Chapter 2
Conceptualizing Distal Drivers in Land Use Competition

Jörg Niewöhner, Jonas Ø. Nielsen, Ignacio Gasparri, Yaqing Gou, Mads Hauge, Neha Joshi, Anke Schaffartzik, Frank Sejersen, Karen C. Seto and Chris Shughrue

Abstract This introductory chapter explores the notion of 'distal drivers' in land use competition. Research has moved beyond proximate causes of land cover and land use change to focus on the underlying drivers of these dynamics. We discuss the framework of telecoupling within human–environment systems as a first step to

J. Niewöhner (✉)
Institute of European Ethnology and Integrative Research Institute THESys, Humboldt-Universität zu Berlin, Berlin, Germany
e-mail: joerg.niewoehner@staff.hu-berlin.de

J.Ø. Nielsen
Department of Geography & IRI THESys, Humboldt-Universität zu Berlin, Berlin, Germany
e-mail: jonas.ostergaard.nielsen@hu-berlin.de

I. Gasparri
Instituto de Ecología Regional, CONICET-Universidad Nacional de Tucumán, Tucumán, Argentina
e-mail: ignacio.gasparri@gmail.com

Y. Gou
School of Geosciences, University of Edinburgh, Edinburgh, UK
e-mail: Y.Gou@ed.ac.uk

M. Hauge · N. Joshi
Department of Geosciences and Natural Resource Management, Geography Section, University of Copenhagen, Copenhagen, Denmark
e-mail: mmh@ign.ku.dk

N. Joshi
e-mail: npjo@ign.ku.dk

A. Schaffartzik
Institute of Social Ecology, Alpen-Adria Universität Klagenfurt-Wien-Graz, Vienna, Austria
e-mail: anke.schaffartzik@aau.at

F. Sejersen
Department of Cross-Cultural and Regional Studies, University of Copenhagen, Copenhagen, Denmark

K.C. Seto · C. Shughrue
Yale School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA

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come to terms with the increasingly distal nature of driving forces behind land use practices. We then expand the notion of distal as mainly a measure of Euclidian space to include temporal, social, and institutional dimensions. This understanding of distal widens our analytical scope for the analysis of land use competition as a distributed process to consider the role of knowledge and power, technology, and different temporalities within a relational or systemic analysis of practices of land use competition. We conclude by pointing toward the historical and social contingency of land use competition and by acknowledging that this contingency requires a methodological–analytical approach to dynamics that goes beyond linear cause–effect relationships. A critical component of future research will be a better understanding of different types of feedback processes reaching from biophysical feedback loops to feedback produced by individual or institutional reflexivity.

Keywords Telecoupling · Social space · Systemic effects · Competition as process · Power/knowledge

2.1 Distal Drivers—A Conceptual Challenge

Land as a biophysical entity always has a specific presence in Euclidian space. Its extent can be measured in areal and topographic terms. Its position can be located relative to a global grid of longitude and latitude. Land use, therefore, necessarily possesses a local component. Land is always used some*where*. Yet the notion of 'land use' complicates the picture. Some*one* is doing the using. For a long time, this has been straightforward: An individual or a group of people is using land for their own purpose, e.g., to live and produce something on it, most commonly food.

Today, land use at all spatial levels is influenced by long-distance flows of raw materials, energy, products, people, information, and capital creating a need for novel theoretical and methodological approaches to the analysis of causal relations in land systems. An increasing spatial decoupling of drivers and outcomes in current land use patterns is challenging the straightforward relationship of local land use and consumption most evident in subsistence agriculture; think, for example, of a tropical forest being protected from agricultural use through the international 'Reducing Emissions from Deforestation and Forest Degradation' (REDD+) program. This forest might simultaneously be used by the international group of participating states as a carbon sink to slow down global climate change, it may serve local people to sustain their livelihoods in multiple ways, and it might also be of particular symbolic or spiritual significance for yet another group of people.[1]

[1]We emphasize that this symbolic dimension is by no means restricted to indigenous groups. Debates in Germany in the 1980s about 'Waldsterben,' i.e., the dying of forests due to increasingly acidic rain, made abundantly clear how important forests are in German discourse and symbolism. Not least the concept of the 'risk society' has been developed by German sociologist Ulrich Beck under the impression of the debates about dying forests.

Moreover, the REDD+ protection of a forest area may also serve the purpose of protecting biodiversity. Hence, many nonhuman actors also use the forest.

Thus, the same piece of land can be subjected to multiple uses at the same time. Land use may involve agents of different kinds, such as human and nonhuman. What may be considered 'use' and a 'legitimate use' depends on epistemic and ethical perspectives and varies with the observer. And the reasons why a piece of land is used in a particular way may not be found locally.

