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Explanations in Telecoupling Research

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1 Introduction

Not all research is about explaining, but explanation is an important component of many scholarly endeavours, and research on telecouplings is no exception. Indeed, telecoupling has been proposed precisely as a framework to help understanding and explaining phenomena that could be observed in a local context, but where the causes of these phenomena were at least partly invisible when only observing the local situation. The notion of telecouplings can be seen as an empirical phenomenon, that is, specific linkages between places through distal processes, flows and networks and the actual outcomes, such as land-use changes, through which

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these linkages manifest themselves in distinct human-environment (H-E) systems. Alternatively, it can also be considered as an analytical framework or heuristic device to analyse these kinds of processes in coupled H-E systems (see Chaps. 2 and 3). By nature, research on telecouplings is challenging, since they typically involve complex combinations of local and distant causes with interactions, feedback and spatial and temporal lags, all features that complicate tracing the explanation of a given phenomenon. This chapter will discuss how a telecoupling approach can contribute to some types of explanations in H-E systems' research and for what purposes.

The first section will present a brief survey of the literature about explanations in H-E systems' research. The second section will discuss the circumstances under which the telecoupling approach can specifically be fruitful to build understanding and explanations of phenomena related to H-E systems and particularly land-use change. The third section will then discuss specific challenges related to explanations when studying systems that are complex and composed of distant components such as in globalisation and telecoupling research.

2 Explanations in Human-Environment Systems Research

Telecouplings are presented as either an analytical framework or heuristic device to analyse some processes in coupled H-E systems, or concretely as a specific type of such coupled H-E systems (Liu et al. 2013, Chap. 2). Therefore, it is worth starting with a short digest of the discussion about *explanations* in the broader literature on H-E interactions. A more elaborate treatment of the issue and methodologies for causal analysis in H-E systems research can be found in Meyfroidt (2016). Epistemologically, H-E (or social-ecological) research lie at the interface between social and natural sciences, implying a perpetual tension between the mainstream epistemology in natural sciences and a wider diversity of epistemologies in social sciences and humanities. On the one hand, post-positivism largely embraces the positivist notion that objective explanations can be captured by scientific endeavour combining empirical analyses and rational reasoning, though acknowledging the subjectivity of the researcher and possible

biases. On the other hand, social constructivist and hermeneutic approaches focus mainly on explanations as discourses or mental representations and more broadly as social and cultural constructions that may be shared among certain social groups and conflicting or interacting with those of other groups. In this epistemology, especially relevant for telecouplings are the anthropological theories of scapes that articulate the different types of information and cultural flows that link distant places (Tsing 2005). Further work is needed to improve the dialogue between these different forms of explanation (see Chap. 18). Much of this chapter will focus on the first, post-positivist approach where explanation essentially amounts to understanding the causes and mechanisms through which some events or features arise. Explanation therefore goes beyond the mere description of phenomena (Meyfroidt 2016; Magliocca et al. 2018). Explanations may serve different purposes. A key goal is to design policies or other forms of interventions to steer an H-E system of interest in a desired direction. This builds on the premises that a proper explanation of how and why a given phenomenon arose serves as a basis for a credible theory of change of how the intervention is supposed to act on the system. Another common goal is that explanations support the design of scenarios or projections—be they quantitative modelling or through qualitative narratives—of different possible future evolutions of a system.

Explanations in post-positivism build on three modes, namely the deductive-nomological mode grounded in laws that are combined to provide a logical explanation to a given event or to an observed regularity; the inductive mode based on identifying empirical regularities between some phenomena and their possible causes; and the abductive mode that starts from the effect and search for the most plausible and simple cause, ruling out other candidate explanations (Walton 2005). Different disciplines are more strongly building on one or the other approach, for example, neoclassical economics and political ecology typically give a strong weight on deductive explanations building on a set of assumptions such as on rationality of actors and the influence of power struggles and inequalities, respectively. Other disciplines, such as geography, have traditionally built more on inductive generalisations, such as the forest transition theory that explained long-term shifts in forest cover trends based on generalising regularly observed processes in agriculture, forestry and, more broadly,

socio-economic and political spheres (Meyfroidt et al. 2018). Abductive reasoning is widely used in case studies to explain specific phenomena (Walters 2017), but typically requires being combined with inductive and deductive approaches to produce explanations of more general phenomena.

