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Organizing collective innovation in support of sustainable agro-ecosystems: The role of network management

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ABSTRACT

Designing and managing sustainable agro-ecosystems remains a significant challenge for society. This is largely because their expected functions and values are multiple, and diverse networks of actors and institutions control common pool resources at different scales. Networks are expected to play an important role in facilitating collective innovation in agro-ecosystems, through enabling knowledge acquisition and transfer, resource mobilization for effective governance, and cooperation. However, in order to realize their potential benefit networks require effective management. Drawing on case studies located in the peri-urban agro-ecosystems surrounding Montreal (Quebec, Canada) and Paris (France), we analyze four collective innovation initiatives aiming to reduce the negative impacts of agriculture on the environment. For each case, we assess the contribution of network managers to the core tasks of: "Connecting" (initiating and facilitating interaction processes between actors), "Framing" (guiding interactions through process agreement), "Knowledge brokering" (facilitating knowledge transfer and capitalization) and "Exploring" (searching for goal congruency by creating new content). We then pay particular attention to the activities associated with Exploring across our cases and consider the implications for more collective approaches to designing innovation in agricultural landscapes. Our results suggest that, despite heterogeneity in the activities of network managers in each context, network managers devoted efforts across each of the four tasks. Yet, building a shared vision and engaging diverse stakeholders in a common goal over time were reported as challenging. We identify that the network managers tended to set objectives at the outset, and that design processes were often confined to a limited subgroup of actors. While these strategies were viewed as being efficient in the short term, they likely limited the success of the collective enterprise in the long run.

1. Introduction

Defining and creating sustainable agro-ecosystems remains a significant challenge for society. This is largely because their expected functions are multiple (Foley et al., 2005), their values are partly unknown and they are often perceived differently by social actors (Martín-López et al., 2014). Importantly, the design of sustainable agro-ecosystems cannot rely only upon incremental improvement of what exists; it also requires path-breaking innovation in practices, organizations, and in the way we view and manage ecosystems (Biggs et al., 2010). According to Kemp et al. (2007), orchestrating such transitions towards sustainability requires radical changes in the functions of complex social and ecological systems, requiring more open and adaptive forms of governance that are oriented towards learning and experimentation. Shaping desired changes in agro-ecosystems means envisioning and creating new types of agro-ecosystems, which requires a design reasoning, i.e. exploring the unknown, on the basis of knowledge capitalization and the formulation of what is desirable (Hatchuel et al., 2009). This is all the more challenging when considering that knowledge concerning agro-ecosystems is limited and fragmented, their delimitation is unclear, stakeholders often have diverging interests, and there is no single legitimate designer (Berthet et al., 2016).

Diverse networks of actors and institutions at different scales, including autonomous entrepreneurs (farmers) and heterogeneous actors (residents, naturalists, agri-food industry, local authorities, scientists, etc.) result in highly distributed control of agro-ecosystems, necessitating cooperation and network management (Kemp et al., 2007). Networks are recognized as important forms of multi-level governance (Provan and Kenis, 2007; Bodin and Crona, 2009; Saint Ville et al., 2017); they can facilitate collective action (Powell and Grodal, 2005; Lejano and de Castro, 2014) and innovation in agro-ecosystems (Batterink et al., 2010; Klerkx et al., 2010; Bourne et al. 2017). In the

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Table 1
The four main functions of network managers and their related tasks (sources: van Lente et al., 2003; Klijn et al., 2010; Kilelu et al., 2011; Giest and Howlett, 2014).

Connecting	Framing	Knowledge brokering	Exploring
• Initiating and facilitating interaction processes between actors • Fostering cooperation (by removing obstacles, creating incentives) • Activating (i.e., involving and committing) the right players • Sometimes 'deactivating' actors • Articulating options and demands • Resource mobilizing	• Guiding interactions through process agreement • Establishing and influencing the operating rules of the network • Creating and changing network arrangements for better coordination • Facilitating intellectual property rights attribution • Fostering institutional support • Innovation process monitoring and evaluation of outcomes	• Managing and collecting information and knowledge • Facilitating learning processes (feedback mechanisms, experimentation…) • Creating an environment conducive to knowledge exchange and productive interaction	• Creating new content by exploring new ideas • Stimulating variety • Making sense, searching for goal congruency • Supporting strategy development • Altering the perceptions of the network participants • Influencing the actors' values and norms

