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Linking marine and terrestrial ecosystem services through governance social networks analysis in Central Patagonia (Argentina)

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ABSTRACT

The complex relationship among diverse natural factors in a given ecosystem and with society could be not explicitly reflected in governance actions and policy. Social networks are useful tools to characterize these links but few studies include social and ecological nodes. We applied social network analysis to characterize governance and use networks in a coastal socio-ecological system while testing (i) if governance links reflects ecosystem services (ES) use links, (ii) if social links reflect ecological relations between continental and marine ES and (iii) if relations among social actors are associated with their use of and participation in the management of ES. We use structured interviews to build one-mode use and governance networks with social actors and two-mode networks relating social actors and ES. Our results showed cohesive, low density and centralized networks of governance and use. We found that actor–actor links reflect ecological relations between continental and marine environment, but actor–actor relations are weakly correlated with those derived from actor–ES relations, meaning that actors with common interest about ES are no necessarily working together. This paper also shows that social networks are useful to highlight gaps and paths to move the system toward more effective co-management structures.

1. Introduction

The governance of ecosystem services (ES) is usually influenced by unpredictable changes (Folke et al., 2004). Slow or abrupt changes in the environment resulting from unsustainable use of natural resources have led the scientific community to propose a paradigm shift based on the ecosystem approach (Chapin et al., 2010). This approach integrates three principles simultaneously: reducing vulnerability to potential unwanted changes, developing resilience scenarios aimed at finding more desirable paths to shocks and uncertainty (Costanza and Folke, 1997), and transforming undesirable trends into new opportunities for resilience (Walker et al., 2004). The resilience of the ecosystem depends largely on key species that inhabit a particular ecosystem. Proper maintenance of these key species ensures functional diversity of natural cycles and processes necessary for the stability of socio-ecological systems (Chapin et al., 2010).

Under this context, ecosystem governance not only deals with the management of the ecosystem, but also with related social aspects such as decision-making, social interaction and power relations. The necessity to include perspectives from various stakeholders is important for understanding potential strategies for sustainable ecosystem management. It is quite common that stakeholders with different stakes have different perspectives on management strategies (Hauck et al., 2014).

The ecosystems based approach has the potential to lead to a better understanding and management of marine social–ecological systems (Hilborn, 2007). Compared to traditional single-species management, an ecosystem-based or holistic approach is assumed to be the most adequate for adaptive management of the inherent complexity and diversity of a social–ecological system (Ostrom, 2011). Because of the complexity of social–ecological systems, there will remain uncertainty regarding causal relationships within ecological and social systems and their responses to external drivers (Folke et al., 2004). For that reason it is highly recommendable to follow an adaptive process in which actors can learn about uncertainty and non-linearities, in particular when investigating the interconnected feedbacks between continental and marine social–ecological systems (Armitage et al., 2008).

In terrestrial ecosystems, the most relevant change during the last 50 years was the profound modification of the soil towards land for cultivation and the applications of new technologies in

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order to increase the flow of provisioning ES (food, fiber, wood). As result of these transformations, marine social–ecological systems have been also affected due to the increase of erosion, the flow and transport of sediments and organic matter as well as the increase of nutrients which ultimately can generate contamination and eutrophication (Millennium Ecosystem Assessment, 2005).

Despite strong interactions between land uses and coastal ecosystems, land–sea interactions are almost always ignored when designing policies by governments (Beck, 2003). However, recent research has been stimulating an integrated decision-making process to take into account these interactions. Under this context, important progresses are expected in the implementation of the ecosystem based approach if social actors who are using ES and those with the responsibility of managing them are closely related and work jointly in a given area. Nevertheless, little research has been done on this topic in the field of terrestrial and marine social–ecological systems jointly. In addition, although the lack of a policy in which the relationships between actors are managed, it is expected that actors with similar interests using ES will also try to construct social networks to deal with the same problems (Coleman, 1990; Liu et al., 2007).

Social network analysis (SNA) has proven to be useful tool in studying and explaining social phenomena to provide an innovative framework to analyse the social dimension of social–ecological systems (e.g. Bodin and Crona, 2009; Crona and Bodin, 2010; Ramírez-Sánchez and Pinkerton, 2009). Key findings emerging from this work is the important interplay between social capital and leadership for effective resource governance. Examples from documented transitions in natural resource governance show that networks of contacts between user groups and scientists are important for increasing exchange of information, leading to changed mindsets and deeper understanding of critical issues facing management (Meijerink and Huitema, 2010). In addition, SNA is progressively cited as instrumental in enabling coastal communities to adaptively respond to different drivers and to initiate and sustain successful transformations in navigating towards resilient social–ecological systems (Bodin and Crona, 2008). The study of social networks has been motivated by the argument that the various positions occupied by actors within the social structure are related to their access to opportunities and resources (Marín and Berkes, 2010).