Land use science research has grappled with the spatiotemporally distributed nature of land use for decades. When the analysis of remote sensing data was producing land cover maps documenting changes over time at different scales, the question 'why' these changes were occurring loomed large immediately. To address this new set of questions, a distinction between proximate causes and distal or underlying drivers has been established (Lambin and Geist 2006). Others have spoken of direct and indirect effects on land use transitions (Marcotullio 2014) or of pressures and drivers (Young et al. 2006). Proximate causes are considered direct and local, distal drivers underlying or root. 'The proximate causes of land use change explain how and why local land cover and ecosystem processes are modified directly by humans, while underlying causes explain the broader context and fundamental forces underpinning these local actions. In general, proximate causes operate at the local level (individual farms, households, or communities) and underlying causes originate from regional (districts, provinces, or country) or even global levels, though complex interplays between these levels of organization are common. As a result, underlying causes also tend to be complex, formed by interactions of social, political, economic, demographic, technological, cultural, and biophysical variables' (Guyer et al. 2007).

Research on proximate causes has long been primarily a challenge in terms of data availability, quality, and analysis. It has set out from the initial questions 'what is happening where?' and 'who does what on a specific piece of land?' Contributions from physical geography, and particularly the remote sensing community, have provided an understanding of land cover dynamics that enables the research community to now ask questions about underlying and distal drivers of land use change. Understanding these drivers requires the development and deployment of suitable (remote) sensor technology and increasingly fine-grained temporal and spatial analytical techniques to increase coverage and analytical resolution. Yet, a rather more complex difficulty lies in the integration of biophysical land cover and land use data with qualitative, often disaggregated 'ground-based' data. The chapters by Joshi and Gou in this section demonstrate the challenges that arise when land use changes rapidly and when categories such as 'degraded forest' struggle to discriminate sufficiently enough and meaningfully between actual land use practices. A thick analysis of such processes that are as much biophysical as they are social requires empirical data on the natural and cultural dynamics, on land cover and ecosystem characteristics as well as markets, regulation, social and moral orders, and cultural and environmental history. And it requires multiple disciplinary perspectives and conceptual advances to relate them

to each other. Established conceptual distinctions between nature and culture are unlikely to be up to the task (Palsson et al. 2013).

Research on underlying and often distal drivers faces another problem. It is often not feasible to reconstruct—let alone understand or predict—all underlying factors and their interactions that have shaped a particular decision or event and thus 'caused' a particular land use. Given the important context of global social and environmental change, it is often necessary to consider the manifold interactions between individual land use decisions and thus discern trends, feedbacks, and emergent effects that only manifest at levels of analysis above individual decisions or events. Research on distal drivers in global land use change thus needs to select and prioritize from an overwhelmingly complex intermingling of relevant factors. This is a process that is informed by empirical data, but cannot in itself be determined by it. Prioritization needs to be theoretically and conceptually shaped and legitimated.

2.2 The Telecoupling Framework

The concept of 'teleconnection and telecoupling' offers one such conceptual framework with which to analyze distal drivers of land use change under conditions of global social and environmental change (Friis et al. 2015; Seto et al. 2012). As set out originally, the framework starts from a systems-theoretical perspective and assumes that human and natural systems are coupled. 'Systems are defined as a set of human and natural components interacting to form a whole' (Liu et al. 2014). Telecoupling occurs when 'causes generate a telecoupling between a minimum of two coupled human and natural systems, which produce effects that are evident in one or more of the systems. A telecoupling is produced by agents that facilitate or hinder the flows of material/energy or information among the systems' (ibid.: 122). Analyzing processes of telecoupling relies on five components: coupled human natural systems, flows, agents, causes, and effects.

2.2.1 Systems

Systems are divided into sending, receiving, and spillover systems. Spillover systems are systems that are affected by telecoupling processes, although they have until that moment not been connected or not been known to be connected to the sender–receiver coupling. Telecoupling thus focuses attention on effects that emerge anew or that have thus far not been visible through the dominant lenses of knowledge production and governance (Eakin et al. 2014).

2.2.2 Flows

Flows forge the connections between systems. They mediate the coupling. 'Flows exchange material, energy, or information between the systems. Material or energy includes biophysical and socioeconomics entities (goods, food, natural resources, organisms, and carbon), whereas information includes knowledge and agreements (trade agreements, land titles, and agricultural techniques)' (Liu et al. 2014). Flows can also be thought of as manifestations or traces of processes that underlie them, and so measurement of flows can be thought of as an indirect measurement of effects from coupling processes.

2.2.3 Agents

As coupled systems comprise human and natural components, the concept of the agent has been introduced. The perhaps more obvious 'actor' is in the social sciences commonly reserved for human agents; i.e., it is tied to concepts of intentionality, motivation, and behavior as used in psychology and economics and as rooted in much of Western philosophy (Palsson et al. 2013). Agent on the other hand marks a less anthropocentric and more inclusive 'site of agency' and thus incorporates not only human individuals and groups of people, but also herds of animals or government agencies. The boundaries of the category 'agent' are not clearly defined within the telecoupling framework.

