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Valuing ecosystem services for conservation and development purposes: A case study from Kenya

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ABSTRACT

This paper mapped and valued key inter-related drylands ecosystem services of importance to pastoralists, crop farmers, the tourism industry, conservationists, and policy planners in the Ewaso Ng'iro basin, the largest of the five major basins in Kenya. We used an ecosystem services approach where only final benefits are valued to avoid double counting. The final benefits are ecosystem services or commodities which have an economic value. The supply of ecosystem services depends on the functioning of ecosystems, but rarely ecological and institutional boundaries coincide and often stakeholders in ecosystem services cut across a range of institutional zones and scales. Land use and management influence the system processes, properties and components that are the basis of services provision. Although much has been written about the need to quantify and value ecosystem services, there are fewer spatially explicit studies that delineate the supply and demand areas for ecosystem services and assess the trade-offs between ecosystem services over space and time especially on drylands.

Based on the spatial distribution of resources and the existing competition over these resources, this paper assesses the current values attributed to the selected ecosystem services. Then, by mapping existing supporting infrastructure and drivers of land use change such as demographic pressure, we highlight trade-offs and synergies among alternative uses and opportunities for sustainable development. In particular, the paper identifies services that will be lost if a particular part of landscape is modified: e.g. benefits for livestock and wildlife can be affected by the lack of conservation of corridors and rangelands, while water supply and irrigated crops can be compromised by increased water demand as result of human population pressure mainly at the upstream sub-catchments.

We demonstrate the value of spatial analysis to land use investments and management and highlight how conservation and management of ecosystem services require the understanding of the spatial links between ecosystems and human well-being.

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1. Introduction

Ecosystem services are the benefits that people obtain from ecosystems that are indispensable to the well-being of all people in all places. The Millennium Ecosystem Assessment (MEA, 2003) has contributed to the understanding of the relations between human and ecological well-being, but research incorporating services into conservation planning and development is just beginning (McDonald, 2009). In fact, the relationships between ecosystem management and ecosystem services and the impact that different management measures may generate on human well-being have not been enough explored, while they could be used to support decision making processes with respect to trade-offs involved in land cover and land use change (Tallis and Polasky, 2009). Land use and management influence the system processes, properties and components that are the basis of the ecosystem services provision. Their change will therefore cause a change in supply of a specific service or of a complete bundle of services provided by an ecosystem (de Groot et al., 2010; Wainger and Mazzotta, 2011).

The integration of ecosystem services into decision making relies on access to scientific information showing where ecosystem services are provided, how they have been used and how they will be affected by alternative plans and policies. There are several available instruments to analyze implications of land use and management changes, among them, spatially explicit analysis that involves mapping and valuing together with visualizing ecosystem services (de Groot et al., 2010). So far, landscape maps have almost uniquely included land cover or land uses. This information is not sufficient in the context of planning and it needs to be integrated with data showing the heterogeneity in the quality and quantity of services provision (Troy and Wilson, 2006).

In a management perspective it is needed to identify where natural resources of interest to people are generated, and where and how people are consuming them (McDonald, 2009). In this sense, ecosystem-based planning is an approach that seeks to identify and understand the important ecological characteristics of a landscape or region and look at the multiple ecosystem services produced, and then use these information to design plans that guide the development of ecologically-responsible human activities (Christensen et al., 1996). Furthermore, decision-making in planning can be more comprehensive and integrated when ecosystem-based planning is combined with watershed management (Kennly and Bobrowsky, 2002).

Although much has been written about the need to quantify and value ecosystem services (Fisher and Turner, 2008; Naidoo et al., 2008; Cowling et al., 2008), there are fewer spatially explicit studies that delineate the supply and demand areas for ecosystem services and assess the trade-offs between ecosystem services over space and time and this especially on water basins in drylands of Eastern Africa regions.

Despite their vulnerability, the high dependency of their residents on the ecosystem and the conflicts in place for the use of water and other natural resources, drylands in fact hardly receive any attention in spatial and economic studies

on ecosystem services (Niemi et al., 2010). In these regions, the water basins present multiple ecosystems services that can be shared among different users. In addition, they are also rich in biodiversity, plants, wildlife and livestock. This rather fragile ecosystem frequently experience drought conditions and pressure exerted by the increase in population and adverse human activities (NEMA and UNDP, 2009). Besides, the scarcity of water in drylands leads to many constraints and conflicts in use. This accentuates the need for wise management and planning especially in water-scarce semi-arid areas.

The analysis of water basins ecosystem services in drylands presents a series of challenges. If from one hand the supply of ecosystem services depends on the functioning of ecosystems, from the other hand rarely ecological and institutional boundaries coincide and often stakeholders in ecosystem services cut across a range of institutional zones and scales (Cash and Moser, 1998).

After decades of neglect, the government of Kenya is committed to revitalize drylands of Kenya. In this context it needs data and tools to compare alternative land and water uses between livestock, crop production and wildlife based tourism (GoK, 2007a; MDNKOAL, 2008). Most of these production systems have been neglected and the importance of these areas undervalued especially in the provision of ecosystem services.

Studies on the Ewaso N'giro area have almost uniquely included a bio-physical perspective (Mutiga et al., 2010a) or have been focused in the upper part of the basin (Liniger et al., 2005; Mati et al., 2000). Few studies have focused on the entire catchment and on the conflicts across it (Mutiga et al., 2010b), but none focusing on economic valuation of the services provided by the catchment and the trade-off given the competing water use and land use changes.

Using an integrated approach in this study we map and value key interrelated drylands ecosystem services of importance to pastoralist, crop farmers, the tourism industry, conservationists and policy planners.

We use this information to understand the spatial development requirement in the region and to evaluate the evidence base trade-offs and synergies between economic development and environmental constraints.

1.1. Ewaso Ng'iro water basin

The Ewaso Ng'iro water basin is one of the five major catchments in Kenya (Fig. 1). It covers seven districts and it has an area of 83,847 km² and a population of approximately 1.85 million with about 40% living in absolute poverty (World Resources Institute et al., 2007).

It comprises of communal and trust lands, cattle ranches and private wildlife conservancies managed by pastoral communities and commercial enterprises (which occupy the dry lowland of the basin), as well as agricultural plots managed by agribusinesses and smallholder farmers (mainly located in the mountain foot zones). The mountain forests are protected area. It is a critical area for drylands as it is crossroads between wildlife conservation, livestock keeping, and crop agriculture (including irrigation).

This site is a very important wildlife area in Kenya with more than twenty species of indigenous large mammals and

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