Research on H-E systems typically falls under what is called "historical sciences", that is, scientific investigation that focuses on explaining social and natural phenomena as they occurred in the real, historical world, such as in history, sociology but also geology or evolutionary biology, as opposed to phenomena described in the laboratory through experimental sciences (Meyfroidt 2016). The assumption is that phenomena observed are always specific occurrences of a more general class of phenomena that are sought to be explained, which are never exactly and entirely reproduced or reproducible, and where single factors cannot be perfectly isolated. The manifestation of new phenomena over time changes the universe studied. The telecoupling frameworks precisely emerged as an approach to keep up with increasingly complex and distant chains of interactions that produce H-E outcomes, as a result of new forms of globalisation and linkages between places. Emerging phenomena such as land grab, biofuels or private-sector led and hybrid forms of land-use regulations (Lambin et al. 2018), among other things, forced a rethink of theories and knowledge about H-E processes. As such, human agency leads to perpetual emergence of new situations, decisions and behaviours, which in turn require adaptation in problems conceptualisation.

Building explanations in H-E systems research often relies on a back and forth between the abductive goal of explaining the causes of a given observed effect (Walters 2017), and quasi-experimental approaches that focus on explaining the effects of a given cause (Ferraro and Hanauer 2014; Law et al. 2017). As a result, explanations in historical sciences rarely result in the formulation of general, universal covering laws, but rather rely on a dialogue between regularities and general mechanisms or laws on the one hand and contextual interpretation of contingencies on the other (Meyfroidt 2016). Explanations of specific cases can form a basis for more generalised forms of knowledge, which can range from mostly descriptive claims to those inferring causal effects, causal mechanisms and theories (Magliocca et al. 2018). One way through which explanations can be generalised is through middle-range theories, that is, contextual

generalisations, which describe chains of causal mechanisms that explains a well-bounded range of phenomena, and the conditions which trigger, enable or prevent these causal chains (Meyfroidt et al. 2018).

3 Why and for What Do We Need a Telecoupling Approach?

Against this backdrop, what is new about the telecoupling concept compared to the multiple fields and frameworks that study H-E systems? In other words, what are the kinds of phenomena or the analytic perspectives for which the telecoupling framework may be useful or perhaps even required? Research on H-E systems have a long tradition of focusing on understanding the dynamics in a particular place. Early research tended to consider these as "cases" or self-contained entities that could be studied as closed systems, where understanding endogenous processes would suffice to explain the dynamics (Fig. 4.1A) (e.g. see the discussions in Turner et al. 1993). Over time, important progress was made in considering more directly the multiple and cross-scalar interactions and feedbacks between the focal system and the rest of the world.