2.2.4 Causes and Effects

'Causes are factors that generate dynamics (emergence, change in strength) of a telecoupling. Most telecouplings have multiple causes: cultural, economic, political, technological, or ecological. These are interacting categories' (Liu et al. 2014). The environmental and socioeconomic consequences and impacts of a telecoupling process are analyzed as effects. They are structurally categorized into types: indirect effects, feedbacks, cascading, and legacy effects with often nonlinear and time lagged dynamics (Liu et al. 2014). In addition, system dynamics are understood as hierarchical reaching from flows between multiple systems (high), to a focus on the facilitating agents and cause–effect relationships (intermediate) to particular characteristics of interest (low).

It is important to note that today virtually all land systems are telecoupled (Eakin et al. 2014). Flows of trade, migration, transnational land deals, and financial capital or species invasions are enveloping the globe. In some ways, this is not new. Ever since antiquity, human settlements have been shaped by local social and environmental conditions as well as regional and global flows. The local has never really

been local but always been shaped by constant exchange processes. Yet, the exchange of people, information, and goods today unfolds with unprecedented speed, intensity, and extent. The degree and quality of interdependence has increased with the liberalization of trade and financial markets, the fall of many socialist governments, and the rapid unfolding of information and communication technologies all happening since the late 1970s and at full speed really only since 1989. The resource use of 7.3 billion people has produced a situation of manifold localized resource scarcities and raised matters of distribution with a renewed urgency. 'Feedbacks within systems are now tighter, more rapid, and multiscalar; the potential for rapid acceleration to systemic transformation (thresholds) or crisis arising from multiple systems interactions is higher' (ibid.: 145). Lastly, different forms of industrialization and urbanization at an unprecedented scale are taking place across the globe, leading to new settlement patterns and changing lifestyles and in conjunction largely driving more energy and resource intensive forms of dwelling (Creutzig et al. 2015). And, last but not least, the scientific community is producing new knowledge about these global interdependencies contributing to what one might call a 'planetary moment' in human and natural history: Never before have the planetary dimensions of human action been specified more clearly than today.

Telecoupling is meant to function as an umbrella concept under which to discuss the effects of these macrochanges on concrete transitions in land use change globally. Yet, it has been noted that this will not be achieved in any simple additive or mechanical fashion of factors within a single analytical framework. Rather, there exists a 'need to integrate epistemologies, methodologies, and analytical approaches to expand on place-based land use tradition through a focus on new networks and system interactions involved in land change' (Lambin and Geist 2006). The current global configuration might be conducive to such a pathway as ethical concerns about global imbalances start to play a greater role in decision-making processes across scales of governance. New forms of social contracts, moralities, and empowerment arise and sustainability and resource limitations are now increasingly important motivations for action.

The telecoupling framework is being developed (Friis et al. 2015) in order to be able to deal adequately with the complexities of processes shaping land systems under conditions of global change as reflected in changes in communication and trading patterns, land governance structures, and policy regimes as well as processes of transition that more often than not do not follow linear paths toward modernity. Overall, scholars have diagnosed an increasing spatial decoupling of local land uses from the most important driving forces (Seto et al. 2012). The relative simplicity of the telecoupling framework, which offers much heuristic value, reveals limitations, when interacting forces of land use change are situated within vastly different ecological, economic, political, and cultural contexts.

It has therefore been suggested to carefully widen the disciplinary knowledge base upon which the telecoupling framework rests. Friis and her colleagues have suggested learning from

- economic geography to differentiate the analyses of networks of actors and their power relations through approaches to global production networks and value chains;
- socioeconomic metabolism studies to add material—energetic components and temporality to established economic analyses of flows by drawing on ecological economics, ecological anthropology, industrial, and social ecology;
- political ecology to address questions of power and agency in processes of land systems transitioning with particular attention on human–environment relations;
- cultural anthropology to better understand scaling issues, the demarcation of system boundaries, and 'unexpected' couplings through the thick analysis systems of exchange within which virtually all land systems are embedded (Friis et al. 2015).

This volume adds further observations that may contribute to the broadening of land system science's knowledge base. This section in particular discusses the challenges to the notion of 'distal' drivers in relation to land use competition. In the following, we introduce and explore analytical dimensions of the notion of 'distal drivers' in land use competition that go beyond a largely Euclidian understanding of proximate and distal to also consider social, institutional, and epistemological aspects.

2.3 Analytical Dimensions of 'Distal Drivers' in Land Use Competition

2.3.1 Going Beyond Proximate and Distal: Competition as a Distributed Process

Urbanization, transnational markets, and the increasing importance of internationally coordinated land protection/conservation activities have shifted analytical attention from the immediate pressures on land use toward the more complex interactions of underlying drivers. Supply and use chains, international flows of governance, certification schemes, the transnational mobility of people, goods, services and knowledge, the systemic effects in ecological systems, increasingly networked forms of social movements, and resistance are processes that operate in complicated spatial, temporal, and institutional constellations that are difficult to contain within coherent systems thinking.

Hence, the notion of the distal driver has become central to the analysis of land use change and competition (e.g., Seto et al. 2012). While basic economic understandings of competition may frame competition as that between two actors over a resource that only one can attain, it is clear from the above that land use competition is a highly distributed process. It is distributed across space and time, across agents, and across flows that operate in very different modes and according to different logics.

