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The current and future value of nature-based tourism in the Eastern Arc Mountains of Tanzania

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ABSTRACT

The financial benefit derived from nature-based tourism in the Eastern Arc Mountains (EAMs) of Tanzania has never been assessed. Here, we calculate the producer surplus (PS) related to expenditure on accommodation in the EAMs. This estimate is based on the number of visitor bed-nights collected from a representative sample of hotels, coupled with spatially explicit regression models to extrapolate visitor numbers to unsampled locations, and adjusted to account for how far visits were motivated by nature. The estimated annual PS of nature-based tourism is ~US$195,000. In order to evaluate the future impact of different forest management regimes on PS over a 25 year period, we compare two alternative scenarios of land use. Under a 'hopeful expectations' scenario of no forest loss from protected areas, the present value of PS from nature-based tourism is ~US$1.9 million, compared with US$1.6 million under a 'business-as-usual' scenario. Although the value of nature-based tourism to the EAMs is lower than that generated by Tanzania's large game reserves, these revenues, together with other ecosystem services provided by the area, such as carbon storage and water regulation, may enhance the case for sustainable forest management.

1. Introduction

The relationship between nature-based tourism and biodiversity conservation has been the focus of considerable attention in recent years (Yu et al., 1997; Christ et al., 2003; Stem et al., 2003; Naidoo and Adamowicz, 2005a, 2005b; Adamowicz et al., 2010; Kirkby et al., 2011; Lui et al., 2012; Peh et al., 2013; Sekar et al., 2014). It is widely posited that, if well managed, nature-based tourism can promote conservation of protected areas (Ceballos-Lascurain, 1996; Damania and Hatch, 2005; Alpizar, 2006; Mitchell et al., 2009; Kasangaki et al., 2012). The effectiveness of nature-based tourism in providing incentives for sustainable ecosystem management often depends inter alia on sufficient returns to neighbouring communities through profit-sharing mechanisms (Bookbinder et al., 1998; Walpole and Goodwin, 2000; Kiss, 2004; Coria and Calfucura, 2012).

Tanzania is globally recognised as a popular tourist destination for its 'Big Five' savannah safaris, the spice island of Zanzibar, and the highest mountain in Africa, Mt. Kilimanjaro. Tanzania has over a quarter of its land area allocated to protected areas of various kinds (World Bank, 2010), and boasts seven UNESCO World Heritage Sites. Nature-based tourism to protected areas and overall tourist volume are both increasing annually, in line with other developing countries (Balmford et al., 2009; Karanth and DeFries, 2011). For example, from 2000 to 2010 there was a 56% increase in recorded numbers of international visitors (from ~501,000 to ~782,000; MNRT, 2012). Consequently, tourism has increased its contribution to GDP, from US

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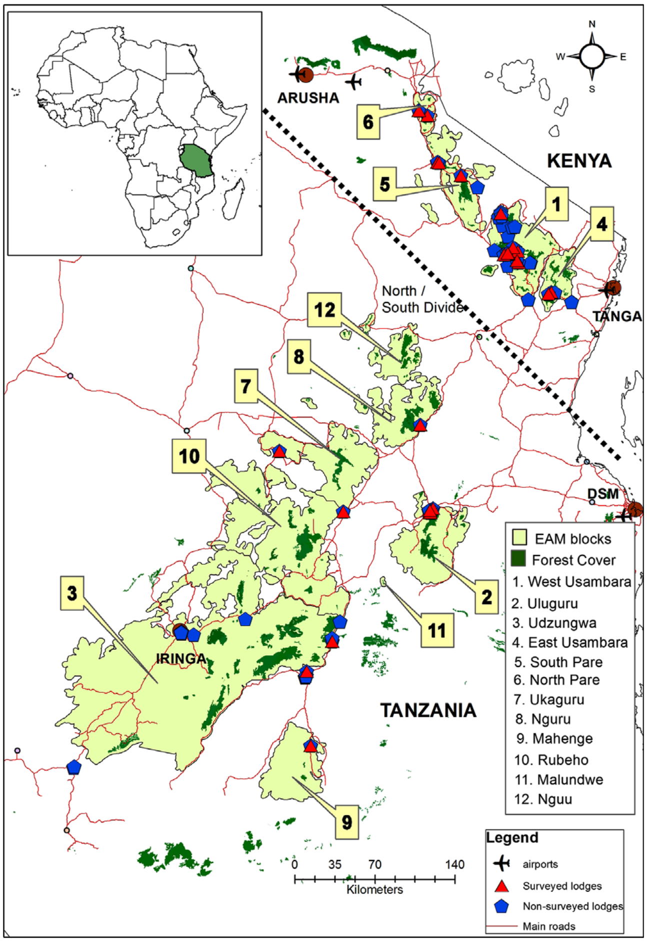