In spite of scientists have already studied the influence of social network structures and different initiatives to stimulate the adoption of co-management in complex systems (Armitage et al., 2008; Bodin et al., 2006), it is important to highlight that almost all studies have taken into account only a few number of ES (Bodin and Crona, 2008). Most of the research efforts have been focused on the use of SNA and the identification of users exploiting fisheries resources in coastal communities in order to describe the existence of formal and informal social networks as successful ways of bottom-up community based natural resource management (Folke et al., 2011). In this context, the research by Rathwell and Peterson (2012) is noteworthy because address direct and indirect interactions of institution shearing interests in different ES at the watershed scale using two-mode networks.

In SNA, while one-mode data records ties between nodes of one class, two-mode data records ties between two sets of nodes of different classes, and the corresponding networks are called two-mode networks (Borgatti, 2009). These kinds of data are often referred to as affiliations because reflects co-memberships in organizations or participation in events and ties between organizations through their members. In our case study, two-mode networks allow us to record the relations between ecological and social factors, being ES and social actors the two modes or classes of nodes considered. Similarly to the affiliation example, two mode networks reflect association of social actors through ES that could be compared to associations established directly between social actors which are recorded in one mode networks.

This study explores the relation between existing ES of the study area and social actors by using two-mode networks in order to examine opportunities and treats of the governance system. For that reason, the objectives of this paper are to characterize governance and use network while assessing (i) if governance links reflects ES use links, (ii) if the links among social actors reflect the ecological relations between continental and marine factors and (iii) if relations among social actors are associated with their use of and their participation in the management of ES.

2. Materials and methods

2.1. Study area

The social–ecological system which forms the basis for the analysis in this paper is located in Comarca VIRCH-Valdés, in the NE of Chubut province and Central Patagonia (Argentina, Fig. 1). *Comarca* is an administrative unit created by the provincial government to improve regional productive strategies. The Comarca VIRCH-Valdés concentrates over than 24% of Chubut province population, which mostly inhabits main cities (Trelew, Puerto Madryn and Rawson), and smaller towns (Gaiman, Dolavon and Puerto Pirámiedes).[1] Climate is temperate semi-arid, with an average annual rainfall of 250 mm and high inter-annual variation (Paruelo et al., 1998). Most rural area consists of private properties where extensive sheep ranching for wool production is the main economic activity. Sheep feed on natural pastures and shrubs characteristics of the southern Monte Phytogeographic Province (León et al., 1998). However, this activity is declining due to the drop of prices combined with large droughts, which led to a huge migration from rural to urban areas, stressing the concentration of population in main cities. So most of population is engaged in commercial and administrative activities, and those related with textile industry in Trelew or aluminium production in Puerto Madryn.[2] In this context, some of the causes already identified by the Millennium Ecosystem Assessment (2005) which usually cause the degradation of ES are present in the area: the unplanned economic growth, the demographic changes and the decline of agriculture.

This administrative unit includes tow distinctive areas: the lower valley of Chubut River (VIRCH because of its Spanish name) and Península Valdés. The valley is a highly productive area within a semi-arid region because an extensive irrigation system based on Chubut river waters. It is 90 km long with variable width between 7 and 10 km. This area consists in numerous small private properties which main productions are fruits and vegetables. Producers of the valley usually associate for process and trade of their products.

Peninsula Valdes is a geographic feature unique in the world. It has an area of approximately 350,000 ha and is located between the Gulf of San Matias and Golfo Nuevo at 42°00′42°48′S, 63°32′ to 65°16′W. Its shores are composed of varied coastal geomorphological features including bays, gulfs, cliffs, and beaches that contribute to the aesthetical value of ecosystems. Steppe is the predominant vegetation type of Peninsula Valdes, with low shrubs, grasses, and plants. The waters of the peninsula are valuable natural breeding areas for many varieties of sea birds and large marine mammals, such as whales and sea lions. Peninsula Valdes is home to characteristic species of Patagonian

[1] Last National Census data (2010) available at ⟨http:www.estadstica.chubut.gov.ar/home⟨.

[2] ⟨http:www.estadstica.chubut.gov.ar/home⟩.

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