In such a constellation, the distinction between proximate and distal loses significance. A proximate pressure, e.g., the decision of a local farmer to plant crop X instead of Y, may be direct and local relative to the plot of land under investigation. Yet, the farmer's decision between competing alternatives is only one step in a distributed process. This process may involve evaluating past success of other crops grown on this land, checking prices on markets in different locations, considering the institutional (legal, cultural, and ethical) setting and implications of this process, mediating positions within a social network, and pondering knowledge about global change and the implications of this decision for the local social—ecological system or even the global climate. This means that individual land use decisions are embedded in multiple social, political, historical, and ecological contexts and as such each decision is conditional upon more or less distal drivers. When it comes to competition over land, it is therefore important to understand that decisions regarding land use are mediated in many different ways in which the (Euclidian) spatial component is integrated into a broader spatial and temporal set of processes. As outlined in the overall introduction to this book, we understand competition over land use in the same way. Competition must be understood as a relational concept that focuses our analytical attention on the properties and qualities of relations between drivers in land use change. Adding to this, the following sections explore the increasingly distributed and processual nature of competition.

Moving away from an understanding of land use competition as a single decision-making moment and toward seeing it as a mediated process requires paying analytical attention to the contingent nature of decision-making processes. Consider transnational agricultural markets as an example. Their dynamics are crucial in formatting local land use. Econometric approaches have made valuable inroads into connecting a quantitative understanding of demand and supply, quality of produce, and buyer–seller relationships to land use patterns (Garrett et al. 2013). Others, often qualitative approaches, particularly from human geography, anthropology, and science and technology studies, are beginning to emphasize the role of historically developed connections between countries and regions, the role of personal trust between producers and traders, or the role of knowledge about market dynamics and local contexts of production and consumption (Ouma et al. 2013). The competition between different land use decisions is thus a complex process set within a social history and embedded within concrete social interaction, economic and technical infrastructures as well as institutional framings and cultural and moral orders. Add to this the complex dynamics of biophysical connections and flows at different spatial and temporal scales and it becomes clear that a social-ecological understanding of land use competition needs a broad portfolio of theories and methods to capture the processual nature and multiple embeddedness of land use competition (Young et al. 2006).

2.3.2 Space: Material and Social Distance

While largely meant in the sense of 'underlying' in the literature, the term 'distal' in distal drivers is firmly rooted in a Euclidian understanding of space. This is not accidental but reflects the understanding of space prevalent in the land use science literature. Space is commonly understood in material or biophysical terms. Distance is hence measured in Euclidian terms. A driver of land use change may be out of sight and operate 'at a distance.' A prominent example might be the changing patterns of consumption in urban centers driving patterns of agricultural production in increasingly faraway hinterlands. These may be increasingly meat-based diets in industrializing and urbanizing economies or post-material trends toward organic produce from community-supported agriculture in the urban centers of the Global North.

Physical distance may play a role in these cases. Seto and colleagues have already differentiated distance and the patterning of exchange in a spatially explicit model of urban land teleconnections (Seto et al. 2012). They focus on the distribution of senders and receivers within what they suggest ought to be conceived of as an urban–rural continuum. This is a useful framework as it begins to shift from actors of urban–rural teleconnections to the spatially explicit analysis of telecoupling processes. We suggest a further expansion of this thinking here: Physical distance remains a relevant measure, e.g., where issues of space-dependent transaction costs are concerned. Yet, the key message of this type of analysis lies in preparing the analyst for the unexpected, i.e., for the fact that drivers of local land use may be operating at a distance or in Seto's case in multiple sites all at different distances. This is really a functional understanding of distance that only happens to take physical shape, because of geographical thought styles and mapping methodologies. It is not difficult to imagine the same distribution of drivers, but on the basis of social rather than physical distance.

Social space and distance cannot be measured in Euclidian terms. What it is, how it operates, and how it may be studied depends very much on the analyst's social theoretical stance (Niewöhner 2014b). Most social scientists will agree that within groups of people living together forms of social order emerge. These shape to a considerable degree how individuals are positioned relative to each other and how they may interact. What kind of social and moral order emerges within a group of people, how it is continuously legitimated and (de)stabilized, how and by whom it might be changed, and how it operates in everyday life depends on a multitude of aspects reaching from rather stable structural and institutional elements often captured in socioeconomic terms to much more fluid individual motivations and actions, as well as various forms of interaction between these dimensions. Most social scientists today thus consider emerging social orders as comprising dispositional and situational elements. Processes of social ordering unfold within and thus reproduce social space (e.g., Bourdieu 1984). Social space positions agents toward each other and thus produces social differentiation. Such processes of differentiation within social space may be analyzed, for example, with an emphasis on

individual and group-based social and cultural capital, a focus on power, knowledge, and access to political and economic resources or shared strategies of identification and belonging. They result in groups of people, where the notion of group is understood in relational terms, i.e., as distance within social space from others, rather than as homogeneous and stable entities with a fixed culture or identity.

