Environmental Science & Policy 66 (2016) 31–39

Contents lists available at ScienceDirect

Environmental Science & Policy

journal homepage: www.elsevier.com/locate/envsci

The governance of ecosystem services in river basins: An approach for structured data representation and analysis

Kathrin Knüppe, Dr.*, Christian Knieper

Institute of Environmental Systems Research, Osnabrück University, Germany

ARTICLE INFO

Article history:
Received 6 April 2016
Received in revised form 13 July 2016
Accepted 18 July 2016
Available online xxx

Keywords:
Water governance
Ecosystem services
Management and transition framework
Relational database
South Africa

ABSTRACT

River basins provide a wide range of ecosystem services important for human well-being. Ecosystem functions and their value to humans have been thoroughly studied. However, the role of governance characteristics for the sustainable management of ecosystem services has been largely ignored up to now. To close this gap, this article introduces the latest modifications to a database building on the Management and Transition Framework (MTF) that serve to study the relationship between water governance and management systems and their performance with regard to impacts on ecosystem services. This comprehensive approach facilitates structured data collection and representation in order to analyze single case studies or compare case studies regarding the governance and management of water resources and associated ecosystem services. It allows the user to investigate whether certain water governance characteristics, such as stakeholder involvement or vertical integration of governance levels, are associated with a change in the management of ecosystem services or a measurable change in their state. A simplified case from South Africa shows how the database modifications allow addressing links between governance and management processes on the one side and ecosystem services and the way they are handled on the other side. Applying the MTF database leads to evidence-based insights into best practices as well as failed management approaches and interventions. This in turn provides knowledge that can be transferred from science to practice supporting sustainable governance of ecosystem services.

1. Introduction

Worldwide, water crises caused by rising demand for the resource and extreme weather events such as floods and droughts are steadily increasing and constitute a threat to human well-being. In addition, a decrease in ecosystem integrity and the associated loss of ecosystem services is observed in many locations around the world (MA, 2005). Ecosystem services are *"the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life"* (Daily, 1997, p3). Decreases in the level of ecosystem services in the Anthropocene result primarily from human interventions such as the overuse of natural resources or the clearing of natural vegetation for agriculture and industrial purposes as well as urban development. Enhancing the resilience of ecosystem services is therefore of substantial policy interest (Biggs et al., 2012). In doing so, the focus of water management is often on technological or institutional panaceas while the complex and site-specific set of context conditions in individual river basins is ignored (Pahl-Wostl, 2015).

The research presented here builds upon the assumption that an ecosystem services approach supports integrated water resources governance and management.[1] Such an approach might help water managers to identify trade-offs and synergies between human needs and environmental water requirements. Trade-offs often arise when the provision of one service is enhanced at the cost of reducing the provision of another service while synergies can be fostered when multiple services are enhanced simultaneously and, thus, harmonize the multi-functionality of water systems (e.g., river landscapes) (Bennett et al., 2009). If natural

* Corresponding author.
E-mail address: kathrin.knueppe@uos.de (K. Knüppe).

http://dx.doi.org/10.1016/j.envsci.2016.07.009
1462-9011/

[1] The term governance refers to the interactions among structures, processes, rules, and traditions that determine how people make decisions and share power, exercise responsibility, and ensure accountability, and the means by which stakeholders have a say in the management of natural resources (Cundill and Fabricius, 2010). The term management refers to analyzing, monitoring, developing and implementing measures to maintain natural resources in a state that is within desirable ecological limits (Pahl-Wostl, 2015).

resource managers do not acknowledge these trade-offs, it is likely to impair the effectiveness of any policy response for effective management. In this context, the relationship between governance and management systems and their performance with regard to impacts on the state of various ecosystem services is not well understood (cf. Primmer et al., 2015). This link is not trivial, and causal links behind this are difficult to identify. This is basically due to mismatches between ecological and political scales, the time lag between a cause (management action) and its resulting change (alteration in ecosystem services), and the simultaneous influence of various context factors (e.g., demographic and economic trends) (cf. Ostrom, 2005). Nevertheless, the scientific community addressing the governance of ecosystem services is growing (e.g., Rathwell and Peterson, 2012; Gómez-Baggethun et al., 2013) and research insights are being transferred to policy and economic players (e.g., Muradian and Rival, 2012; Ruckelshaus et al., 2015).