context of collective innovation, networks have been shown to play important roles in knowledge acquisition and transfer, resource mobilization for effective governance, and cooperation (Bodin and Crona, 2009; Dessie et al., 2013; Reed and Hickey, 2016). However, as noted by Giest and Howlett (2014), such innovation networks are not self-forming or auto-poetic, requiring leadership to enable reciprocal communication flows among heterogeneous actors, build trust and ensure long-term cooperative structures (van Lente et al., 2003; Batterink et al., 2010; Kilelu et al., 2011). Previous research has examined the diverse functions of network leaders in order to unveil their contribution to fostering collective innovation, including the social and organizational aspects of managing collective innovation processes, and the cognitive aspects of social learning and knowledge brokering. However, the contribution of network managers to steering innovative design processes has, to date, received much less attention. Using innovative design theory (Hatchuel et al., 2009) that formalizes design reasoning, this paper seeks to help address this knowledge gap. Drawing on four collectively organized innovation initiatives that aimed to reduce the negative environmental impacts of agriculture in the peri-urban agro-ecosystems surrounding Montreal (Quebec, Canada) and Paris (France), we explore the core role played by network managers in setting up and steering collective action, and in particular, collective design processes in multi-level agricultural systems.

2. Conceptual framework

2.1. The functions of network managers in innovation processes

Boerzel (1998, 254), quoted by Giest and Howlett (2014), defined a social network as 'a set of relatively stable relationships which are non-hierarchical and interdependent, linking a variety of actors who share common interests with regard to a policy and who exchange resources to pursue these shared interests acknowledging that cooperation is the best way to achieve common goals'. However, there are also situations in which there is a clear need for collective action, but the actors involved do not necessarily see their shared interests, at least initially. Such situations are quite common in the field of natural resource management, including agro-ecosystem management (Berthet et al., 2018), where there is often a need to engage initially reluctant actors for the success of the collective initiative. As Klijn et al. (2010, 1065) underline, "interactions within the network may produce sharp conflicts about, for instance, the distribution of the costs and benefits of a solution." The actors involved may also have different perceptions on the nature of the problem(s), the desired solution or the best organizational arrangements to utilize to ensure cooperation, and this can be a major obstacle to achieving meaningful outcomes that satisfy those actors.

Networks have been well studied in the context of innovation processes as an interesting organizational form, beyond market and hierarchy, through which to source knowledge, access new technologies, create value and reach new markets (Smart et al., 2007). Networks have been shown to facilitate the generation and diffusion of knowledge and information about the systems under management (Isaac et al., 2007), the articulation of options and demands for innovation (Klerkx and Leeuwis, 2009), the allocation of key resources for effective governance (Carlsson and Sandström, 2008), a commitment to common rules among actors (Scholz and Wang, 2006), and the resolution of conflicts (Hahn et al., 2006; Bodin and Crona, 2009). Networks are both consciously planned, as actors deliberately interact and attempt to structure these interactions with organizations and rules, and also unplanned, as a result of spontaneous interactions and pre-existing rules (Klijn et al., 2010). However, such networks generally require effective management in order to realize their potential (Giest and Howlett, 2014). According to Giest and Howlett (2014), the role of network managers, whether they be a formal association, a specific individual, an organization or some combination of these, is key to realizing collective outcomes. More specifically, the management strategies of leaders will significantly influence the structure and dynamics of the network (Gage et al., 1990; Meier and O'Toole Jr, 2001).

Previous research has helped to conceptualize the various roles and functions of network managers in realizing collective action (Table 1) [see, for example, Klijn et al., 2010 and Giest and Howlett, 2014]. In the context of innovation networks, such roles and functions have been explored through concepts such as "network brokers" (Hellin, 2012), "systemic intermediaries" (van Lente et al., 2003), "innovation intermediaries" (Howells, 2006; Kilelu et al., 2011; Agogué et al., 2017), "innovation brokers" (Klerkx and Leeuwis, 2009; Batterink et al., 2010) and "innovation champions" (Klerkx and Aarts, 2013). Taken together, these studies identify a diversity of important tasks associated with network management, which we summarize under four broad categories: Connecting, Framing, Knowledge brokering and Exploring (see Table 1), considered both non-exhaustive and non-independent.

While these four functions are complementary, and any network manager may attempt to fulfil them all, there exist various types of manager who will develop some functions over others (Klerkx and Leeuwis, 2009; Kilelu et al., 2011): e.g. knowledge brokers vs. enterprise development support intermediaries.

In the context of collective innovation for sustainable agriculture, the diversity of stakeholders and their divergent views on the values of innovation (which can be non-monetary), as well as the complexity of agro-ecosystems and the difficulty to set clear objectives at the outset of an innovation process, raise crucial network management challenges. In this paper we aim to clarify the contribution of network managers to the four functions of Connecting, Framing, Knowledge brokering and Exploring in agricultural innovation initiatives, and pay particular attention to the importance given to the Exploring tasks using recent advances in design theories (Le Masson et al., 2010; Hatchuel et al., 2018) to help characterize these activities.

2.2. Design theories, a new perspective on innovation

Design theories have become increasingly applied to innovation and