Fig. 1. The Eastern Arc Mountain blocks in Tanzania (light green), ranked according to Producer Surplus (1, high; 12, low), in terms of nature-based tourism. The map depicts mountain extent, lodge distributions, forest cover (dark green), and the north-south divide between the two main tourist circuits. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

$615 million in 2005 to US$1.75 billion in 2010, making it the largest source of foreign exchange and constituting about 8% of the Tanzanian GDP (Mitchell et al., 2009). International tourism is regarded as a means for alleviating poverty in Tanzania (Nelson et al., 2009) and is included in the development plans for the country (Nelson, 2012). Domestic tourism in Tanzania remains small, with low household income indicated as the primary constraint (Mariki et al., 2011).

Tanzania is less recognised as a destination for forest-based nature tourism. The country has relatively small areas of moist forest, mainly within the protected areas of the Eastern Arc Mountains (EAMs) – part of a global Biodiversity Hotspot (Myers et al., 2000; Mittermeier et al., 2004; Burgess et al., 2006, 2007). Tanzanian forests, supporting endemic monkeys, birds and reptiles, offer different attractions to the adjacent game parks, being mostly visited for hiking and as a challenging destination for natural history enthusiasts. Nature-based tourism and recreation are categorised as cultural ecosystem services (e.g. Haines-Young and Potschin, 2011; UK National Ecosystem Assessment, 2011; de Groot et al., 2012; Egoh et al., 2012). They include both market and non-market benefits and are part of a larger set of ecosystem services provided by the natural habitats of the EAM (Fisher et al., 2011a, 2001b).

Our objective is to assess the market benefits of nature-based tourism in the EAMs (Fig. 1) in Tanzania. We use scenario analysis to explore how these benefits might plausibly change under alternative policies of future development in the region.

2. Methods

2.1. Study region

The EAMs comprise 13 blocks from south-eastern Kenya (one block; Taita Hills) to southern Tanzania (Fig. 1) and cover an area of 5.2 million hectares with an associated watershed of 33.9 million hectares (Platts et al., 2011). They were formed at least 30 million years ago (Schlüter, 1997; cf. adjacent volcanoes Mts. Kilimanjaro and Meru, c. 2 million years ago). The EAMs are globally recognised as a centre of species endemism and diversity, with hundreds of endemic plants and animals (Myers et al., (2000); Burgess et al., 2007). Besides biodiversity, the EAMs provide a suite of ecosystem services (Swetnam et al., 2010) beneficial at local to global levels, including carbon storage (Willcock et al., 2012) and the regulation of river flows for drinking water, irrigation and hydropower. The total population of the EAM blocks is estimated at 2.3 million people (Platts et al., 2011), most of whom rely on farming as their main source of income (NBS, 2002). People living in the EAMs depend on the forests and woodlands for firewood, charcoal, timber and building poles (Schaafsma et al., 2014). Other non-wood products obtained include thatch, honey, bushmeat, fruits, vegetables and medicines. As is the trend across the African continent (Fisher, 2010), small-scale agricultural expansion, logging, and the extraction of biomass for fuel and construction are considered to be the main causes of forest degradation and deforestation, resulting in a considerable loss of forest and woodland over many years (Hall et al., 2009; Green et al., 2013).