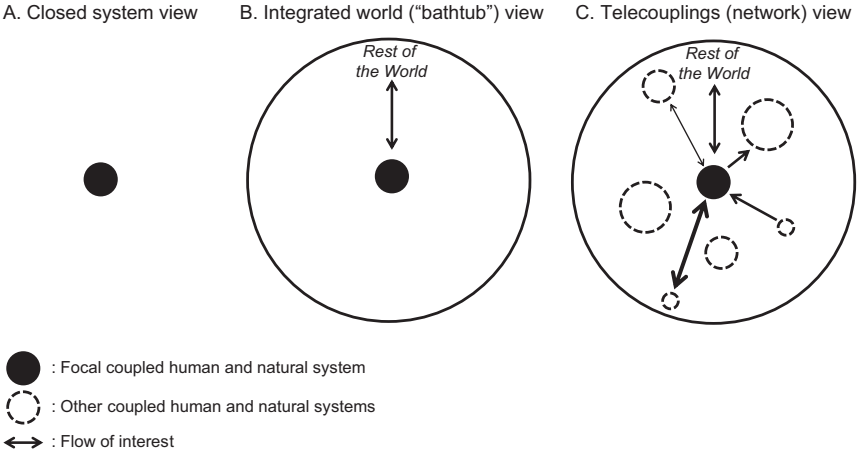

Fig. 4.1 Conceptual diagram of the *closed system*, *bathtub* and *telecoupling* conceptualisation of H-E changes related to distant drivers

Such advancements initially conceptualised these linkages within an open systems approach, where processes occurring in other places or at other scales were considered as exogenous or contextual factors affecting local dynamics (Fig. 4.1B) (Lambin and Geist 2006; Meyfroidt et al. 2013). The origins of the signals coming from the outside world, as well as the destinations of possible feedbacks from the studied system, were considered largely irrelevant. In this view, the outside world can be interpreted as a "bathtub", into which flows are well mixed and fungible—that is, products are fully substitutable notwithstanding their origin or other characteristics—, so that this outside world is essentially treated as one homogenous place. In geographical terms, this view would be slightly nuanced by considering that the influence of features from the outside world monotonously decreases with Cartesian distance to the focal system. In economic terms, it suggests that trade would function as if markets were fully integrated and any bilateral flow between two countries is susceptible to drastically change over time due to change in global markets conditions. In this approach, mobilising knowledge about several specific distant H-E systems takes the form of comparisons of disconnected case studies rather than investigations of the linkages between these systems.

But with increasing recognition of the complexity of linkages between H-E systems separated geographically or along other dimensions (institutionally, culturally, economically…), the limitations of the bathtub view for understanding H-E dynamics and for identifying efficient policies to steer such dynamics in desired ways has become apparent. Several authors have critiqued the misleading conclusions that can be drawn from looking at places as being disconnected case studies, instead of considering them as interacting (Meyfroidt et al. 2013; Munroe et al. 2014; van Vliet et al. 2016). This critique has, for example, targeted studies that link forest transition and recovery in temperate countries to domestic economic growth, in a relation akin to environmental Kuznets curve, but obliterate the role of North-South trade dynamics in promoting forest recovery in the North. Critical sociological theories related to world system theories, such as dependency theory, core-periphery relations and (ecological) unequal exchange (Hornborg 1998; Moran et al. 2013), highlight that with whom a country trades matters greatly to determine the outcomes of this trade.

Several studies showed the growing importance of distant causes and indirect consequences of land-use changes as they arise across international borders and in the context of differing national policy and socio-economic regimes (Meyfroidt et al. 2013, Chap. 2). With globalisation, land-use displacement and leakage have emerged as major research priorities in land system science and their effects have been shown to depend on the specific places where such displacement occurs (Jadin et al. 2016). Actors and drivers of land change thus increasingly operate across distant places, moving capital, knowledge, institutions and labour strategically to shape and respond to dynamic human and natural environments (Gasparri et al. 2016; le Polain de Waroux et al. 2016, 2018). Other studies investigated, for example, the distinct effects of a given type of actors depending on their geographic origin, such as studies of the distinct behaviours and impacts of domestic, Chinese and other traders and logging companies in the timber sector in Africa (Cerutti et al. 2011; Wertz-Kanounnikoff et al. 2013) or in agriculture in Southeast Asia (Friis and Nielsen 2017). With increased influence of external actors and processes in local land systems, tracing the complex supply chains of products exported from these localities, including the actors and locations involved, as well as potential spillovers and leakages, becomes crucial for governance (Godar et al. 2016, Chaps. 8 and 9). Hence, understanding these complex linkages requires moving beyond considering distant relations as exogenous factors in an open "bathtub" systems approach.

