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How does adaptive co-management relate to specified and general resilience? An approach from Isla Mayor, Andalusia, Spain

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ABSTRACT

Resilience provides a framework to study the dynamics of social-ecological systems (SESs). The inherent complexity and uncertainty of SESs reveals the necessity for new approaches in management, such as adaptive co-management (ACM). The objective of the present research is to analyse the link between ACM and specified/general resilience debate. For the empirical analysis, a qualitative case-study approach is conducted in Isla Mayor, a southern municipality of Spain with an intensive rice cultivation tradition and a few limited secondary activities such as fishing and tourism. First, we explore five different faces of ACM in Isla Mayor's rice farming: (1) institution building, (2) power sharing, (3) governance, (4) problem solving, and (5) knowledge co-production, social learning and adaptation. Secondly, we analyse specified and general resilience from two perspectives: (1) stakeholders' perceptions, (2) adaptive capacity and self-organization. The results highlight the existence of a task-oriented process aimed at solving problems related to the rice activity. This process has contributed to shape a new multi-level governance system and sharing of power between public authorities and local rice farmers, seemingly contributing to an improved rice cultivation specified resilience. However, the lack of collective power and vertical/horizontal links in the governance framework of the remaining socio-economic activities in the region have given rise to some difficulties in their management and interactions with the rice sector, thereby raising barriers to diversify activities and enhance general resilience. The case shows that ACM can provide the opportunity to navigate the trade-offs between specified and general resilience.

1. Introduction

A constantly changing environment, its complexity and uncertainty, all demand new complex, integrative and holistic approaches. We need theoretical and methodological proposals that bring about a continuum between nature and culture (Ruiz-Ballesteros, 2013), which is to say, *the integration of an organism in its environment* (Ingold, 2000) or *humans-in-nature* (Berkes and Folke, 1998).

The concept of social-ecological systems (SESs) provides a new analytical framework, entailing the view that social and natural systems are in fact linked and the delineation between them is artificial and arbitrary (Berkes and Folke, 1998). They are defined as "systems, in which cultural, political, social, economic, ecological, technological, and other components interact" (Resilience Alliance, 2010). SESs as complex adaptive systems (Janssen and Ostrom, 2006) hold characteristics such as reciprocal effects and feedbacks loops, nonlinearity and thresholds, surprises, legacy effects and time lags, resilience and heterogeneity (Liu et al., 2007).

Resilience, as the capacity of a SES to absorb disturbance while maintaining its essential structure, functions, feedbacks, and therefore identity (Gunderson et al., 2002; Holling, 1973; Walker and Salt, 2006), provides us with a framework to analyse complex and dynamic social-ecological relationships (Folke et al., 2010). Embracing change and appreciating what's needed for a system to absorb unexpected disturbances are in fact the pillars of resilience thinking (Walker and Salt, 2006). Unlike the conventional natural resource management approaches focused on individual components of natural resource systems (Clark and Dickson, 2003), resilience requires a dynamic systems' view. Sustainability of SESs, in terms of long-term maintenance and/or enhancement of their resilience capacity as well as their ability in generating ecosystem services (ES) (Millennium Ecosystem Assessment, 2003), requires new management approaches such as adaptive co-management (ACM).

ACM is the result of the evolution of co-management (CM) and adaptive management (AM) toward a common ground. AM has emerged from applied ecology literature dealing with uncertainty in

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natural resources management (Holling, 1978). It focuses on learning-by-doing and takes place over the medium to long term through cycles of learning and adaptation (Plummer et al., 2012). CM, however, is mostly associated with the commons literature. It is defined by The World Bank (1999, p. 11) as "the sharing of responsibilities, rights and duties between the primary stakeholders, in particular, local communities and the nation state, a decentralized approach to decision-making that involves the local users in the decision-making process as equals with the nation-state". In other terms, CM of common-pool resources depicts some kind of power sharing arrangements between the State and a community of resource users (Carlsson and Berkes, 2005). Despite having diverse historical trajectories, the fusion of AC and CM has been necessary, as AM without collaboration lacks legitimacy, and CM without learning-by-doing does not develop the ability to address emerging problems (Berkes, 2009). This union, represented as ACM is defined as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, on-going, self-organized process of learning by-doing" (Folke et al., 2002).

Maintenance and/or enhancement of resilience in complex and uncertain SESs demand new management approaches. This is why many scholars have focused on the relationship between ACM and resilience. Olsson et al. (2004) propose that the process of ACM development has the potential to expand desirable stability domains and make SESs more resilient. In fact, resilience is also a normative concept, since it refers to maintenance of a desired system configuration in the face of change. Whose desires should therefore be prioritized? Resilience thinking "has to be situated in the context of complex, contested, and changing human interests, and the uncertainty of the outcomes of human interactions" (Armitage and Johnson, 2006). This in turn highlights "the critical role of human interactions mediated through adaptive co-management processes" (Plummer and Armitage, 2007).