Distances can be mapped in social space as they can in physical space. And the two forms of space interact. Segregation in cities, for example, can be understood as differences in social position and forms of capital inscribing themselves into material form through the size of plots of lands and houses, architectural styles, etc. The structure of the physical space will then act to manifest and reproduce distinctions in social space.

This brief discussion of physical and social space illustrates that 'distance' can take different forms. Hence, one can easily imagine teleconnections between different contexts and actors that are socially distant but physically close. Particularly in the highly dense and socioeconomically differentiated urban centers of the world, effects on land use competition may arise in close physical proximity to each other, but at a vast distance in social terms as they relate to entirely different social worlds. In contrast, diasporic networks of people that have considerable impact on the distribution of economic means in many contexts may be physically distant, but socially close. Many cases of land use competition develop in the context of sharp increases in the value of land. Market integration, the rise of biofuels, or technological advances enabling agricultural production are typical examples. Investigating such cases, it is important to consider the entanglement of physical and social space as emerging markets change existing social spaces. The chapter by Hauge in this section is a case in point. Detailing how middlemen rise to relative prominence in South Vietnam thereby changing established local social orders and the distribution of agency within a local social-ecological system, Hauge shows how a particular land use change is embedded in a historically, politically, and socially mediated process of competition between two types of rice cultivation and marketing.

It is one of the key challenges for an interdisciplinary land systems science to better understand the mutual constitution of physical and social space or, more broadly speaking, the manifold entanglement of nature and culture. For the emerging environmental social sciences and humanities, this means first and foremost coming to terms with the biophysical environment as a social phenomenon (Palsson et al. 2013). For the natural sciences, it requires an appreciation of the social and historical contingency and complexity of 'the social' as a unit of analysis *sui generis*.

2.3.3 Systemic and Relational Perspectives

The notion of distal drivers as outlined above is rooted within systems thinking: Human and natural components interact in coupled social-ecological systems. Systems thinking enables a view from outside or above, identifying system

boundaries, components, and linkages (Young et al. 2006). The point of systems thinking is not to identify the independent effects of individual factors, but rather to focus on synergies and interactions between factors (Lambin and Geist 2006). The focus is on processes more than on nodes. Agent-based modeling in social-ecological systems analysis reflects this desire. Here, nodes or actors are assigned simple rules to then analyze the patterning that arises from these agents in interaction.

We expand on this systemic approach here to suggest what in anthropology is referred to as a relational perspective (Beck 2008; Niewöhner 2014a; Strathern 1991) and what science and technology studies calls relational materialism or actor–network theory (Law and Callon 1992; Law and Mol 2002; Latour 2005). Relational thinking shifts the basic analytical unit from the human actor of rational choice theories to the concrete practices of making connections between agents. It tries to better understand the actual 'how' of making connections within practices of land use competition, whereas the systemic approach focuses on the 'what' of links within systems. We do not argue that the relational perspective is superior to the systemic approach. Rather we think of the two as complementary and mutually enlightening in analysis. Where systems thinking has its strength in quantifying flows and analyzing the topography of social-ecological systems, relational thinking comes into its own by analyzing the quality of relations, the adequacy of system boundaries, and the topology of patterns of land use competition in practice (Marres 2012). In this way, analytical perspectives may be reversed with one starting from actors and systems, the other from relations and practices.

2.3.4 Patterns of Practice in Land Use Competition

Lambin and Geist rightly point out that the search for independent drivers of land use change might be mistaken. Instead, 'different patterns or modes may represent the interactions between the various causes of land change.' The two authors distinguish four modes of interaction between drivers: (1) one cause dominating all others; (2) a connection of causes in causal chains, i.e., in sequential order; (3) independent but synchronous action of several factors on one variable; and (4) interventions in synergetic factor combinations producing feedbacks and reciprocal action (Lambin and Geist 2006: 62ff.).

This systematic is driven by a top-down view onto a network of factors or a system. Following on from our suggestion of a relational perspective, we suggest another understanding of the notion of mode or patterning here that is useful to further differentiate our understanding of connections among drivers. We suggest paying attention to the different patterns of practice within which land use competition unfolds. Social and cultural anthropology has long argued that human practices are characterized by particular patterns and that participating in these

patterns brings order to how people act in particular group- and context-specific ways (Roepstorff et al. 2010). This view rests on the basic insight that action is always embedded in three heuristically different environments: normative orders (institutions, markets, and moral values), social dynamics, and material conditions (cf. Parsons 1937). The idea of patterns of practice emphasizes that actors, who want to solve practical problems of land use competition, must always do so interactively with others in concrete social-ecological situations (Alexander 1988). These interactions form patterns of practice and develop their own routines and implicit logics.

It is of course not only anthropology that has developed this perspective. The concept of 'languages of valuation' in ecological economics (Martinez-Alier 2008) is making a very similar point. Here, the emphasis is on the different values that people may assign to a piece of land. It is the attempt to broaden the economic or monetary logic often in operation in ecosystem services into a set of languages of valuation within which those affected by land use change may express their interests or stakes.