The telecoupling perspective (Eakin et al. 2014; Friis et al. 2016) represents one form of response to this need. It aims at describing and studying H-E systems with an explicit consideration of the multiple links that may exist between different systems, including via flows of people, money and products, but also of information, governance, norms and technology (Chaps. 2 and 3). This framework becomes particularly useful when the distinct effects of flows depend on their specific origin and destination, the actors involved, as well as on the structure of the network that connect actors and flows (Fig. 4.1C). In geographical terms, this would correspond to analysing linkages between places based on social, cultural or political networks such as linguistic, ethnic or post-colonial bonds, rather than on mere Cartesian distance. In economic terms, this would mean that we observe a significant degree of persistence in trade flows,

that is, markets that exhibit forms of stickiness or rigidity which influence how shocks restructure the production and trade relations and thus also the allocation of environmental impacts (Villoria and Hertel 2011). The presence of such stickiness is called the "Armington assumption" for trade in agricultural products. These rigidities or preferred connections can arise, for example, from some hard to account for differences between products originating from different places making them imperfect substitutes (Agcaoili-Sombilla and Rosegrant 1994), specific linkages between trading partners due to ethnic networks (Coughlin and Wall 2011), colonial history (Head et al. 2010), consumer concerns about the perceived sanitary risks of some production places (Kawashima and Sari 2010; Garrett et al. 2013; Schierhorn et al. 2016), tensions that affect certain trade routes such as piracy (Burlando et al. 2015), specific institutional ties or transport infrastructures, or multiple other factors (Anderson and van Wincoop 2004).

When designing a study based on the telecoupling approach, the price to pay compared to the bathtub view is increased complexity in analytical terms, including for defining manageable and meaningful units of analysis and for tracing the causal connections between places, actors and variables. The telecoupling approach is thus relevant when the researcher assumes that the links and flows between the focal system and different networked nodes (H-E systems) are not all equally important or relevant or do not all function in the same way, and that disregarding this heterogeneity would hinder the understanding of the processes and outcomes of interest in the focal system and in others. In that sense, using the telecoupling or network perspective is a strategic decision that should reflect and match the assumptions of the researcher about the behaviour of the system of interest and the balance of costs and benefits of engaging with increased complexity. Two examples illustrate this: Analysing the specific trade networks of soy between Brazil, other South American countries, Europe and other soy consuming countries help understanding how the competitive advantage that Brazilian soy has built on the European markets has facilitated an upgrading of the soybean supply chain, which in turn helps to explain why Brazilian soybean farmers have adopted environmental certification programmes on a larger scale than their competitors (Garrett et al. 2013). In contrast, a counter-example is provided by

Müller et al. (2013), who analyse the main agents of deforestation in the Bolivian lowlands in order to design spatially effective policies for reducing deforestation. Although they acknowledge that international trade is an important underlying driver of these changes, the specific destination of exports is not considered as relevant for their purposes, which makes this study thus closer to the bathtub view.

4 Complex Causal Chains in Telecouplings

When a telecoupling perspective is adopted, how can we then concretely approach the task of building causal explanations in complex chains that link distant places and people?

Two key questions, which in practice are strongly interrelated, are:

1. Among the multiple flows and linkages between the focal system and the rest of the world, how can we identify which ones actually matter for explaining a given phenomenon? and
2. How can we actually establish causality in situations that are characterised by complex interactions and feedbacks across places and scales?

I first discuss here the question of where and how to set the boundaries of the analysis. A first approach, which is expressed in the original telecoupling framework and by some empirical studies, is to start by an H-E system that we can consider as bounded, that is, a system that largely functions or functioned as a well-identifiable system absent the specific telecoupling that is studied. This may be, for example, the Brazilian Amazonian land-use system (da Silva et al. 2017) considered as an integrated H-E system where land use is structured based on the interactions between local human (population, technologies, economic structures, policies and so on) and environmental components (e.g. the soils, climate and vegetation). Then, this approach identifies a specific flow of interest between this system and some outside place, which changes or dynamics are hypothesised to strongly influence the original H-E system (e.g. here, dramatic increase in soybean flows from the Brazilian Amazon to China).