Tourist destinations on mainland Tanzania can be divided into the northern and southern circuits (Fig. 1; Mariki et al., 2011). The northern circuit is more popular and consists of Mt. Kilimanjaro, Ngorongoro crater and the Serengeti and associated parks within easy reach of Arusha and Moshi (Sekar et al., 2014), while the southern circuit includes the Selous Game Reserve, Mikumi and Ruaha National Parks. There are also smaller tourist flows to destinations in the far west, such as Gombe, Mahale and Katavi National Parks. The EAMs straddle the northern and southern circuits and are accessible to tourists arriving in the major cities of Arusha, Tanga, Dar es Salaam, Morogoro and Iringa.

Table 1
Distribution of 120 surveyed and non-surveyed hotels across the Eastern Arc Mountains study region.

	Mountain block	Mt. Area (ha)[a]	Number of hotels within 30 km of the EAMs			
			Surveyed	Unsurveyed	Low cost	High cost
Northern Circuit	North Pare	51,030	3	1	4	0
	South Pare	232,750	5	7	9	3
	West Usambara	294,520	19	25	29	15
	East Usambara	114,500	3	3	4	2
Southern Circuit	Nguu	156,290	0	0	0	0
	Nguru	256,490	1	0	1	0
	Rubeho	798,440	2	0	2	0
	Ukaguru	324,260	2	0	2	0
	Uluguru	305,730	6	8	4	10
	Udzungwa	1,937,530	4	27	23	8
	Mahenge	260,640	3	1	4	0
	Malundwe	3280	0	0	0	0
All Eastern Arc Mountains		***5,083,252***	***48***	***72***	***82***	***38***

[a] Areal extent from Platts et al. (2011). For forest area under current and future scenarios, see Appendix 1

2.2. Data collection

Data were collected in 2009–2010 from 48 hotels across the EAMs (Table 1; Fig. 1). We sampled all of the mountain blocks with accommodation; no public lodging was found in the Nguu and Malundwe mountain blocks. For each hotel, we interviewed hoteliers and used data from visitor books to record annual visitor numbers (broken down by nationality), occupancy rates (bed-nights) and prices. Based on hotelier interviews and visitor numbers at parks and reserves, we also estimated the proportion of visitors whose visits were motivated specifically by nature (see below). Reviewing Tanzanian travel guides (Briggs, 2009; Williams and Watt, 2009; Finke, 2010; Fitzpatrick, 2012), we identified a further 72 (non-surveyed) hotels within 30 km of the EAM boundary (Fig. 1), a distance over which median population density sharply declines (Platts et al., 2011).

2.3. Predicting total visitor rates

Visitor numbers (number of visitor bed-nights per year) from the 48 surveyed hotels were modelled using linear regression with the results then used to estimate visitor numbers for the 72 hotels we did not survey directly (Fig. 2). We developed separate models for Tanzanian and international visitors because these groups are expected to make different choices in terms of accommodation and destination because of different budgets and requirements. Candidate predictor variables included accommodation class, Euclidean distance to main roads (km), local population density (LandScan, 2008), and Euclidean distance to the nearest forest or woodland (as defined in Swetnam et al., 2011). Bed-nights, distance to forest and local population were $\log_e$-transformed to correct for positive skew. We also explored the use of look-up table approach, using median values of visitor numbers within each accommodation class (details in Appendix A). However we preferred the regression model approach because it is more robust for international visitors (Appendix B), and because it can be employed to predict changes in the spatial distribution of visitors over time (see 'Scenario analysis').

2.4. Producer surplus

Our analysis focuses on producer surplus (PS) as part of the total social value of the tourism business, the other part being consumer surplus (CS). CS is the difference between the maximum that consumers would have been willing to pay (reflecting the total utility they derived from a product) and what they actually paid; CS represents the consumption value of tourism. In the Tanzanian context, two-thirds of the nature-motivated tourists to the EAM are foreigners or 'international visitors' (see below), and they 'take their CS home with them,' meaning that much of the CS value of tourism does not accrue to the Tanzanian economy.

