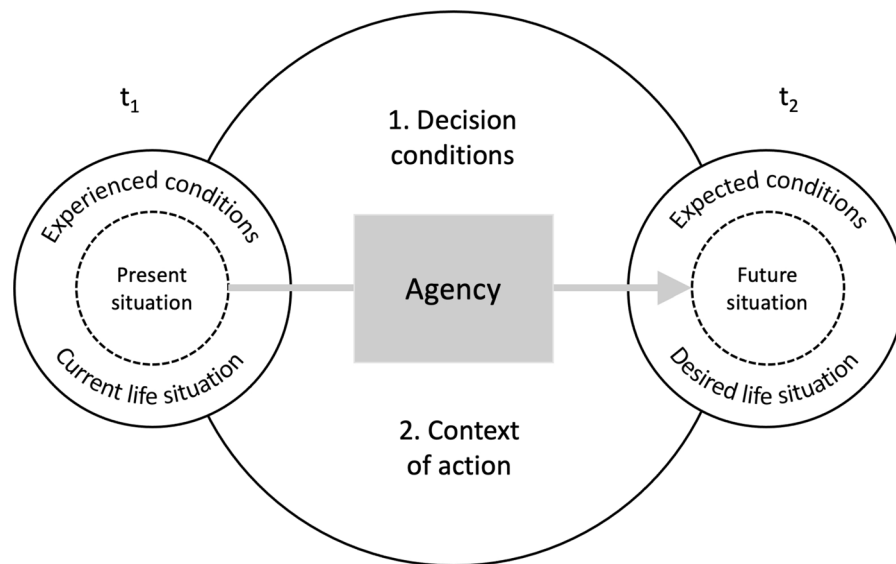


Fig. 3 Outline of a theory of agency in land systems. From a situated standpoint in the present (t_1), agents review the current situation on the land and take stock of the resources at their disposal to change it, taking account of the finite financial, ecological and social resources they are aware can be mobilised seen from their position. On this basis a better yet still realistic future can be visualised (t_2), which renders change and persistence meaningful, profitable and/or necessary. Such realistic

visions of the future are reconstructed and deliberated upon continuously as part of the daily practice through which the landscape is maintained and changed. A key observation here is that the distinction between (1) Decision conditions and (2) Contexts for action, is fluent and varies between agents and situations. This deeply affects agency, which is constituted based on the appraisal of options seen from the situated perspective of agents

margin of influence on their future. Others effectively find ways to work around perceived conditions and develop creative, unanticipated ways of operating and developing their landscape resources. Furthermore, phenomena appear and reappear to agents in the guise variously as conditions for agency and as potential objects for agency. However, the local and emergent (systemic) consequences of this for land systems, including feedback mechanisms from decision making to land use practices and back, is not accounted for in current theory, indicating a need for conceptual development. The review of the three clusters of theory (“[Specific components of agency in the context of agricultural land systems](#)”) indicates that the missing component in current theories may be an understanding of the contextuality of agency: i.e. how situations and positions of decision making influence the contribution of the sources of agency outlined in the theories and combine to influence decision making. One reason for this appears to be a strategy of theory formulation whereby components and factors of agency are sought out and described primarily as components for inclusion in varieties of middle-range

theory, i.e. conceptual models indicating typical relationships and outcomes of factors within a mechanistic or functionalist frame of reference (Magliocca et al. 2015; Meyfroidt et al. 2018; see also Van Eetvelde and Christensen 2023 for a comprehensive outline of varieties of theoretical contributions in landscape research). While the virtue of this approach is that it allows object-oriented and categorical description of essential characteristics of components in ways matching description practices in many ecological sciences (deLaplante 2008), it also prohibits the development of a more situationally sensitive conceptualisation of object characteristics as potentially fluent and contextual, which would help solve the challenges here identified, as voiced within for example affordance theory (see f.x. Hincks and Powell 2022). This is the most widespread approach to theory building in the contributions reviewed. In contrast, work on relational explanatory devices have emphasized situational understandings of components of theory as fluent, constituted by the assemblages they form in social flows within societies (Latour 2004). Here the notion of essential characteristics is abandoned,