Institutional analysis in turn explores the idea of rules in institutionally formatted processes of competition, particularly around matters of land use and resource use (e.g., Ostrom et al. 1993). Such rules may be formally codified as in laws and regulations. Yet, they may also be conventionalized or routinized at the level of everyday social-ecological practice.

Knowledge plays an important role in shaping such routines and conventions. For example, the widespread mismatch between environmental information accessible to local populations and macrolevel institutions has been noted (Lambin and Geist 2006). A better understanding is needed of how institutional arrangements operate across scales and how this affects people involved in and affected by land use competition. Restoring a sense of agency to local people is an important claim in many land use conflicts (Poteete and Ostrom 2004). Yet, it would be a mistake to analytically treat 'local people' as if they were disconnected from the rest of the world. Not least anthropological research has shown to what degree and how people are embedded in global flows of people, goods, and information (e.g., Hannerz 1993; Strathern 1992). While it is clear that powerful structural asymmetries with regard to agency and knowledge exist between groups of actors, any simple global regimes versus local people framework is bound to miss important elements of land use competition dynamics.

We thus need to pay attention to how these patterns of practice in land use competition are actually constituted. In particular, it is important to better understand the entanglement between ecological, economic, political, and social agents. This is not least a methodological challenge as most methods—e.g., econometrics, governance analysis, ecological analyses, or ethnographic methods—have coevolved with their objects of study and thus operate in rather domain-specific ways.

2.3.5 *Power and Knowledge Structure What Counts as Legitimate*

Environmental social sciences keep emphasizing the importance of power and hegemony in processes of land use competition. The land sciences have so far not developed an explicit focus on the role of power, albeit for different reasons: The physical sciences are primarily interested in the states and dynamics of the material world and thus do not have an immediate need for a theory of (sociopolitical) power. For many economists, power in the context of competition refers to the risk of concentration of market power in monopolistic structures. Political power is thus understood as the regulating framework within which market dynamics are analyzed.

For the social sciences, power is a key variable in analyzing social processes such as competition. Conceptually, power comes in two forms. One is largely congruent with the commonsensical meaning of the word and refers to the power to enforce one's will against the will of others in a social situation (e.g., Weber 1922/2002). The exercise of power may be agreed upon or coercive, and it may be legitimate or not. In democratic systems, power is given to elected representatives. In the analysis of political constellations that are set up to govern land use competition, this notion of power is conventionally used. Actors have the power to enforce agreed upon rules. This usually applies to territorial jurisdictions such as nation states or provinces. Within the trans- and particular the international realm, the role of these powers is weakened due to the absence of institutions with the power to enforce rules and impose sanctions. Institutional analysis, as well as analyses of governance regimes, usually operates implicitly or explicitly with such a notion of power.

A second notion of power plays a much lesser role in the land science community. This notion originates with the French philosopher Michel Foucault (Foucault 1972). Foucault ties the notion of power not to individual people or institutions, but to discursive practices and formations. A discursive formation comprises not only the language, codes, conventions, and habits, but also the material artifacts of a particular time and society. Discourse shapes the orders of truth; i.e., what may count in any given society as true and real. Power then operates within these discursive formations through the micropolitics of everyday interaction. In land use competition, ecosystem services may serve as a good example (e.g., Daily and Matson 2008). The valuation of ecosystems through particular mechanisms is a major driver in land use competition. It brings such diverse issues as natural resources, biodiversity, or indigenous knowledge onto a common denominator—the 'service'—to further process toward a consensus on the value of a particular piece of land or ecosystem. The rapid spreading of the concept of ecosystem service assessment throughout the world can be understood as driven by a discourse that makes it seem true and legitimate that nature ought to be valued in order to trade, develop, or protect it. This process is not simply driven by a few powerful global actors—though these, of course, exist. It can occur, because

scientific and market expertise within a larger capitalist market mode of governance align to make the valuation of nature in a particular way seem meaningful while alternatives appear to be naïve or simply not thinkable (Chan et al. 2012).

This is not about judging the meaningfulness of the concept of ecosystem services. It is an analytical perspective that investigates the conditions that lead to such a concept becoming the dominant lens through which to understand the value of land. Scientific knowledge plays a key role here. Much of ecosystem service assessment relies on scientific data about land and land use. The same is true for many other concepts such as metabolic flows, biodiversity, or planetary boundaries.

Scientific knowledge and its circulation globally has become a key driver of land use and land use competition. In its most obvious form: Global climate change would not exist in its current form if it were not for global climate science. This is not only saying that the way we know and problematize our planet is heavily shaped by scientific knowledge, particularly as it is impossible to experience *global* climate change directly and without the help of global climate science, but also pointing out that scientific knowledge about global climate change shapes our responses and interventions. Scientific knowledge circulates globally and this knowledge increasingly drives land use decisions. For the global land science community, this means being 'reflexive,' i.e., constantly questioning the data produced, the methods used, and the categories developed as well as their respective wider societal and ecological consequences. Gou (Chap. 6) in this volume contributes to this debate by asking about the role of radar versus optical sensors in detecting land degradation and the largely unquestioned normativity of the label 'degraded.' Reflexivity means being aware of the looping effects between scientific knowledge, the categories produced on the basis of that knowledge, and the effects these categories have in the real world (Hacking 2006, see also Chap. 1). The role of technology in this process, e.g., sensor technology development in remote sensing, is vital.