To better understand the interdependencies and feedback loops between water governance and management systems and their performance with regard to impacts on the state of ecosystem services, this article introduces the latest modifications that were made to a database (Knieper et al., 2010) derived from the Management and Transition Framework (MTF) (Pahl-Wostl, 2015). The framework offers a system-oriented approach (Richmond, 1994) in which ecosystem services are used as a bridging concept to characterize human-environment interactions. In this article, we present the latest version of the MTF database, version 11c, and describe modifications that were made to the database since the paper by Knieper et al. (2010) in order to facilitate analyses of the governance and management of ecosystem services. The overall intention of the MTF database is to understand social-ecological systems (e.g., river basins) and the complexity of governance and management processes embedded is these systems. This in turn allows researchers to better understand how ecosystem services can be managed towards more sustainability. The new insights can be used to identify best practices or failed management approaches, which in turn is important for practitioners (e.g., water authorities, watershed planners).

The next section introduces the relevance of ecosystem services for integrated water governance and management. After explaining the conceptual and methodological foundations of the MTF database and introducing modifications with respect to the governance and management of ecosystem services, its application is illustrated in a case. Due to space restrictions, this paper does not elaborate a full case study analysis. Rather we want to provide a simplified illustration of how the extensions of the MTF database can be used. We then discuss the case application and provide some critical reflections on our approach. Finally, we provide conclusions and highlight future investigations that could be carried out with the MTF database.

2. An ecosystem services approach for integrated water governance and management

River basins provide a wide range of ecosystem services that are important for human well-being. Ecosystem services can be grouped into three broad categories: (i) provisioning services, such as household water supply and water for cropping/irrigation and livestock purposes, (ii) regulation and maintenance services, such as water pollution control and flora and fauna habitats, and (iii) cultural and social services, such as river landscapes for recreational activities (Haines-Young and Potschin, 2010).

Albeit the concept of ecosystem services is partly criticized for its anthropocentric viewpoint as it excludes the intrinsic value of nature (e.g., McCauley, 2006; Sagoff, 2008), we follow the Millennium Ecosystem Assessment (MA, 2005), in which ecosystem services are used to conceptualize the connections between humanity and the sustained functioning of the environment. In this context, collaborative and participatory governance in multi-level systems is assumed to play a key role in delivering high quality environmental policy output and increasing the legitimacy and effectiveness of implementation and compliance (Newig and Fritsch, 2009). Therefore, the concept of ecosystem services is important for several reasons: It represents the benefits humans derive, directly or indirectly, from ecosystems (MA, 2005) and hence, translates complexity of ecological structures and processes into tangible goods and services valued by humans (de Groot et al., 2002). This improves the integration of social, economic and environmental considerations in strategic decision-making (Pittock et al., 2012). The concept has the potential to highlight and communicate trade-offs between different forms of usage (e.g., land-use, flood risk management, urban development) (Rodríguez et al., 2006) and to allow for a comprehensive evaluation of policy goals in order to realize synergies among different ecosystem services (Hauck et al., 2013).

The ecosystem services concept is well-known both in natural and social scientific communities, and the number of government-supported ecosystem services initiatives around the world is growing (State of Global Ecosystem Services Policy Developments, 2009). The Convention of Biological Diversity's Ecosystem Approach developed the so-called Malawi Principles, which support the integrated management of land, water, and living resources, which in turn promotes conservation and sustainable use in an equitable way (Smith and Maltby, 2003). This provides an important basis for the management of ecosystem services. However, numerous policy makers and market players argue that many approaches for the management of ecosystem services are too fuzzy and substantial knowledge required for a systematic and comprehensive application is lacking (Nahilk et al., 2012; Schleyer et al., 2015). One of the most significant challenges to the governance of ecosystem services is integrating social and ethical factors together with environmental aspects into water management and related sectors (Norgaard, 2010). Many water managers and politicians lack knowledge and awareness of the interactions (and the implications of these interactions) between different ecosystem services and, therefore, fail to manage natural systems appropriately (Rodríguez et al., 2006; Daily, 1997; Braat and de Groot, 2012). In particular, slowly changing factors that underlie regulation and maintenance services (e.g., soil fertility, groundwater levels) are often ignored by policy-makers and rarely addressed actively in policy and management processes (MA, 2005). However, it is often these slowly changing factors that lead to unanticipated regime shifts in ecosystems that can cause rapid, irreversible changes in ecosystem services and human well-being (Carpenter et al., 2009). Bennett et al. (2009) found that declines in regulating ecosystem services often impair an ecosystem's resilience. Society tends to sacrifice regulation and maintenance as well as cultural and social services while continuing to encourage policy and management to prioritize provisioning services (e.g., water for irrigation and food production).

In order to overcome these challenges, the role of governance of ecosystem services in the transition towards integrated and sustainable water management must be better understood. Given the predominantly centralized and top-down development of water management historically, most governance systems do not provide the structural conditions necessary to implement integrated approaches (Ostrom, 2005; Biggs et al., 2012). For a shift in favor of the ecosystem services concept, we propose that change towards participatory management and collaborative decision making is required. Therefore, targeted analyses of internal structures of complex governance and management systems should include not only governmental actors, but also various non-governmental actors participating in policy formulation and