in favour of relational understandings of the capacity and potential of agents and objects in networks. What is gained by this is an inclusive, processual understanding of situations, directionality and interaction as explanations of agency. What is lost however, is the ability to clearly distinguish and model essential characteristics in for example individuals, species, biotopes, populations subjected to evolutionary development flows, ecological adaptations etc.—making relational theories largely incompatible with much ecological reasoning. As such, while both object-oriented and relational approaches contribute to explaining agency in the context of land systems, they also both tend to reproduce a priori distinctions between essential characteristics and relational factors and positions. This does not appear to be productive for further theory development since, as the case study illustrates, both are needed to understand ecologies in practice. This points to the need for compound, empirically founded explanatory devices expressing the combined effect of relational and essential components of agency.

The case study illustrates that by focusing on likely and desired futures as an explanatory device, it was possible to gain access to the agents' own summations of their situation and those decision conditions they see as constituting their agency, which consequently do structure their practices. This is essentially a way to reconstitute the theoretical division between agency and structure empirically, instead of based on theoretical or a priori conjecture, and develop an analysis which could potentially encompass all situationally relevant aspects of the action space experienced by agents—i.e. all of the opportunities and constraints entailed by structural conditions and all of the knowledge and ignorance, the resources beliefs and cultural values affecting their decision-making. Of course agents do not themselves know all the reasons for their actions, and their actions are not fully explained by their perspectives or opinions. But they are explained by the future they imagine for their property, because that future is formed based on a realistic appraisal of the conditions seen from the position and situation of the agents. This illustrates that using empirical interpretations of reality provided by agents instead of interpretations structured by a priori theoretical notions may be a way to bracket out and thus overcome some of the problems facing comprehensive theoretical work in land systems

research and other fields dealing with socio-natures and/or integrated social-ecological systems.

Outline of a theory of agency

The review introduced in this article established that a sufficient understanding of agency should take into account (1) the position of agents within spatial patterns in landscapes; (2) the ability of agents to interpret and encompass patterns cognitively, empowering strategic engagement with systemic as well as local processes; (3) the position of agents within relational patterns in societies; and (4) the ability of agents to continuously reconstitute and redefine meaningful relations through social exchange, empowering engagement with the social meaningfulness of individual decisions and actions (see Table 1, “[Parallel conceptions of agency and holism in the social and environmental sciences](#)” and “[Redefining the object of study: several sciences—one land system](#)” for a more detailed analysis of this). This entails an understanding of the human agent as someone who takes part as an individual in the functioning of a cohesive larger whole (the land system), in which every component that the agent engages with is indiscriminately social *and* ecological in that it consists in the progressive composition of a common world, constituting a functional whole that is more than the sum of its individual parts—a socio-natural holon.

The human component of such a theory of agency can be summed up as a perspective where subjective and objective aspects of human existence are understood to be collapsed and combined in practice, expressed as a totality through decisions and actions. Concepts of human agency addressing these insights have been developed empirically over a long period within critical psychology and ecological psychology, from where inspiration can be drawn (Schraube and Schraube 2015; Lobo et al. 2018). Here “individual human beings are basically grasped from the standpoint and perspective of individual subjects participating as agents in relation to their societally mediated scopes of possibilities” (Dreier 2020). By underscoring the *possibilities* for agency experienced by individuals, it is emphasized that objective “environmental conditions” for practice form an important part of human agency. Yet by stressing that these appear to agents as socially mediated *scopes* of possibilities, it

is underlined that agents engage with land use options with *subjectivity* (meaning, culture, values, opinions, ambitions, beliefs etc.), which is understood to deeply affect what appears possible and desirable for individuals as seen from their situated position in the land system. As such, for objects of agency (such as land units in a land system) “their social meaning centers on what can be done with them, [while] their subjective meaning centers on how this matters to particular subjects” (Dreier 2020) both of which relates to a combination of essential and relational factors.

