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journal homepage: [www.elsevier.com/locate/ecoser](http://www.elsevier.com/locate/ecoser)

# Tropical forest conservation versus conversion trade-offs: Insights from analysis of ecosystem services provided by Kakamega rainforest in Kenya



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## ARTICLE INFO

## Article history:

Received 23 April 2014

Received in revised form

18 December 2014

Accepted 14 March 2015

Available online 3 April 2015

## Keywords:

Biodiversity conservation

Economic valuation

Ecosystem services

Kakamega rainforest

## ABSTRACT

Ecosystem services provided by tropical forests are becoming scarcer due to continued deforestation as demand for forest benefits increases with the growing population. There is need for comprehensive valuation of key ecosystem services in order to inform policy and implement better management systems to enhance the supply of ecosystem services. This study estimates local economic value of key ecosystem services provided by Kakamega rainforest and examines how the information can support sustainable forest management in Kenya. This is the only rainforest in Kenya and it has exceptional biodiversity value including several unique species not found anywhere else in the country. Kakamega rainforest also provides a classic case of conflict between conservation and exploitation goals given the dense population around it. We carried out elaborate household and visitors surveys to collect data used to estimate the economic value of three main ecosystem services. We estimated the total economic value of key ecosystem services (excluding biodiversity value) at about US\$ 7.4 million per year or US\$ 415 ha<sup>-1</sup> yr<sup>-1</sup>. The local economic benefits are considerably less than forgone returns from agricultural activities if the forest were to be converted to the best agricultural uses. Arguably, continued protection of this forest is justified on the basis of the unknown value of its rich biodiversity and capacity to sequester CO<sub>2</sub>. Empirical findings show that the existing forest management system was less effective due to resource constraints and institutional weaknesses. Our study provides insights for the need to manage this forest for multiple uses. We recommend an integrated management strategy that balances local resource needs with biodiversity conservation. We suggest that improved stakeholder collaboration can facilitate sustainable management of this forest resource. Besides, carefully crafted payment for ecosystem services mechanisms and broad environmental education programs can support sustainable forest conservation for this and other similar forest ecosystems in Africa.

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## 1. Introduction

Natural forests constitute an important ecosystem that provides not only private goods for direct human use, but also public services with indirect use or non-use benefits (MA, 2005; Glenday, 2006; Daily et al., 2009). The supplied ecosystem services contribute to the maintenance of both the ecological functions and improvement of human well-being across space and over time. Ecosystem services have previously been defined as the tangible and intangible benefits derived from ecosystems that “produce human well-being” (MA, 2005; Fisher and Turner, 2008; TEEB, 2010b). Three main categories

are distinguished: provisioning services such as timber and non-timber products harvested from the ecosystem; regulating services such as carbon sequestration and cultural services including the intangible benefits people derive from ecosystems for spiritual, cultural heritage and recreational purposes (TEEB, 2010a; Haines-Young and Potschin, 2011).

Ecosystem services provided by tropical forests are becoming scarcer due to the supply side stressors and the demand side pressures. For example, deforestation threatens the supply of essential ecosystem services by compromising functional capacity of the forests. At the same time, population driven demand for ecosystem services exerts unprecedented pressure on the forest ecosystems (Lambin et al., 2003; MA, 2005; Morton et al., 2006; Schmook and Vance, 2009). Besides, rationing of public budgetary resources for conservation programs limits the realisation of sustainable forest management targets in many developing countries. It has been postulated that

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analysis and valuation of ecosystem services can support the design of sustainable management alternatives (Freeman, 1991; Bockstael et al., 2000; Hassan, 2003; Glenday, 2006; Wunder, 2007; Ansink et al., 2008; Benhin and Hassan, 2008; Hein, 2011). However, it is not always clear how ecosystem services translate into stakeholder incentives in forest management and whether the knowledge of economic value of ecosystem services is sufficient to trigger better ecosystem management practices (Hein et al., 2006; Daily et al., 2009).

The objective of the study is to estimate the local economic value of ecosystem services provided by Kakamega rainforest in Kenya and examine how this information can support sustainable forest management. In particular, we analyse to what degree local ecosystem benefits provide a motivation for conservation and sustainable use of Kakamega rainforest. We first analyse the local and selected national benefits provided by the forest, and subsequently analyse the way stakeholders are involved in management of the forest. The forest is selected for this valuation study for three main reasons. First, Kakamega rainforest provides a bundle of important ecosystem services. It has biodiversity of international significance, serves as a tourist attraction, is a carbon sink, and is a source of several rivers that drain into Lake Victoria (Glenday, 2006; Ouma et al., 2011). This forest is therefore of high conservation significance and understanding the monetary value of ecosystem services that it provides may help in its sustainable conservation. Secondly, the areas around Kakamega rainforest exhibit high population densities (e.g. 1045 people/km<sup>2</sup> in Vihiga County). The forest is threatened by over-exploitation and encroachment as recently established in an analysis of land use change based on remote sensing images of the past 25 years (Mutoko et al., 2014a). Increasing dependence of local residents on the forest—for firewood, poles, charcoal and grazing—provides a classic case of conflict between conservation and exploitation goals (Fashing et al., 2004). Trade-offs involving these goals requires a thorough analysis that we explored in this study. Thirdly, Kakamega forest is the easternmost patch of the equatorial rainforests of Africa that once stretched from Ivory Coast to Kenya (Müller and Mburu, 2009). Some forests remain in Gabon, Congo and Uganda (Lovett and Wasser, 2008). Kakamega forest is the only remaining Guineo-Congolian rainforest in Kenya. Hence, the ecosystem services generated by this forest are regionally representative and their comprehensive valuation has potential policy and management implications for similar forest ecosystems in Africa.