2.3.6 Technology Makes Connections

Technology has become an important driver in land use competition. First and foremost, information and communication technologies increase the rate, extent, and speed of information exchange. For example, in the context of market access, being able to communicate instantly over vast distances is changing social relations and systems of exchange. Research on globalization shows how a world that has always been networked through trade routes and colonizing powers is now connected much more intimately. Diasporic cultures develop in close connection with people in the home countries, migration routes are rapidly being communicated across vast regions, social movements connect and learn in global networks: information, knowledge, goods, and people flow differently through such global scapes (Appadurai 1991).

Agricultural technology also develops and spreads quickly through global agricultural businesses and information exchange. As Gasparri shows in this volume

(Chap. 4), the arrival of new, more salinity tolerant soy plants in the Chaco region rapidly turned what was a dry forest largely inhabited and managed through local pueblo systems into one of the hotspots for global soy production, thus triggering massive land use change. Importantly, technology holds the potential to make unforeseen connections and create new trajectories. Such surprising connections have already been discussed in the context of the telecoupling concept. Spillover effects and the coupling of systems so far unconnected is a major point of analytical attention. The role of technology in helping to establish these connections outside of known trajectories and systems of governance must not be underestimated.

2.3.7 Recognizing Different Temporalities in Land Use Competition

The concept of underlying drivers of land use competition points to the increasing functional distance of local land use from the highly mediated processes of global competition and decision-making. The role of different temporalities is crucial in this context. We suggest to distinguish three forms of temporality.

History

Patterns of land use and that of land use competition have environmental and sociocultural histories. As particularly Hauge, Schaffartzik, and Gasparri (Chaps. 3, 4 and 5) demonstrate in this section, land use patterns have a legacy in environmental, political, and social contexts. History can be considered part of a discourse (see above, Foucault) that structures to some degree what may count as feasible and legitimate. It also helps to understand social and political relations, traditions and routines of land use, belief systems, and the potential for conflict. History, however, is not only the consecutive succession of past events, e.g., of political regimes or property systems. Rather, in many regions of the world, several historically formed systems of land governance exist at the same time. One may speak of a palimpsest insofar as several different systems of governance may 'shine' through what is currently considered the official rule and code of conduct. Layers of governance may relate back to a colonial past, to times of occupations, or to different settlement periods or political systems. This means that land use competition does not unfold according to one official land governance system. Instead, actors may find ways of legitimately drawing on older systems in order to stake their claim. Oftentimes, the analytical distinction between formal and informal is introduced to clearly distinguish an official way of how things should be done and other, somehow vernacular ways of how things are actually done. This perspective is deeply embedded in a modern Euro-American understanding of nation states with their heavily rationalized bureaucratic structures. For many regions of the world, what is readily lumped together as 'informal' constitutes the norm and understanding the logics of such historically layered systems of governance is paramount to understanding land use competition.

It is also worth noting that most historians today will not conceptualize history only as a representation *of* the past. History is always also a representation *for* something; i.e., it is written today in a particular context, by particular people with a particular goal in mind. Hence, the idea of history as a single linear string of events is problematic. Multiple histories usually emerge on the basis of different sources and different readings of archival sources. The question who tells the history of a particular region in what way is an important one. Historical narratives offer frameworks to understand and legitimate developments in the present and they help to make possible futures and expectations more or less plausible (Brown and Michael 2003). Hence, contested histories, particularly in regions of the world where written archives are nonexistent or have been produced by colonial powers for very particular purposes, need to be analyzed with great care rather than taken for granted as a given narrative.

Potentiality

Many commentators of social-ecological development have pointed out that modernity and its almost universal underlying capitalist market logic entails the promise of a better future: political and social systems that engender reliability in social expectations, secure or higher income, better health care, safer and cleaner living environments, more extensive education, and partaking in the world of consumer goods. These are the promises and expectations built into the discourse of global development and market integration. They may remain implicit or they may be discussed explicitly often when people are faced with their expectations not being met over extended periods of time.

An extensive literature on aspirations, hope, and expectations demonstrates how powerful such factors can be a driving force in the present (Kornienko 2014). In the context of land use competition, it is important to be analytically aware of and sensitive to these imagined or materialized social potential(itie)s (Sejersen 2015) that come with certain prospects of land use development. Sejersen has shown in the context of industrial development in Greenland that decisions to allow the building of large industrial sites in the country are not only driven by typically rationalized decision-making based on actual cost-benefit analyses. Rather the potentiality of a development plays an important role. What narratives about a different future may be attached to a certain piece of land, a landscape, or a proposed site of development? These are powerful factors that do not work predominantly at the level of individual imagination, but rather operate as social imaginaries that help to form collectives and alliances around particular visions of the future.