This definition of agency includes environmental and individual as well as subjective and objective factors in a coherent, inclusive understanding of humans as beings engaged with meaningful practice from a situated position—i.e. with specific limitations and possibilities in place—within land systems. While this does not fully address ecological aspects of agency and does not account for how to conceptualise causalities pertaining to concrete limitations and possibilities of agency, it does offer a promising outset for developing an outline of a new integrative theory of human agency relevant to land systems overcoming the limitations of purely essentialist or relational traditions of thought. It stresses the participation of human agents in structurally arranged wholes, and could replace theories of agency currently in wide use, which tend to overstate subjectivity (Waterton 2018), biophysical and structural factors (Turner et al. 2020) or relational configurations and assemblages (Head 2012) as sources of human agency in land systems.

Based on the review, an improved model of agency in land systems emphasizing the position of agents in social-ecological contexts of action can be outlined (see Fig. 3). Here *position* refers to the situation of agents in spatial patterns and social flows of relations, forming a standpoint of decision making. This takes place within functional *contexts of action* delineating the agency of individuals, conditioning actions and practices imagined, planned and realized by agents (Fig. 3).

For agents, inhabiting a position in a land system means to have a basis for forming opinions and experiences, making it possible to “determine from case to case what is good, or valuable, or what ought to be done, or what I endorse or oppose. In other words, it is the horizon within which I am capable of taking a stand” (Taylor 1989). In this now classic

definition of self and sociality described by Taylor, the “interpretation of self happens against the backdrop of a whole ‘landscape of meaning’ within which an agent operates” (Taylor 2016). As such, agency may be understood (as a research object) by the scientific observer through interpretation, i.e. by seeing the world from the position and context of agents within the land system, with an aim to “bring to light an underlying coherence” of the common world as experienced by the individual thus situated (Taylor 1971; see also Huff 2017). In this sense, understanding agency is to understand the totality of objects and their meanings seen from the vantage point of an empirical position (Lehman 2017) situated within a social *and* ecological whole (Taylor 2016; Antrop and Van Eetvelde 2017) here referred to holistically as a land system (or socio-natural holon). In a nutshell, this form of objectification of subjectivity—the process of making human worlds available for inspection from the outside of their original context—is a process of building generalized models of first person perspectives. This is likely to be a fruitful focus for further research on agency in land systems. As the case study shows, analytic vocabularies may be developed in this way, which explain continuous patterns of land use as well as breaks and disruptions in their development, seen from an integrated yet generalized first person perspective.

It follows from this view that components of a land system shift in terms of the value or meaning they hold for agents and the way they contextualise land use practices, in alignment with the fluid positioning and orientation of agents. Beings and ecologies may be visible to agents as objects or may at other times be imperceptible and inaccessible, for example if they appear to be of no separate form, have no apparent meaning or relevance when considered as objects, or are relegated to a group of objects for which specific limitations or modes of existence are believed or assumed to apply. Objects and meanings can in this way be understood to arise through agency on two conditions, possibility and conceivability, that must both be met for objects to appear to humans as decision conditions in the land system. In this perspective, specific empirical instances and forms of agency within land systems can be investigated in ways that place processes of categorisation and interpretation practices

conducted by agents at the centre of analysis, while retaining a realist approach to the assessment of limitations and possibilities imposed by ecological reality.

Author contributions All authors contributed equally to the conception, literature review, analysis and writing of the manuscript. All authors read and approved the final manuscript. The lead author was responsible for thought leadership and conceptual development.

Funding Open access funding provided by Roskilde University. This work was supported by FWO Research Foundation Flanders (Grant numbers K800321N), the Faculty of Science of Ghent University and the IGN International Academy of the University of Copenhagen.

