Ecosystem Services 20 (2016) 1–14

Contents lists available at ScienceDirect

Ecosystem Services

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

Valuing forest ecosystem services and disservices – Case study of a protected area in India

K.N. Ninan [a,*], Andreas Kontoleon [b]

[a] Centre for Economics, Environment and Society, Koramangala ST Bed, Bangalore 560047, India
[b] Department of Land Economy, University of Cambridge, 19 Silver Street, United Kingdom

ARTICLE INFO

Article history:
Received 2 January 2016
Received in revised form
12 May 2016
Accepted 13 May 2016

Keywords:
Economic valuation
Forest ecosystem services
Disservices
Added value
Net benefits

ABSTRACT

This study estimates the value of forest ecosystem services provided by a protected area in a biodiversity hotspot in India. It also addresses some of the shortcomings identified in existing literature by estimating the value of several intangible benefits, and disservices of forests ignored in most valuation studies, as well as the added value from intact forests as compared to from alternative landscapes. Using primary and secondary data, and economic valuation techniques the study shows that the total net benefits provided by the Nagarhole national park in Karnataka, India are considerable. The added value of benefits from the park is also higher as compared to from alternative landscapes considering just three ecosystem services. If these are factored in decision making it could strengthen the economic case for conserving forests in tropical countries such as India where there is immense pressure to divert forests for meeting development needs.

1. Introduction

Traditionally forests have been valued only for the tangible benefits that they provide such as timber and non-timber forest products (NTFPs). The intangible benefits provided by forests such as watershed and soil protection, regulating climate, nutrient cycling, etc have been undervalued since these are not traded in conventional markets or difficult to value. If these values could be captured and factored in decision making it could lead to better conservation outcomes, especially in strengthening the economic case for justifying conservation of forests versus diverting them to non-forest uses. However, there is immense pressure in many biorich tropical countries to divert forests for meeting pressing development needs such as raising agricultural or export crops, setting up hydroelectric, industrial and mining projects, etc. How to balance conservation with development needs therefore poses a big challenge to scientists and planners.

Despite there being several valuation studies, very few have assessed the total (net) economic value of forests in biodiversity hotspots. The few that are available are limited in scope or have other drawbacks. For instance, a recent global survey indicated the shortcomings of existing forest valuation studies such as focusing on a limited number of services such as soil and water conservation, carbon sequestration and recreation for which data are readily available and hence easier to calculate, not accounting for the disservices of forests, as well as estimating the net benefits of conserving forests versus that from alternative uses (Ninan and Inoue, 2013a). This survey highlighted the need for more comprehensive studies across countries and forest sites especially in Asia, Africa and South America which are the regions experiencing high deforestation rates as per the Global Forest Resources Assessment for 2010 (FAO, 2010).

Keeping the above in view this study focusses on India which is one of the seventeen megadiversity countries in the world. It is also home to two of the 34 biodiversity hotspots in the world, namely the Western Ghats and the Eastern Himalayas. Despite the large area under forests (over 70 million ha as per India's State of Forest Report, 2015 which is over 21% of India's total geographical area) and also containing two biodiversity hotspots there are hardly any studies in India which have tried to assess the economic value of the services provided by its forests. Added to that with India trying to accelerate economic growth and relax forest laws, there is immense pressure to divert forests to non- forests uses. Hence there is a pressing need to undertake an economic valuation of the ecosystem services, especially intangible benefits, provided by forests in India. This study therefore seeks to estimate the value of ecosystem services provided by a protected area in a biodiversity hotspot in India. It also addresses some of the shortcomings identified in the global survey cited above by estimating the value of several intangible benefits ignored in most valuation studies, estimating the value of disservices of forests such as wild

* Corresponding author.
E-mail addresses: ninankn@yahoo.co.in (K.N. Ninan), ak219@cam.ac.uk (A. Kontoleon).

http://dx.doi.org/10.1016/j.ecoser.2016.05.001
2212-0416/

life damages and forest fires, as well as the net benefits obtained from intact forests as compared to from alternative landscapes for selected services. Policymakers need such information in order to gain support for conservation funding but also to engage local communities and develop incentives for conservation (Mullan and Kontoleon, 2008; Madsen et al, 2011; Carrasco et al., 2014; Mullan, 2014). Further, the methodology adopted relies on existing valuation estimates and can be used as a template by researchers and policy practitioners to conduct similar studies in other forest sites.

2. Study area

For conducting this study Nagarhole National Park (also known as Rajiv Gandhi national park) located in Karnataka state in South India has been selected (Fig. 1). The park falls within the Nilgiris biosphere of the Western Ghats biodiversity hotspot and covers an area of about 643.39 km^2. The park is rich in flora and fauna and is home to about 32 species of large mammals, 252 species of birds, 32 species of reptiles, 13 species of amphibians and 10 species of fish (Kumar, 2014). The park is noteworthy for its many endangered species including the Asiatic elephant, royal Bengal tiger, leopards, Indian wild dogs, wild buffaloes, etc. The park has a good density of tiger population (about 8.4 tigers/100 km^2 in 2011) and was designated as a critical tiger reserve by the Government of India in December 2007 (Kumar, 2014). It also has a good density of elephants. The vegetation of the park primarily consists of moist and dry deciduous forests (over 73%), with the rest being under semi-evergreen and scrub forests, plantations and marshy swamps (Appayya, 2001).