In contrast, PS accrues to hoteliers in Tanzania. PS can be calculated as the sum of profits (the excess of what producers earn over their production costs, i.e. revenues minus costs) plus fixed costs (Fig. 2) (Kirkby et al., 2010). Fixed costs are expenses that must be paid for some time even after a business stops operating; examples are interest on loans, long-term leases, and salaries to contracted employees. If society prevents a tourism business from operating (for example, if the land is given over to agriculture), the business suffers a welfare loss of foregone profits *plus* what it must still pay out in fixed costs. Thus, a full compensation to the hotelier would be the PS (Just et al., 2004). To the extent that hotelier profits remain in Tanzania, PS is the value of nature-based EAM tourism that accrues to the Tanzanian economy, and thus, PS estimates the domestic, tourism-derived incentive to conserve nature in the EAMs. This is the major reason that we focused on PS, and not CS, in this study.

Many environmental valuation studies exist that use non-market valuation to estimate CS – the social welfare part that is not reflected in standard economic statistics. Common methods to calculate the CS of recreation and tourism include stated preference (SP) approaches such as choice experiments and contingent valuation (Lee, 1997; Barnes et al., 1999; Naidoo and Adamowicz, 2005b; Kim et al., 2007), and the travel cost method (Cameron, 1992; Randall, 1994; Shrestha et al., 2002). SP studies rely on the construction of a hypothetical market in which the environmental amenity is offered in scenarios of change compared to the current situation; the respondent is then asked to express his/her willingness-to-pay (WTP) for avoiding or obtaining this change. Typically, in the case of forest conservation, such changes include a range of ecosystem services, not only recreational services, but also existence values as well as other cultural, regulating or provisioning services, etc. It is difficult to assign portions of a total WTP to these different value categories (e.g. Ferrini et al., 2008). Since our aim was to get a recreational value for nature-based tourism only, we decided not to use the SP methods. Also, the travel cost approach poses the difficulty of assigning the different cost components of multi-purpose trips, especially in case of one-off international visits. Travel cost models based on random utility theory also require variation in the number of visits and travel cost to the site for the estimation of a demand curve. In our study,

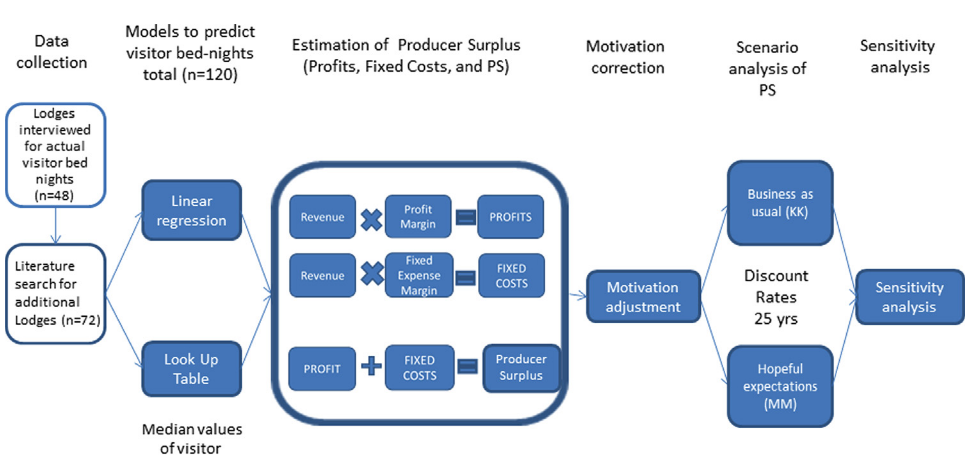

Fig. 2. Methodological approach applied in this study.

a large proportion of visitors come to the EAM from abroad as part of a longer holiday to Tanzania, the EAM may not be their main destination, and repeat visits are rare.