Based on this flow the researchers will define a second H-E system (e.g. China), which is telecoupled to the initial system. This defines two systems that are distinct but coupled over distance. At this stage, in principle, any feature from each system (e.g. from the Brazilian Amazon and from China) can be considered as relevant for the explanation, and this will constitute the boundaries of the analysis. This perspective thus helps to draw boundaries in geographic terms but is not, in itself, sufficient to set up analytical boundaries of what features of the considered H-E systems matter. Any additional system can be coupled following the same logic, if additional spillovers that involve other H-E systems are identified, but phenomena outside of any of the coupled systems will not be considered in the analysis. This approach for setting boundaries is very widely used in studies that seek to describe telecoupled systems, that is, map the flows, actors and processes involved in the telecouplings.

Another, more fluid, approach for bounding the analysis is similar to the chain of explanations approach in political ecology (Blaikie and Brookfield 1987) or progressive contextualisation (Walters 2017). This approach will also start by a focal system, but instead of considering its coupling with another well-identified and bounded system, it will follow the different flows stemming in and out of the focal system to progressively redefine boundaries and scope of the system of interest. In effect, this approach ends up with a telecoupled system in the sense that the system of interest now becomes composed of people and features that can be spread across multiple places and only incorporates the features of each place that are considered as relevant. As such, the telecoupling framework is used to facilitate an analysis of which flows and connections that links to a given H-E change. One example starts by considering the initial system of interest as the land-use system of a given Laotian village, aiming specifically at explaining rapid expansion of banana plantations (Friis and Nielsen 2017). The analysis then identifies the specific importance of Chinese investors and traders that contract local farmers for banana planting, tracing these flows to Chinese consumers in China's large cities, the specific role of Chinese policies supporting fresh fruits consumption and geopolitical tensions between China and the Philippines, which triggered a need for Chinese retailers to find new sources of banana. The authors end up by redefining their system of inter-

est as the "banana land system", "constructed and understood as the lowland fields, the villagers leasing out the land, the stakeholders in the cross-border banana production network, and the governance institutions aimed at regulating the land-use change" (Friis and Nielsen 2017, 14). This system incorporates aspects of what happened in Laos, China, the Philippines, for example, but does not require considering that "China" is one system telecoupled with this other "Laotian village" system. This perspective thus largely moves beyond the initial telecoupling framework, as the identification of several distinct systems that exist in themselves and are then coupled becomes irrelevant. The boundaries of the analysis are not based on the identification of these distinct systems that are then coupled, but rather on an explicit decision to stop the exploration of the chain of explanations at the point that matches the goal of the research as well as the practical capabilities and resources of the researchers. In the above example, the researcher may decide to put aside the explanation and investigation of the geopolitical tensions between China and the Philippines as a root cause of Chinese investors' presence, to instead focus on how to improve the local processes of land governance to empower local communities in relation with external actors. In practice, this second approach is thus intimately linked with the second question of assessing causality, as the limits of the focal system are, in fact, given by the identification of relevant causal linkages. This approach for setting boundaries is thus more relevant for studies that seek to actually explain the causal chains that give rise to telecouplings.