Availability of data and materials Not applicable.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical approval Not applicable.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Adams S (2021) The pragmatic holism of social–ecological systems theory: explaining adaptive capacity in a changing climate. *Prog Hum Geogr* 45(6):1580–1600
- Angelstam P, Munoz-Rojas J, Pinto-Correia T (2019) Landscape concepts and approaches foster learning about ecosystem services. *Landsc Ecol* 34:1445–1460
- Angelstam P, Fedoriak M, Cruz F et al (2021) Meeting places and social capital supporting rural landscape stewardship: a Pan-European horizon scanning. *Ecol Soc* 26(1):11
- Antrop M (2021) Landscape mosaics and the patch-corridor-matrix model. In: Francis RA, Millington JDA, Perry GLW, Minor ES (eds) *The Routledge handbook of landscape ecology*. Routledge, pp 25–48
- Antrop M, Van Eetvelde V (2000) Holistic aspects of suburban landscapes: visual image interpretation and landscape metrics. *Landsc Urban Plan* 50:43–58
- Antrop M, Van Eetvelde V (2017) *Landscape perspectives: the holistic nature of landscape*, 1st edn. Springer Netherlands, Dordrecht
- Arbuckle JG, Morton LW, Hobbs J (2015) Understanding farmer perspectives on climate change adaptation and mitigation. *Environ Behav* 47:205–234
- Atkinson W (2020) *Bourdieu and after: a guide to relational phenomenology*. Routledge, New York
- Bell S (2012) *Landscape: pattern, perception and process*. Routledge, New York
- Bieling C, Plieninger T (eds) (2017) *The science and practice of landscape stewardship*. Cambridge University Press, Cambridge
- Bourdieu P (1977) *Outline of a theory of practice*. Cambridge University Press, Cambridge
- Brooking T, Pawson E (2010) *Seeds of empire the environmental transformation of New Zealand*. I.B. Tauris, London
- Brown VA, Harris JA, Waltner-Toews D (eds) (2019) *Independent thinking in an uncertain world: a mind of one's own*. Routledge, London
- Burton RJF, Wilson GA (2006) Injecting social psychology theory into conceptualisations of agricultural agency: towards a post-productivist farmer self-identity? *J Rural Stud* 22:95–115. <https://doi.org/10.1016/j.jrurstud.2005.07.004>
- Burton RJF, Forney J, Stock P, Sutherland L-A (2020) *The good farmer: culture and identity in food and agriculture*. Routledge, London
- Carnahan D, Hao Q, Yan X (2019) Framing methodology: a critical review. In: *Oxford research encyclopedia of politics*. <https://oxfordre.com/politics/view/10.1093/acrefore/9780190228637.001.0001/acrefore-9780190228637-e-1026>. Accessed 22 Jun 2020
- Christensen AA (2013) Mastering the land: mapping and metrologies in Aotearoa New Zealand. In: Pawson E, Brooking T (eds) *Making a new land*, 2nd edn. University of Otago Press, Dunedin, pp 310–327
- Christensen AA (2016) *Agrarian landscape management in a modernized world*. PhD Thesis, Department of Geosciences and Natural Resource Management, Faculty of Science, University of Copenhagen
- Christensen AA, Brandt J, Svenningsen SR (2017) *Landscape Ecology*. In: Richardson D, Castree N, Goodchild MF et al (eds) *International encyclopedia of geography: people, the earth, environment and technology*. John Wiley & Sons Ltd, Oxford, pp 1–10
- Ciais P, Sabine C, Bala G et al (2013) Carbon and other biogeochemical cycles. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM (eds) *Climate change 2013: the physical science basis*. Contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp 465–570