3. Materials and methods

Information and data for undertaking this study has been collected from the Office of the Director, Rajiv Gandhi National Park, Hunsur, Karnataka State and from the management plans prepared for the park (Appayya, 2001;Kumar, 2014). Besides we have also relied on official publications of the Indian Ministry of Environment and Forests such as the State of Forest Reports, India Green House Gas Inventory Report for 2010, etc. These have been supplemented with data and information from journal articles, research reports and other publications which are cited in the text. For estimating recreation, grazing and NTFPs benefits we have relied on primary and secondary data. To estimate the value of other services provided by the park we have relied on secondary sources of data and information. More details are spelt out in relevant sections.

For valuing forest ecosystem services and disservices, economic valuation techniques have been used. Table 1 lists the ecosystem services and disservices evaluated in this study and the norms and valuation methods used to estimate these values. Due to lack of data some services such as water purification, flood protection and cultural services of forests have not been estimated in this study. We have also not estimated timber values. This is because the park is a protected area and as per Indian forest laws no timber felling is permitted in national parks and tiger reserves. Although there may be some illegal felling of timber by timber poachers and others (sometimes in collusion with corrupt local forest officials) no data is available on this. Hence our estimates should be considered as a lower bound value. The data used for the study are for 2013 or latest available data at the time of analysis. The estimated values in Indian Rupees have been converted into US dollars using the exchange rate of 1 US$= Rs. 61.27 the average annual for 2014.

4. Results and discussion

4.1. Valuation of ecosystem services and disservices

4.1.1. Water conservation

There are different methods to estimate the hydrological services provided by a forest. What method one uses depends on what aspect of hydrological benefits or services provided by the park is to be estimated in the study. It could be hydropower generation, flood protection benefits, sediment control, water provision, etc. So choice of the method used to estimate water values depends on what hydrological benefit or service is being valued in the study. In our study we have estimated the water conserved or retained in the park from rainfall. The water balance model that we have used (average annual rainfall minus evapotranspiration/runoffs) to estimate the water values from the park have also been used by other researchers (e.g. Xue and Tisdell, 2001; Biao et al., 2010; Mashayekhi et al., 2010; Ninan and Inoue, 2013b) because of its relative ease of computation and availability of required data as compared to other alternatives. For instance, an assessment of the flood protection or sediment control benefits of forests requires data on hydrological flows, flooding patterns, sediment flows, etc. which are not readily available. Evaporation and run off rates vary depending on several factors such as forest and site characteristics, canopy cover, soil profile, amount, pattern and intensity of rainfall events, topography, etc. A study in a forest region in Uttara Kannada district of the Western Ghats estimated the average evaporation/run offs rates to be on average 38.75% during 2004 and 2005 (Krishnaswamy et al., 2013). Using this parameter and the average annual precipitation for the Nagarhole national park which is 1208 mm for the park area falling within Kodagu district and 777 mm for the park area falling within Mysore district the average annual rainfall that is intercepted and conserved in the park is estimated to be over 399.9 million m^3 (Table 2).

The quantity of water conserved in the park may be higher than implied by the above figure. This is because a number of tributaries of the river Cauvery which originates from the head reaches of the Western Ghats flow through the park. However, data on the inflows and outflows of these rivers are not available or even if available not accessible to the public because of a long standing dispute between Karnataka state and neighbouring states over sharing of the water from the river Cauvery which is under adjudication in India's Supreme Court.

We now need to estimate the economic value of the water conserved in the park. In the literature one finds that researchers have used a variety of methods and proxies to estimate this value namely (1) the economic cost of storing water in man-made reservoirs or dams (e.g. Xue and Tisdell, 2001; Biao et al., 2010; Ninan and Inoue, 2013a, 2013b), (2) the shadow price of water derived from an optimization model that related groundwater recharge rates to forest conservation (e.g. Kaiser and Roumasset, 2002), (3) the price of water or electricity (e.g. Guo et al., 2001), and (4) the averted flood damage costs to assess the flood protection benefits of forests (e.g. Ruitenbeek, 1989; Kramer et al., 1997; MRC, 2001). Because of its relative ease of computation and data availability, a number of researchers (e.g. Xue and Tisdell, 2001; Biao et al., 2010; Ninan and Inoue, 2013b) have used the economic cost of storing water in man-made reservoirs or dams to estimate the value of water conserved in forests as compared to other alternative methods. For instance, the method used by Kaiser and Roumasset (2002) to derive shadow prices from an optimization model that related groundwater recharge rates to forest conservation to evaluate the watershed benefits of the Ko'olau watershed in Hawaii requires data on site-specific groundwater recharge rates and groundwater levels which are not readily