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Semantic knowledge network inference across a range of stakeholders and communities of practice

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ABSTRACT

This paper provides empirical and experimental assessments of thematic knowledge discourses based on two case studies in the US Virgin Islands and Florida. We utilize a latent semantic indexing analysis over natural language corpus to classify and categorize knowledge categories. We computed TF*IDF scores and associated co-occurrence Jaccard similarity scores to construct semantic knowledge networks. Using network analysis, we computed structural metrics over four composite groups: neighbor-based, centrality, equivalence and position. The analysis show that structural network characteristics of environmental knowledge can exponentially predict associations between knowledge categories. We show that connectivity play a critical role on acquisition, representation, and diffusion patterns of knowledge within local communities. We provide evidence of a global prevalence of a shared knowledge core. We show that core social-ecological attributes of knowledge follow scale-free, power law distributions and stable, equilibrium network structures. We identify two distinct models of bidirectional translation: a bottom-up and a top-down.

1. Introduction

In the last decade multiple studies have underlined the importance of the relationship between knowledge and environmental conservation. In many of these studies, *traditional ecological knowledge (TEK)* and/or *local ecological knowledge (LEK)* is/are shown to have strong connections with environmental conservation and social-ecological stewardship (Basurto et al., 2013; Becker and Ghimire, 2003; Berkes and Turner, 2006). Others tackle the relationship between scientific knowledge and sustainability (Kristjanson et al., 2009). Villa, Athanasiadis, and Rizzoli (2009) for example, provide a review of semantic knowledge models addressing ecological and environmental modeling applications, and discuss the broader adoption and feasibility of new approaches. Rivera, Minsker, Work, and Roth (2014) use a text mining framework to classify and develop sustainability criteria and indicators at a regional scale. In many of these studies, the concept of knowledge is addressed as a rather abstract and in a somewhat descriptive manner (Kiptot, 2007; Tàbara and Chabay, 2013). In other studies, the content of knowledge was evaluated against decisions and behaviors related to environmental conservation and action in these local systems (Dutta, Morshed, Aryal, D'Este and Das, 2014; Grant and Berkes, 2007). And, in some studies, knowledge was measured as a list on survey responses (Cinner et al., 2010). Often, the concepts of collective knowledge and social learning are used interchangeably and without a clear set of definitions and/or boundaries related to their perspective functions and effective roles in the social-ecological systems. On the other hand, many studies focus on formal or formalized ontologies and ontological frameworks (Martínez-García et al., 2018; Polhill et al., 2016).

Collective knowledge systems interact and operate across the full extent of social-ecological systems. They incorporate individual and cognitive characteristics of knowledge, social perceptions of reality

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(Berger and Luckmann, 1967), ecological reflections of reality, as well as institutional and governance dimensions. Knowledge systems exist and function in the heart of informal institutions and social norms, but also directly relate our everyday social realities to formal institutional rules and arrangements. Social-ecological stewardship critically depends and builds upon existing collective knowledge structures.

1.1. Effective institutional governance in managing social-ecological commons

Our ability to examine and analyze the efficiency, efficacy and effectiveness of our governance systems and the institutional arrangements in place and at work towards managing our commons critically depends first on the context, nature and characteristics of the governance systems themselves. It also depends on the weak network or web of connections between institutional processes that form management functions, and key systemic components of the linked social-ecological system. The presence of weak links or ties between core institutional processes and both social and ecosystem functions are often the catalytic drivers of institutional change.

Efficient governance systems with respect to social-ecological system management can function both to the benefit of the ecosystem services and functions of the natural system, and to the strengthening of the social system and the communities of practice within the management scales of reach. From the ecological standpoint, ecosystem health and ecological resilience are among the most important functions and processes that one needs to pay attention to, albeit a number of secondary ecosystem and landscape processes bare significance to the analysis. From the social standpoint, the triplet of cognitive/dispositional, collective or social and institutional interactions represent important components of such an analysis (Fig. 1).