Nevertheless, most research on the relationship between ACM and resilience does not make distinction between the two types of resilience: general and specified. Specified resilience (SR) refers to the resilience of some particular part of a system to one or more identified kinds of shocks; whereas general resilience (GR) is the resilience of any and all parts of a system to all kinds of shocks, including novel ones (Folke et al., 2010). The *Resilience of What to What* (Carpenter et al., 2001) is a question that could lead us to assess SR in a specific SES. GR's analysis, however, requires the evaluation of the system's capacity in handling uncertainties and, therefore, the broad vs. restrictive perception of possible shocks among stakeholders. This ability to manage shocks is in fact related to the system's adaptive capacity, which is an important key to GR (Walker and Salt, 2012). In other terms, "social capacity to learn and revise shared goals or assumptions in a flexible way through monitoring and evaluation is necessary for enhancing the general resilience of SESs" (Yu et al., 2016; p. 70). Scholars concur that diversity is one of the key conditions in enabling general resilience (Biggs et al., 2012; Carpenter et al., 2012) as it fosters adaptive capacity. From this perspective, GR becomes-mainly- a normative concept. While it is clear the interests of a specific group are being prioritized to maintain or enhance SR, it is especially important to include all possible stakeholders in GR's analysis for a broad diversity of actors and wider deliberation. In other terms, the empowerment of varied stakeholders in the governance configuration is a key issue in GR's analysis.

So, does ACM contribute to GR and/or SR? As it has been analysed, the literature on ACM highlights a basic pattern: research mainly focuses on only one specific resource or environmental aspect of the system. From 108 revised articles, the three most frequent resource-types were related to forestry, fisheries, and water resources (Plummer et al., 2012). These excessively one-resource oriented ACM approaches could be enhancing knowledge on how SR works, but could also hinder knowledge about the system's GR. As suggested by Cifdaloz et al. (2010) through a robustness-vulnerability trade-off framework, institutional arrangements that are very well tuned to cope with specific shocks may generate vulnerability to novel shocks. However, "distinguishing between robustness and rigidity traps is not inherently clear in resilience thinking, as rigidity trap from one perspective can represent another's robustness" (Robards et al., 2011). Trade-offs between SR and GR are therefore of particular significance and ACM needs to take these two notions of resilience into account.

This paper aims (1) to analyse how an ACM scheme relates to SR and/or GR and (2) to study the trade-offs between both types of resilience analytical scales. To carry out these objectives, we use a case study form Isla Mayor (Andalusia, Spain), where rice farming has basically shaped the municipality's socio-economic structure, while fishing and tourism represent minor secondary activities in the area. The specific goals of this paper are: 1) to explore and characterize ACM in rice farming, 2) to analyse and discuss SR in rice farming and GR in the whole Isla Mayor SES, and 3) to discuss the trade-offs between SR and GR through the ACM lens.

2. Study area and research methodology

2.1. Study area

Isla Mayor is a municipality located in the province of Seville in the southwest of Spain. Part of the Autonomous Community of Andalusia, Isla Mayor is approximately 40 kilometres from the city of Seville. It has a surface area of 114.4 km^2 and a population of 5938 (SIMA, 2015). It is an island surrounded by the Guadalquivir River with an 87% of water uses dedicated to agriculture and livestock sectors (CHG, 2012). Given its particular geographical situation close to the mouth of the river in the last segment of the Guadalquivir estuary, it is highly affected by salinity resulting form the Atlantic Ocean tides. The entire municipality is located northeast of the Doñana National Park within the Guadalquivir marsh ecosystem. These marshes support great bird diversity and are used as a migration route for a total of 370 species, migrating between Europe and Africa (Junta de Andalucía, 2008). The physical environment of the area provides exceptional topography and climate for rice cultivation (González-Arteaga, 2005; Moral, 1993), which occupies about 85% of the entire territory and is the primary land use of the area (SIMA, 2014).

Isla Mayor is a relatively recent municipality and rice has been a central factor in its creation. People began to settle permanently in the zone just after the Spanish Civil War (1936–1939), when the National Institute for Colonization (Ministry of Agriculture) started a vast hydraulic infrastructure, and thus enabled the development of rice farming in the region. With 9.711 ha of rice paddies in 2015, rice farming is considered the main socio-economic activity at Isla Mayor. Consequently, as the only provider of water, the Guadalquivir River plays a central role in this town. Flooding is the area's irrigation system and this permits a continuous circulation of water during the whole vegetative cycle through a network of distribution and drainage channels.

At present, Isla Mayor's rice farming is highly mechanized so that seeding and spraying operations are mostly carried out by airplanes. The final product is labelled as *Integrated Production (IP)*. IP is a relatively environmentally friendly farming system that implements constant field supervision by specialized and authorized technicians, as well as a limited use of pesticides and fertilizers. It is regulated by national decrees and specific technical guidelines of the Autonomous Community of Andalusia. It also receives grants from the European Union. The IP system was first used in Seville's rice farms in 1998 and developed so rapidly that currently 98% of province's paddies use the IP system. Since its start, the Seville Rice Farmers Federation has mainly coordinated the IP farming system at the local level. This federation was founded in 1986 and is currently a lobby, which represents rice farmers' unity and defends their interests. The region's rice paddies, specially the environmentally friendly IP ones, are significantly contributing to maintain the region's rich diversity of birds. According to a study in this regard (EBD-CSIC, 2009), the reduction of cultivated rice areas in three