To estimate PS we follow the method outlined in Kirkby et al. (2010), a case study in Peru, and derive PS from estimates of overall revenues from hotels, lodges and other types of accommodation that are connected to the EAMs. Such visitor number functions have been used for recreation studies, for example in the UK (Jones et al., 2010; Sen et al., 2014). Annual revenues were estimated using the median price per bed-night from surveyed hotels, separately for low and high class accommodation, assuming that all visitors (Tanzanian and international) pay the same price per night within each accommodation class. We assumed conservative margins for the fixed-costs and profits based on Kirkby et al. (2010) (see Sensitivity analysis), because the interviews with hoteliers did not provide sufficient reliable information for Tanzania. We assumed a fixed-cost margin of 20% of the total revenues, and a profit margin of 10% (lower than the 14% margin calculated from accounting books in Kirkby et al., 2011).

These estimates of PS are expected to be a lower bound of the societal welfare generated by nature-based tourism in the EAMs. We exclude revenues from restaurant or other sales and (as discussed) do not include CS.

2.5. Adjusting visitor rates for motivation

Interviews with 28 hoteliers in 2007 suggested that a proportion of visitors to the EAMs were motivated primarily by a desire to experience nature, as opposed to other reasons related to culture, climate, recreational activities and views (Okayasu, 2008). 'Nature' here includes the following stated motivations: nature, forest, waterfalls, wildlife, flora, primates, and birdwatching, but not scenery or landscapes (views), or hiking. Importantly, this estimate does not distinguish between Tanzanian and international tourists, yet past work suggests that forest nature tourism is attractive mainly to international visitors (Kirkby et al., 2011).

To obtain an estimate for the proportion of international and Tanzanian visitors for whom nature was the primary motive for visiting the EAMs, we interviewed hoteliers on the stated motivations of visitors to the hotels. Hoteliers could mention more than one motivation. We first assigned percentages to the motivation by dividing by the number of motivations mentioned. We then assumed that the nature-motivated guests were firstly international. For example, if a hotel gave two motivations, one of which was nature-related, 50% of all bed-nights were considered to be nature-based tourism related; if this hotel had 25 international and 75 Tanzanian bed-nights, then all international bed-nights, and 25 Tanzanian bed-nights were considered to be motivated by nature. Based on this procedure we calculated that 29% of the Tanzanians and 49% of the international visitors were motivated by nature-related amenities of the EAMs.

2.6. Scenario analysis

Ecosystem service assessments use scenarios to inform decision-making by providing insights into the welfare impacts of different development trajectories (Balmford et al., 2011). We estimated the present value of PS under two scenarios of land use and socio-economic change over a period of 25 years. The scenarios were constructed first as storylines, based on macro-economic data and a series of discussions with Tanzanian stakeholders, and then imposed on to the EAM landscape using rule-based GIS (see Swetnam et al., 2011 and Appendix C). Tourism growth rates in both scenarios are assumed to be positive, based on extrapolating current trends in tourism statistics which show a steady increase in the number of international visitors, both at national level (MNRT, 2012) and in individual protected areas across Tanzania, including Udzungwa National Park and Amani Nature Reserve (both in the EAMs; Balmford et al., 2009).

Scenario 1: ***Kama Kawaida*** **(KK)**. This is a 'business as-usual' scenario, under which visitor rates are expected to grow by 4% annually. This is equivalent to the median annual growth in visitor numbers to Tanzania's National Parks from 1992–2006 (Balmford et al., 2009). The Tanzanian population is increasing rapidly (3% year^{-1}). The area of land under medium-large scale agricultural remains at 15%, but small-scale agriculture continues to expand. Combined with weak forest management, this results in a forest cover loss of 35.5% over 25 years (Swetnam et al., 2011, see Appendix D).

Scenario 2: ***Matazamio Mazuri*** **(MM)**. This scenario means 'hopeful expectations' in Kiswahili. It envisions strictly enforced forest conservation, and hence an overall forest loss of only 4.7% over 25 years. Outside protected areas, the area under medium-large scale agriculture increases to 30%. Population growth is lower with an annual growth rate of 2% per year. Tourism in Tanzania is expected to benefit from its enhanced environmental reputation with an annual increase of national and international bed-nights of 6% (Balmford et al., 2009).