The second question is how to trace causality when the chains and flows are complex and interact across places and scales? Some specific techniques exist to explore causal influences in complex systems such as Convergent Cross Mapping (Sugihara et al. 2012) but these typically require very dense time series of robust quantitative data and can thus hardly be applicable in most studies. A well-known approach in social sciences related to the chains of explanation or progressive contextualisation discussed above is process tracing (Meyfroidt 2016), which takes a point of departure in any component of the system and analyses causal links by decomposing them into increasingly "shorter" links that can be supported by various evidence. As indicated above, different traditions would put the point of departure either in the cause—for example, what

are the causes of a given land-use change in a specific place?—or on the effects—for example, what are the effects of a given policy shock?—and different methods are appropriate for these different questions (Meyfroidt 2016; Law et al. 2017). Conceptually, the theoretical toolbox of complex adaptive systems analysis can be mobilised, with notions of non-linearity, feedbacks, regime shifts or tipping points and others (Walker et al. 2004). Operationally, the appropriate methods are not as straightforward to identify. At least three types of approaches can be mobilised, that is, quantitative empirical methods, simulation modelling and qualitative approaches (see Chaps. 7, 10, 13 and 16). In statistical or econometrics works, spatial statistics are increasingly used to incorporate distant effects causing telecouplings such as through indirect land-use change (iLUC, Richards et al. 2014), agglomeration economies (Richards 2017) or other forms of spillovers (Meyfroidt et al. 2016, 2018). This has proved to generate interesting insights and opening new avenues for research, but these spatial approaches remain limited in that the distant effects are still mostly incorporated based on a measure of spatial (Cartesian) distance or neighbourhood. A way forward to properly acknowledge the nature of telecouplings is to measure distant influences based on various other forms of linkages such as social networks, market connections and others, but these are much more complicated to operationalise.

Simulation modelling of H-E systems and in particular of land use has an already well-established but still progressing tradition of couplings between models of multiple scales. One typical approach is to couple global models, which can be economic (Computable General Equilibrium, CGE) models or Integrated Assessment Models (IAMs) for example, to capture global demand for land-use and trade flows, with local models such as Agent-Based Models (ABMs) to explore how these flows are absorbed and distributed in the local system (Millington et al. 2017). The limitation of this approach is that if often correspond to the integrated market or bathtub vision (Fig. 4.1B) above, in the sense that specific places interact together only indirectly, through their relations with global-scale processes. This approach is limited in its ability to capture the horizontal interactions between specific H-E systems. Coupling models at similar scales for distinct places (e.g. coupling a Brazilian Amazon and a China land-use model) addresses this issue but assumes that the relation

between these two systems is not influenced, mediated or moderated by anything that happens outside of these two places. Incorporating seriously the telecoupling idea in modelling would require coupling local models of the different systems of interest together and to global-scale models that capture these multiple feedbacks.

In qualitative studies, multi-sited ethnography has been proposed as a way to reconsider the place-based focus of anthropological studies (Marcus 1995, Toolbox: Qualitative methods). Although some consider this as mainly a form of comparative analysis where the researcher explores how a similar social phenomenon unfolds across different contexts, many highlight that multi-sited ethnography is perhaps more appropriately described as a form of "trans-site" ethnography, where the site of research (what others would call the system) is formed by discontinuous geographical places or social groups. Research budgets, time and other constraints such as knowledge of local contexts, lack of local contacts providing entry points to the field or language or administrative barriers often hinder the full use of multi-sited research. In-depth qualitative and place-based research thus often focuses on one side of the telecouplings. Overall, studies on telecoupling still mostly rely on ad hoc combinations of methods pulled out of the existing H-E research toolbox.

5 Conclusion

The general principles of explanation in telecouplings research are largely building on research in H-E dynamics, social-ecological systems and complex adaptive systems. Explanations in H-E systems build on the deductive, inductive and abductive approaches and have to balance the identification of regularities and general mechanisms with contextual interpretation of contingencies. A telecoupled or network perspective matters when the distinct effects of flows between H-E systems depend on their specific origin and destination, the actors involved and the structure of the network. Yet, the explicit recognition of the complex networks of relations between places and actors beyond the bathtub view comes with a cost in terms of increasing complexity, with a potentially infinite network of connections to explore. The decisions of adopting

such a network perspective, identifying the relevant connections to explain and where to bound the analysis are thus crucial and should reflect strategic balancing of costs and benefits, requiring a back and forth between theoretical insights and empirical information.

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