- Cressman D (2018) Actor-network theory. In: Ritzer G, Rojek C (eds) *The Blackwell encyclopedia of sociology*. John Wiley & Sons Ltd, New York, pp 1–2
- Cronon W (1996) The trouble with wilderness: or, getting back to the wrong nature. *Environ Hist* 1:7–28
- Cronon W (2000) Resisting monoliths and tabulae rasae. *Ecol Appl* 10:673–675
- deLaplante K (2008) Philosophy of ecology: overview. In: Fath B (ed) *Encyclopedia of ecology*, 2nd edn. Elsevier, Oxford, pp 510–515
- Descola P (2012) *The ecology of others: anthropology and the question of nature*. Prickly Paradigm Press, Chicago, IL
- Diaz S, Settele J, Brondizio ES et al (2019) Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* 366(6471):eaax3100
- Dreier O (2020) Critical psychology: subjects in situated social practices. In: Fler M, González Rey F, Jones PE (eds) *Cultural-historical and critical psychology: common ground, divergences and future pathways*. Springer, Singapore, pp 11–26
- Dudley N, Stolton S (2020) *Leaving space for nature: the critical role of area-based conservation*. Routledge studies in conservation and the environment, 1st edn. Routledge, New York
- Duineveld M, Van Assche K, Beunen R (2017) Re-conceptualising political landscapes after the material turn: a typology of material events. *Landsc Res* 42:375–384
- Dynes RA, Burggraaf VT, Goulter CG, Dalley DE (2010) Canterbury farming: production, processing and farming systems. *Proc N Z Grassl Assoc* 72:I–VIII
- Eidelson RJ (1997) Complex adaptive systems in the behavioral and social sciences. *Rev Gen Psychol* 1:42–71
- Ellis EC (2015) Ecology in an anthropogenic biosphere. *Ecol Monogr* 85:287–331
- Ellis EC (2021) Land use and ecological change: a 12,000-year history. *Annu Rev Environ Resour* 46:1–33
- Ellis EC, Klein Goldewijk K, Siebert S et al (2010) Anthropogenic transformation of the biomes, 1700 to 2000: anthropogenic transformation of the biomes. *Glob Ecol Biogeogr* 19(5):589–606
- Forman RTT (1995) *Land mosaics: the ecology of landscapes and regions*. Cambridge University Press, Cambridge
- Forman RTT, Godron M (1986) *Landscape ecology*. Wiley, New York
- Gerrits L (2023) Traveling between worlds: repositioning methods and theory for research into coupled socio-ecological systems. *Landsc Ecol* 38:4065–4077
- Giddens A (1986) *The Constitution of Society: outline of the theory of structuration*, First, paperback. University of California Press, Berkeley, LA
- Giddens A (2001) Dimensions of globalization. In: Seidman S, Alexander J (eds) *The new social theory reader: contemporary debates*. Routledge, London, pp 245–252
- Glückler J, Panitz R (2021) Unleashing the potential of relational research: a meta-analysis of network studies in human geography. *Prog Hum Geogr* 45:1531–1557
- Graham C, Michael B (2020) Chaos and complexity. In: Kobayashi A (ed) *International encyclopedia of human geography*, 2nd edn. Elsevier, Oxford, pp 133–141