Under these scenarios, the present value of PS was estimated by projecting nature-motivated visitor bed-nights rates over 25 years. The tourism growth rate (4 or 6% per year) determines the overall increase in visitor bed-nights, while changes in the spatial distribution of visitors across the mountain blocks are determined by the coefficients of the regression models. As the population and land use changes are non-linear over time, we performed our calculations at 5 year intervals.

2.7. Sensitivity analysis

We performed a sensitivity analysis to explore the effect of variation in profit margins and discount rates on present values of PS. PS was estimated for profit margins of 10%, 14% (from Kirkby et al., 2011) and 20% (based on interview data from the Udzungwa Mountains), to encompass fluctuations in the tourist market and heterogeneity across hotels. We also used three different discount rates: 5%, 15% and 20%, corresponding approximately to the lower, median and upper rates reported by the Bank of Tanzania between 2005 and 2010 (Bank of Tanzania, 2011). Lower rates are often used for investments of public interest with relatively low risk. The higher rate is more akin to private discount rates, where short-term returns on investment are required to cope with the risk of the volatile international tourism market and economy in developing countries like Tanzania (Naidoo and Ricketts, 2006).

Table 2
Median annual number of visitors to Eastern Arc Mountain hotels, and median prices per bed-night ($n=48$).

	All visitors	*Tanzanian visitors*	*International visitors*	Price per bed-night	Min	Max
Low cost	480	431	49	TSh 12,000 (US$8)	TSh 3000 (US$2)	TSh 45,000 (US$30)
High cost	1533	383	1150	TSh 60,000 (US$40)	TSh 15,000 (US$10)	TSh 200,000 (US$133)

3. Results

The 48 sampled hotels exhibit a wide variation in visitor numbers (measured as visitor bed-nights/year) and prices (Table 2). Low class hotels receive mostly Tanzanian visitors, whereas high class hotels are mainly frequented by international guests (Table 2), reflecting wealth disparities in the two visitor groups. Many of the hotels in the northern circuit (see Fig. 1) fall in the high class segment. The southern circuit offers lower priced accommodation and attracts more Tanzanians (Table 2).

3.1. Total visitor rates

The regression model for Tanzanian visitor bed-nights contains two significant variables, which together explain 21% of the variance in observed bed-nights (Table 3). The first variable shows that the number of Tanzanian bed-nights at a hotel decreases with distance to main roads, suggesting that accessibility is an important factor in Tanzanians' selection of accommodation. The second variable shows that Tanzanian visitor bed-nights tend to be higher in areas of higher population density, indicating that proximity to local amenities may be important.

International visitor bed-nights were significantly greater in higher priced hotels than in lower priced hotels (Table 2), and in hotels located closer to forest and woodland. These two variables explain 52% of the variance in observed international visitor bed-nights (Table 3).

Using these models to predict the visitor numbers for all 120 hotels, we estimate that the total number of visitor bed-nights is ~69,000/year, of which 32% can be attributed to international visitors. Adjusting for motivation, the total annual revenue of the hotels in the EAMs from nature-based tourism is estimated to be US$1.7 million.

Table 3
Linear regression models used to predict annual visitor bed-nights, and to predict changes in the spatial distribution of tourists under future scenarios.

Variables included in visitor model	Coefficient	Standard error
Tanzanian guests		
Constant	−0.531	1.139
Ln (local population+1)	0.340*	0.130
Ln (distance [km] to main road +1)	−0.217**	0.075
Number of observations	*48*	
Variance explained (Adjusted R^2)	*0.208*	
RMSE (5-fold cross-validation)	*1520 (1617)*	
International guests		
Constant	3.038***	0.141
Accommodation cost (0=low; 1=high)	−0.766***	0.150
Ln (distance [km] to forest+1)	−0.308***	0.077
Number of observations	*48*	
Variance explained (Adjusted R^2)	*0.518*	
RMSE (5-fold cross-validation)	*574 (601)*	

RMSE, root mean squared error.
* $p < 0.05$ (t-test).
** $p < 0.01$ (t-test).
*** $p < 0.001$ (t-test).