We carry out an analysis of the economic value of Kakamega rainforest with regards to the two institutions that drive management of the forest: (i) official management by government institutions, in view of the national importance of the forest; and (ii) community co-management by a multitude of local stakeholders as a function of community interests and local perceptions. Innovative aspects of this study are that we focus on an ecosystem that has received to date little attention in the ecosystem services literature, that we compare local economic benefits and opportunity costs of conservation, and that we examine both the ecosystem services used by local communities and their interests in and perceptions of local forest management.

## 2. Materials and methods

### 2.1. The case study area

Kakamega rainforest is located in Western Province of Kenya. The forest lies between latitudes 0°10' and 0°21' North and longitudes 34°47' and 34°58' East (Fig. 1). The area has altitude ranging from 1500 to 1700 m above sea level, receives an average annual rainfall of 2000 mm and the maximum temperature is 26 °C (Müller and Mburu, 2009; Ouma et al., 2011). Kakamega rainforest was first gazetted as a Government Forest Reserve in 1933, then covering about 23,780 ha. The protected forest area

currently covers 17,838 ha out of which indigenous forested area is about 14,000 ha (Müller and Mburu, 2009). Two community managed Nature Reserves created in 1967 at Isecheno and Yala cover about 700 ha. There are two National Reserves at Buyangu and Kisere to the northern part forming the Kakamega National Forest Reserve that was created in 1985, under the strict management of Kenya Wildlife Service (KWS). The area under KWS is about 4470 ha (Fig. 1). Kenya Forest Service (KFS) together with the local community manages the rest of the forest area mainly in the southern part and northern fragments around Malava area (Ouma et al., 2011). The forest is endowed with rich biodiversity of plants, endemic primates, birds and insects. The high biodiversity value of this forest is important for both international and local tourism as well as research purposes. The forest is also a natural sink for CO<sub>2</sub> sequestration thereby contributing to mitigation of global climatic change (Ministry of Environment and Natural Resources, 1994).

The local communities rely on the forest for ecosystem services such as firewood, charcoal, pole wood, pastures, medicinal extracts and wild honey that supplement their livelihood needs (Ouma et al., 2011). They also conduct cultural activities such as male circumcision rites in secluded parts of the forest. According to the 2009 population census, administrative locations (units below the sub-district) neighbouring the forest counted 191,490 people in about 32,000 households (KNBS, 2010).

To derive a representative sample for the assessment of ecosystem services provided by Kakamega rainforest and the effectiveness of the existing conservation management arrangements, we sampled two sites: one managed by KFS covering forest-adjacent households along the stretch from Chepsonoi, Jeptulu to Shinyalu boundary and the other under KWS covering tourists at Buyangu National Forest Reserve.

### 2.2. Definition of indicators for ecosystem services

Proper physical quantification and economic valuation of ecosystem services provided by the forest ecosystem requires careful selection of the benefit indicators, classification and identification of appropriate scale of beneficiaries for valuation (Daily et al., 2000; Hein et al., 2006; TEEB, 2010a). This was important for the application of suitable valuation techniques to retrieve the correct estimate of the monetary value of a complete bundle of the supplied ecosystem services. Based on the available knowledge and local stakeholder consultations, we defined three distinct ecosystem services across the broad categories found in literature (MA, 2005; Brander et al., 2010; TEEB, 2010a). These were provisioning services comprised of seven non-timber forest products (NTFPs), cultural services of recreational tourism and circumcision rites, and biodiversity conservation, which we included to reflect the non-use value of the forest. For each ecosystem service, we identified the measurable benefit indicators, the main consumer groups and their spatial reach (Table 1). We then designed appropriate research methods to collect relevant data for proper quantification and valuation of the key ecosystem benefits.

### 2.3. Data collection and quantification of ecosystem services

We adopted the general frameworks provided by the Millennium Ecosystem Assessment (MA, 2003) and TEEB (2010a). The local and selected national scale ecosystem services generated from Kakamega rainforest were quantified and valued based on interviews with forest-adjacent community and the analysis of secondary data. We selected ecosystem services for our analysis based on their relevance for local forest management. This was informed by earlier focussed group discussions which established the type of benefits the local community derived from the forest and review of literature on recreational services offered at Kakamega Forest National Reserve (Ouma et al., 2011; Mutoko et al., 2014b). In particular, we included in our analysis

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