- Granö JG, Granö O, Paasi A (1997) *Pure geography*. The Johns Hopkins University Press, Baltimore, MD
- Graversgaard M, Christensen AA, Thorsøe MH et al (2023) What does framing theory add to our understanding of collective decision making in nitrogen management? *Landsc Ecol* 38:4139–4155
- Guerrero AM, Bennett NJ, Wilson KA et al (2018) Achieving the promise of integration in social-ecological research: a review and prospectus. *Ecol Soc* 23(3):38
- Hägerstrand T (2001) A look at the political geography of environmental management. In: Buttimer A (ed) *Sustainable landscapes and lifeways - scale and appropriateness*. Cork University Press, Cork, pp 35–58
- Head L (2012) Conceptualising the human in cultural landscapes and resilience thinking. In: Bieling C, Plieninger T (eds) *Resilience and the cultural landscape: understanding and managing change in human-shaped environments*. Cambridge University Press, Cambridge, pp 65–79
- Head L (2017) Cultures of nature. *Int Encycl Geogr* 2017:1–6
- Hincks S, Powell R (2022) Territorial stigmatisation beyond the city: habitus, affordances and landscapes of industrial ruination. *Environ Plan Econ Space* 54:1391–1410
- Hindin MJ (2007) Role theory. In: Ritzer G (ed) *The Blackwell encyclopedia of sociology*. Blackwell, New York, pp 3959–3962
- Holling CS (2001) Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4:390–405
- Huff T (2017) *Max Weber and methodology of social science*. Routledge, New York
- Hui A, Walker G (2018) Concepts and methodologies for a new relational geography of energy demand: social practices, doing-places and settings. *Energy Res Soc Sci* 36:21–29
- Ilbery BW, Bowler I (1998) From agricultural productivism to post-productivism. In: Ilbery BW (ed) *The geography of rural change*. Longman, Harlow, pp 57–84
- Jackman H (2014) Meaning holism. <https://plato.stanford.edu/archives/fall2014/entries/meaning-holism/>
- Kok KPW, Loeber AMC, Grin J (2021) Politics of complexity: conceptualizing agency, power and powering in the transitional dynamics of complex adaptive systems. *Res Policy* 50:104183
- Lansing JS (2003) Complex adaptive systems. *Annu Rev Anthropol* 32:183–204
- Latour B (2004) *Politics of nature: how to bring the sciences into democracy*. Harvard University Press, Cambridge, MA
- le Polain de Waroux Y, Garrett RD, Chapman M et al (2021) The role of culture in land system science. *J Land Use Sci* 16:450–466
- Lehman G (2017) *Charles Taylor's ecological conversations: politics, commonalities and the natural environment*. Palgrave Macmillan, Basingstoke
- Linton R (1936) *The study of man: an introduction*. Appleton-Century, New York
- List C, Spiekermann K (2013) Methodological individualism and holism in political science: a reconciliation. *Am Polit Sci Rev* 107:629–643
- Liu J, Herzberger A, Kapsar K et al (2019) What is telecoupling? In: Friis C, Nielsen JØ (eds) *Telecoupling*:

- exploring land-use change in a globalised world. Springer International Publishing, Cham, pp 19–48
- Lobo L, Heras-Escribano M, Travieso D (2018) The history and philosophy of ecological psychology. *Front Psychol* 9:2228
- Lorimer J (2015) *Wildlife in the Anthropocene: conservation after nature*. University of Minnesota Press, Minneapolis, MN
- Magliocca NR, Rudel TK, Verburg PH et al (2015) Synthesis in land change science: methodological patterns, challenges, and guidelines. *Reg Environ Change* 15:211–226
- Malpas J (2002) The weave of meaning: holism and contextuality. *Lang Commun* 22:403–419
- Marsden T (2013) From post-productionism to reflexive governance: contested transitions in securing more sustainable food futures. *J Rural Stud* 29:123–134
- Marsden T, Murdoch J, Lowe P et al (1993) *Constructing the countryside*. UCL Press, London
- Mead GH (1938) *The philosophy of the act*. University of Chicago Press, Chicago, IL
- Meinig D (1979) The beholding eye—ten versions of the same scene. In: Meinig D (ed) *The interpretation of ordinary landscapes*. Oxford University Press, New York, pp 33–48
- Meurk C (2008) Vegetation of the Canterbury Plains and downlands. In: Winterbourne M, Knox G, Burrows CJ, Marsden I (eds) *The natural history of Canterbury*. Canterbury University Press, Christchurch, pp 195–250
- Meyfroidt P, Roy Chowdhury R, de Bremond A et al (2018) Middle-range theories of land system change. *Glob Environ Change* 53:52–67
- Meyfroidt P, de Bremond A, Ryan CM et al (2022) Ten facts about land systems for sustainability. *Proc Natl Acad Sci USA* 119:e2109217118
- Naveh Z, Lieberman AS (1994) *Landscape ecology: theory and application*, 2nd edn. Springer-Verlag, New York
- Opdam P (2018) Exploring the role of science in sustainable landscape management an introduction to the special issue. *Sustainability* 10:331
- Opdam P, Luque S, Nassauer J et al (2018) How can landscape ecology contribute to sustainability science? *Landsc Ecol* 33:1–7
- Outhwaite W (2000) Classical and modern social theory. In: Andersen H, Kaspersen LB (eds) *Classical and modern social theory*. Blackwell, Malden, MA, pp 3–15
- Patton MQ (2015) *Qualitative research and evaluation methods: integrating theory and practice*, 4th edn. Sage Publications, Thousand Oaks, CA
- Pawson E, Christensen AA (2014) Landscapes of the Anthropocene: from dominion to dependence? In: Frawley J, McCalman I (eds) *Rethinking invasion ecologies from the environmental humanities*. Routledge, London, pp 64–83
- Pawson E, Holland P (2008) People, environment and landscape since the 1840s. In: Winterbourn M, Knox G, Burrows C, Marsden I (eds) *The natural history of Canterbury*. Canterbury University Press, Christchurch, pp 37–64
- Pearson D (2020) Key roles for landscape ecology in transformative agriculture using Aotearoa—New Zealand as a case example. *Land* 9:146
- Petrosillo I, Aretano R, Zurlini G (2015) Socioecological systems. In: Fath B (ed) *Encyclopedia of ecology*, 2nd edn. Elsevier, Oxford, pp 419–425
- Petrosillo I, Valente D, Mulder C et al (2021) The resilient recurrent behavior of mediterranean semi-arid complex adaptive landscapes. *Land* 10:296
- Piironen T (2018) A meaning holistic (dis)solution of subject–object dualism—its implications for the human sciences. *Hist Hum Sci* 31:64–82
- Preiser R, Biggs R, De Vos A, Folke C (2018) Social-ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches. *Ecol Soc* 23(4):46
- Primdahl J, Kristensen LS (2011) The farmer as a landscape manager: management roles and change patterns in a Danish region. *Geogr Tidsskr-Dan J Geogr* 111:107–116
- Primdahl J, Kristensen LS, Busck AG (2013) The farmer and landscape management: different roles, different policy approaches: the farmer as a landscape manager. *Geogr Compass* 7:300–314
- Primdahl J, Kristensen LS, Arler F et al (2018) Rural landscape governance and expertise: on landscape agents and democracy. In: Egoz S, Jørgensen K, Ruggeri D (eds) *Defining landscape democracy*. Edward Elgar Publishing, Cheltenham, pp 153–164
- Raffn J, Christensen AA, de Witt M et al (2023) Introducing a flat ontology into landscape research: a case study of water governance experiments in South Africa. *Landsc Ecol* 38:4193–4209
- Rapport N, Overing J (2007) *Social and cultural anthropology: the key concepts*, 2nd edn. Routledge, New York
- Raymond CM, Bieling C, Fagerholm N et al (2016) The farmer as a landscape steward: comparing local understandings of landscape stewardship, landscape values, and land management actions. *Ambio* 45:173–184
- Reed J, Kusters K, Barlow J et al (2021) Re-integrating ecology into integrated landscape approaches. *Landsc Ecol* 36:2395–2407
- Rescia A, Pérez-Corona ME, Arribas-Ureña P, Dover J (2012) Cultural landscapes as complex adaptive systems: the cases of northern Spain and Northern Argentina. In: Plieninger T, Bieling C (eds) *Resilience and the cultural landscape: understanding and managing change in human-shaped environments*. Cambridge University Press, Cambridge, p 212
- Rogers A, Castree N, Kitchin R (2013) Place attachment. In: *A dictionary of human geography*. Oxford University Press. <https://www.oxfordreference.com/display/10.1093/acref/9780199599868.001.0001/acref-9780199599868-e-1401?rskey=cfVDV2&result=1401>
- Salvati L, Mavrakis A, Colantoni A et al (2015) Complex adaptive systems, soil degradation and land sensitivity to desertification: a multivariate assessment of Italian agroforest landscape. *Sci Total Environ* 521–522:235–245
- Sauer CO (1925) *The morphology of landscape*. University Press, Berkeley, CA
- Schmitzberger I, Wrška Th, Steurer B et al (2005) How farming styles influence biodiversity maintenance in Austrian agricultural landscapes. *Agric Ecosyst Environ* 108:274–290