3.2. Producer surplus

The 120 hotels generate a total annual PS of ~US$508,000 when all visits (irrespective of motivation) are included (at a 10% profit rate and a 20% fixed-cost rate), of which 53% comes from Tanzanian visitors. When the PS values are adjusted for nature motivation, the annual PS for the 120 hotels in our dataset is estimated at ~US $190,000 for the whole of the EAMs. Tanzanian visitors account for ~US$74,000 annually (~40% of annual nature-based PS), whilst international tourists generate ~US$116,000 in terms of PS by staying in accommodation in the EAM. The West Usambaras, Ulugurus and Udzungwas generate the highest PS values (Fig. 1).

3.3. Scenario analysis

In the scenarios, visitor numbers (national and international) increase by 4% (KK) or 6% (MM) per year, meaning that the total visitor bed-nights (unadjusted for motivation) increase from the present-day estimate of ~69,000 to ~1,850,000 (KK) or ~298,000 (MM) after 25 years. Changes in population and land use, via their inclusion in the visitor models, affected the spatial distribution of visitors across hotels. For example, the international visitor model predicts relatively fewer bed-nights if forest close to a hotel is cleared, although absolute numbers may be offset by the exogenous growth in tourism. Here, we present the nature motivation-adjusted present values of PS based on a profit margin of 10% and a discount rate of 15% (Table 4). The 25-year present value of PS under the KK scenario is approximately US$1.6 million, compared with US$1.9 million under the MM scenario. This 16% higher PS in the MM scenario results mainly from the higher visitor growth rate. The

Table 4
Present values (US$) of producer surplus, under two scenarios of future change in population, land use and tourism rates: *Kama Kawaida* (business as-usual) and *Matazamio Mazuri* (hopeful expectations). Present values are over 25 years under a discount rate of 15%, a profit margin of 10%, and a fixed-cost margin of 20%. Visitor numbers are adjusted for nature-based motivation.

	Mountain Block	Scenario 1: *Kama Kawaida*			Scenario 2: *Matazamio Mazuri*			Difference (% increase under MM scenario)		
		Total	Tanzanian tourists	International tourists	**Total**	Tanzanian tourists	International tourists	**Total**	Tanzanian tourists	International tourists
Northern Circuit	North Pare	**5936**	3424	2512	**6895**	4013	2882	**16.2**	17.2	14.7
	South Pare	**78,746**	22,244	56,502	**91,334**	26,105	65,229	**16.0**	17.4	15.4
	West Usambara	**696,873**	106,196	590,677	**807,725**	125,519	682,206	**15.9**	18.2	15.5
	East Usambara	**98,227**	11,008	87,219	**112,335**	11,583	100,752	**14.4**	5.2	15.5
Southern Circuit	Nguru	**3536**	2908	628	**4345**	3619	726	**22.9**	24.5	15.6
	Rubeho	**3194**	3121	73	**3735**	3646	89	**16.9**	16.8	21.9
	Ukaguru	**3641**	3282	359	**4295**	3872	423	**17.9**	17.9	17.8
	Uluguru	**464,267**	277,942	186,325	**535,273**	321,089	214,184	**15.3**	15.5	15.0
	Udzungwa	**275,925**	217,673	58,252	**326,555**	254,567	71,988	**18.4**	16.9	23.6
	Mahenge	**3316**	2926	390	**3802**	3339	463	**14.7**	14.1	18.7
All Eastern Arc Mountains		***1,633,659***	***650,722***	***982,937***	***1,896,294***	***757,352***	***1,138,942***	***16.1***	***16.4***	***15.9***

Table 5
Present values of motivated-adjusted producer surplus over 25 years (US$) for different profit margins and discount rates.