In social-ecological systems, the governance of the commons more often than not emerges as a function of local community social and ecological stewardship. Without it is difficult if not impossible to achieve governance structures that have the necessary legitimacy, power and control to negotiate efficient and adaptive institutions of change (Cowie and Borrett, 2005; de Vos et al., 2013). It is exactly because such adaptive institutional arrangements reflect broader community and societal goals or aspirations, the presence of a synergistic relationship between local stewardship and governance of the commons is critical (Ghorbani et al., 2017). On the other hand, stewardship at the community level alone cannot successfully achieve social-ecological sustainability and resilience in systems where multi-governance of commons is required. This is because of systemic and institutional externalities entering, and likely affecting the social-ecological local system in question.

The degree to which a successful level of management is achieved in the dual stewardship – governance of the commons system perhaps has something to do with the ability and capacity of transference across linked systems and domains of knowledge. The capacity of the dualistic system of knowledge transference is inevitably linked to the capability set and network of interconnected associations across and within the key players or actors of both systems. Such systemic interconnectedness critically depends on the functioning and roles of *knowledge producers, knowledge translators (bi-directional), and knowledge diffusers* in the system. The three roles are complimentary, mutually reinforcing, and non-exclusive of each other.

1.1.1. Knowledge producers

They emerge and function at both scales of the two subsystems (local/global). Yet, the nature of the knowledge produced at each scale differs substantially, albeit dependent of each other. Local knowledge producers operate at the community scale, in the fringe of the natural-social prevalence of the phenomena/problems. They acquire and produce knowledge by merging and combining empirical or observational data/information with local and traditional ecological knowledge, as well as with scientific knowledge. The produced knowledge, more likely than not is raw, unprocessed, and customized to fit the level of local community understanding of reality and the community mental knowledge representation. Global knowledge producers at the level of the governance of the commons often produce knowledge that adheres to strategic and policy objectives and social-ecological imperative realities in which the commons exist and operate. They accumulate and synthesize new knowledge by combining and contextualizing (or re-contextualizing) existing knowledge emerging from the local community mental model interactions. The level of efficiency in such contextualization and synthesizing of new knowledge depends to the degree in which the latter finds its way or reaches their operant level or scale of perception.

1.1.2. Knowledge (bidirectional) translators

They operate often at the margins and “neutral zone” between the local and higher scales of inference. Their role is to bi-directionally translate knowledge from the one subsystem to another and vice-versa (Sato, 2014). They often seek and assist stewardship efforts at the community level, all the while promoting cooperation and coordination among other players and roles at higher levels (e.g., decision makers, managers, policy makers, governance and institutional players,

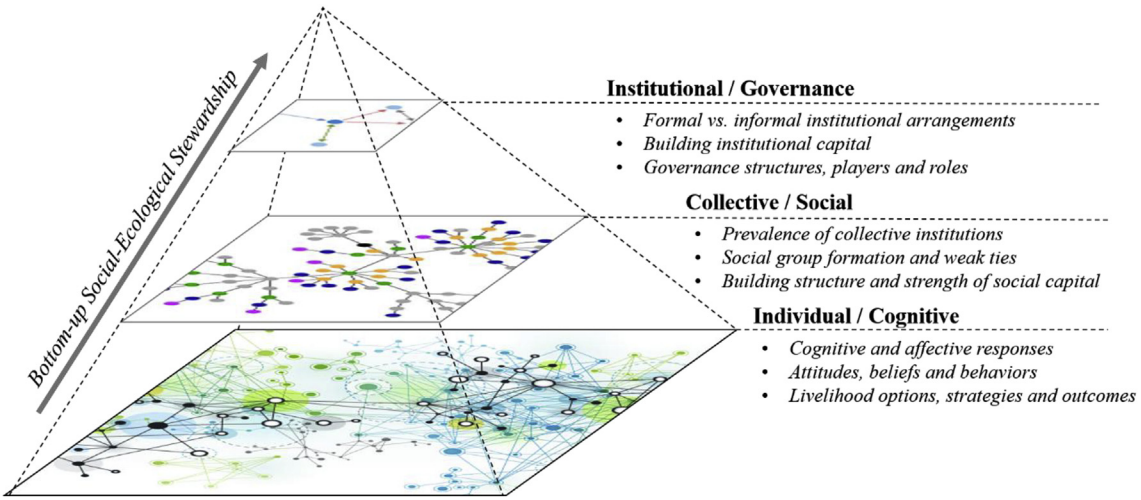

Fig. 1. Conceptual pyramid structure illustrating a bottom-up social-ecological stewardship building from the individual through collective to institutional considerations.