Response Time

History and potentiality are rooted within the same temporality of linear progression—or be it multiple and contested. Response time on the other hand introduces a different temporality altogether. The concept of response time originates in physics and describes the characteristic time it takes for a state variable to respond to a perturbation. It has been used in nonlinear systems theory to identify variables that have strong two-way interactions (Werner and McNamara 2007). It

has been proposed that variables describing human and natural systems have characteristic response times.

This is not only a technical measure that may interest modelers. Understanding land use competition as a mediated process as discussed above means being aware of differences and mismatches in response times between social and physical processes. For example, a particular derivative market operated online and globally may (be able to) respond within seconds or less to news affecting a region's agricultural productivity, e.g., political unrest or new knowledge about developments in regional climate. Changes in the agricultural system, on the other hand, feedback more slowly onto the economic market. This mismatch in timescale might be thought of as an inherent instability in this system where the market system drives irreversible physical change. It highlights the role of social institutions and governance schemes that evolve on the timescale of the natural system and thus stabilize this temporal asymmetry, which in turn may alter investments and business models on the ground-raising issues about social inequality and environmental damage.

Joshi's chapter in this section demonstrates how variations in the gold price change land use quite dramatically on the ground with massive implications of increased environmental degradation (Chap. 7). In her case study, local miners are able to respond quickly to changing market prices, but regulation and enforcement of sanctions are slow to react to the volatility of the market and rapidly moving actors. The result is a dynamic in land use and land use competition that means that those people lose out who require a more stable social-ecological system (Brazil nut harvesters in Joshi's case). Hence, response time within systems and particularly differential response times in coupled systems create very real governance problems. This also demonstrates how the characteristic timescale of coupling can be used to set meaningful analytical boundaries. If the prevalence of coupling language implies an intractably interconnected world, the notion that not all coupling is created equal—that processes acting on different time scales may have linear interactions over short time frames, as in a market driving deforestation—can be exploited to decide which processes are important to the system over a particular time frame. Particularly, the time lags inherent in many environmental developments are problematic in this sense, because land use competition has difficulty in pricing in externalities that have not yet materialized and that are highly uncertain.

2.4 Conclusion: The Contingency of Land Use Competition

We have shown here how an extended notion of distal drivers may address concerns of power, knowledge, and technology. Such an understanding of distal drivers, we suggest, lies at the heart of land use competition framed not as an individual decision event, but rather as a distributed process. Processes of

competition are distributed across geographical, institutional, and social scales, they incorporate different understandings of space, they involve multiple histories and futures, and they need to account for different temporalities, in particular the idea of differential response times within a social-ecological system.

We suggest a relational understanding of land use competition with the concept of 'distal drivers' asking important questions about the nature—quantity and quality—of the relations that are being forged or discarded through competitive processes. An ontologically very heterogeneous set of agents comes to light in this analysis: nature, human actors including society and institutions, knowledge, social and moral orders, and technological artifacts. They all contribute to the specificity of distal drivers in particular processes of land use competition. One might say: They situate land use competition (Haraway 1988), with 'situate' not meaning 'locate' but rather 'embed', within broader social-ecological systems and their contexts (Granovetter 1985).

This type of embedding is a historically and socially highly contingent process: It may unfold along a particular path, but that path is not the necessary path. This has important consequences for our epistemological approaches to studying land use competition. In contingent processes, straightforward cause and effect relationships are hard to specify. This alerts us, firstly, to the important role of uncertainty and ambiguity in social-ecological systems. Secondly, it urges us to carefully consider system boundaries and the range within which our knowledge claims may be considered valid. For example, the price of a good on the market may predict crop choice for the next-growing season for a particular case with a high degree of accuracy and certainty. Hence, operating within the narrow constraints of one growing season, one product and a fixed set of actors may allow us to usefully treat land use competition as a linear set of functions. Yet, extending the system boundaries to include distal drivers, as we have done in this chapter, frames land use competition as a complex set of processes that interact in nonlinear fashion and are virtually impossible to predict. The analysis of the dynamics of contingent processes is in itself contingent, i.e., heavily influenced by methodological and analytical choices. While the plausibility of the respective approaches may be assessed according to their own terms, their legitimacy needs to be considered in a wider scientific, political, and moral context.

The contingency of land use competition thus alerts us to the situatedness of our own knowledge production: situated in a particular time and culture, in a particular set of methods, and a particular disciplinary set of concepts and theories. Distal drivers are too heterogeneous and too complexly related to be adequately known through a single epistemological framework. Neither geoscience, geography, or economics, nor anthropology or philosophy holds the all-encompassing methodological framework to deal with all facets of distal drivers in land use competition. Hence, research on distal drivers will require humility and epistemological openness to translate between the very distal thought styles concerned with distal drivers of land use competition.

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