- Schneider D (1976) Notes toward a theory of culture. In: Basso K, Selby H (eds) *Meaning in anthropology*. University of New Mexico Press, Albuquerque, NM, pp 197–220
- Schraube E, Schraube E (2015) Why theory matters: analytical strategies of critical psychology. *Estud Psicol Camp* 32:533–545
- Smuts JC (1926) *Holism and evolution*. The Macmillan Company, New York
- Sorvali J, Kaseva J, Peltonen-Sainio P (2021) Farmer views on climate change—a longitudinal study of threats, opportunities and action. *Clim Change* 164:50
- Steffen W, Richardson K, Rockström J et al (2020) The emergence and evolution of Earth system science. *Nat Rev Earth Environ* 1:554–554
- Stenseke M (2018) Connecting ‘relational values’ and relational landscape approaches. *Curr Opin Environ Sustain* 35:82–88
- Taylor C (1971) Interpretation and the Sciences of man. *Rev Metaphys* 25:3–51
- Taylor C (1989) *Sources of the self: the making of the modern identity*. Harvard University Press, Cambridge, MA
- Taylor C (2016) *The language animal: the full shape of the human linguistic capacity*. The Belknap Press of Harvard University Press, Cambridge, MA
- Trepl L, Voigt A (2011) The classical holism-reductionism debate in ecology. In: Schwarz A, Jax K (eds) *Ecology revisited: reflecting on concepts, advancing science*. Springer Netherlands, Dordrecht, pp 45–83
- Troll C (1939) *Luftbildforschung und Landeskundige Forschung*. Erdkundliches Wissen. Steiner Verlag, Wiesbaden
- Turner B, Meyfroidt P, Kuemmerle T et al (2020) Framing the search for a theory of land use. *J Land Use Sci* 15:489–508
- Turner BL, Lambin EF, Verburg PH (2021) From land-use/land-cover to land system science. *Ambio* 50:1291–1294
- van der Ploeg JD (1994) Styles of farming: an introductory note on concept and methodology. In: van der Ploeg JD, Long A (eds) *Born from within: practice and perspectives of endogenous rural development*. van Gorcum, Assen, pp 7–30
- van der Ploeg JD (2012) The genesis and further unfolding of farming styles research. *Hist Anthropol* 20:427–439
- van der Ploeg JD, Barjolle D, Bruil J et al (2019) The economic potential of agroecology: empirical evidence from Europe. *J Rural Stud* 71:46–61
- Van Eetvelde V, Christensen AA (2023) Theories in landscape ecology: merging spatial, ecological and social logics in the study of cultural landscapes. *Landscape Ecol* 38:4033–4064
- Vanclay F, Howden P, Mesiti L, Glyde S (2006) The social and intellectual construction of farming styles: testing Dutch ideas in Australian agriculture. *Sociol Rural* 46:61–82
- Verburg PH, Crossman N, Ellis EC et al (2015) Land system science and sustainable development of the earth system: a global land project perspective. *Anthropocene* 12:29–41
- Verburg PH, Alexander P, Evans T et al (2019) Beyond land cover change: towards a new generation of land use models. *Curr Opin Environ Sustain* 38:77–85
- Wagemans J (2015) *Historical and conceptual background: Gestalt theory*. Oxford University Press, Oxford
- Waterton E (2018) More-than-representational landscapes. In: Howard P, Thompson I, Waterton E, Atha M (eds) *The Routledge companion to landscape studies*, 2nd edn. Routledge, London, pp 91–101
- Watkins JWN (1957) Historical explanation in the social sciences. *Br J Philos Sci* 8:104–117
- Whatmore S (2000) Heterogeneous geographies: reimagining the spaces of N/nature. In: Naylor S, Ryan J, Cook I, Crouch D (eds) *Cultural turns/geographical turns*. Routledge, London, pp 265–272
- Wilson GA (2001) From productivism to post-productivism... and back again? exploring the (Un)changed natural and mental landscapes of European agriculture. *Trans Inst Br Geogr* 26:77–102
- Wilson GA (ed) (2007) *Multifunctional agriculture: a transition theory perspective*. CABI, Wallingford
- Wilson GA, Burton RJF (2015) ‘Neo-productivist’ agriculture: spatio-temporal versus structuralist perspectives. *J Rural Stud* 38:52–64
- Wu J (2010) Landscape of culture and culture of landscape: does landscape ecology need culture? *Landscape Ecol* 25:1147–1150
- Wu J (2019) Linking landscape, land system and design approaches to achieve sustainability. *J Land Use Sci* 14:173–189
- Zonneveld IS (1995) *Land ecology: an introduction to landscape ecology as a base for land evaluation, land management and conservation*. SPB Academic Publishing, Amsterdam

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.