Discount rate (%)	Profit margin (%)	Scenario 1: *Kama Kawaida*	Scenario 2: *Matazamio Mazuri*	Difference (% increase under scenario 2)
20	10	1,183,467	1,332,111	13
20	14	1,341,262	1,509,726	13
20	20	1,577,956	1,776,148	13
15	10	1,633,659	1,896,294	16
15	14	1,851,480	2,149,133	16
15	20	2,178,212	2,528,392	16
5	10	4,262,154	5,403,316	27
5	14	4,830,442	6,123,758	27
5	20	5,682,873	7,204,420	27

percentage gain in PS in the MM scenario differs across mountain blocks, because differences in forest losses result in variation in visitor number growth. For example, deforestation in Udzungwa under the KK scenario is projected to be 31%, compared to 1% under MM (Table D1 in Appendix D), so that this mountain block gains more from international tourism under MM (18.4%, relative to KK) than do some other blocks (Table 4).

3.4. Sensitivity analysis

Varying the discount rate from 5% to 20%, and the profit margin from 10% to 20%, led to variation in the present values of PS range from US$1.2 million to US$5.7 million for the KK scenario, and from US$1.3 million to US$7.2 million for the MM scenario (Table 5). Our results also show that the present values are more sensitive to variation in the discount rate than the profit rate. A low discount rate of 5% reflects higher intergenerational equity and puts greater weight on future benefits, for example with a 5% discount rate, the gain in PS in the 'green' MM scenario over the business-as-usual KK scenario is greatest (27%), reflecting the fact that greater weight is given to the nature-motivated tourism revenue expected to accrue from strict forest protection in the future. Lower discount rates thus favour more sustainable development trajectories (Pearce and Turner, 1990). A similar sensitivity analysis was performed for the lookup table approach and is presented and discussed in Appendix C.

4. Discussion

This study is the first to value nature-based tourism across the EAMs of Tanzania and one of a few to value mountain tourism in tropical Africa (Mitchell et al., 2009, Kasangaki et al., 2012). Based on interview and logbook data from almost half of all hotels identified in the area, we calculate that the EAMs receive 69,000 total bed-nights per annum. The annual Producer Surplus (PS) that can be attributed to nature-motivated visitors to the EAMs is US $195,000 per year and accounts for 38% of the revenues of these hotels.

The four mountain blocks with the highest PS from nature-based tourism (West Usambara, Uluguru, Udzungwa, East Usambara – see Table 5) are also associated with the highest levels of biodiversity and greatest forest cover (Burgess et al., 2007; Platts, 2012; Green, 2012). This is probably because the EAMs tend to attract visitors with a particular interest in biodiversity. Indeed, both Udzungwa National Park and Amani Nature Reserve (in the East Usambaras) are internationally renowned as rainforest destinations for bird-watching and host many endemic species. Studies in Uganda have found that there is a positive correlation between the number of bird species and the number of tourists (Naidoo and Adamowicz, 2005a, 2005b). However, our study does not provide sufficient evidence to conclude that biodiversity is the main driver of nature-based tourism to the EAMs. Our results identified factors such as accessibility and local amenities (e.g. shops and markets) for Tanzanians, and accommodation class and distance to forest for international visitors, as main correlates of visitor rates. These findings are in line with previous studies that have found that international rainforest tourism is dependent on accessibility and distance from tourist markets (Gössling, 1999).

Our results show that the EAMs attract two orders of magnitude fewer tourists than do Tanzania's savannah game parks, and Mt. Kilimanjaro (despite being considerably cheaper to visit). The largest protected area in the EAMs, the Udzungwa Mountains National Park, received about 2500 visitors in 2007 (Okayasu, 2008), which increased to around 5000 visitors in 2012 (Udzungwa Mountains National Park pers. comm., May 2013). In comparison, the Serengeti National Park attracts about 300,000 visitors per year (TANAPA, 2009), generating US$20.5 million in park revenues, compared to US$1.7 million nature-based revenue of the hotels in the EAMs. Similarly, our results are dwarfed when compared to the revenue generated by visitors to Mt. Kilimanjaro. When the average amount of money spent by a climber is extrapolated to the estimated 35,000 annual climbers, in-country tourist expenditure is approximately US $50 million, of which 28% is considered pro-poor expenditure (Mitchell et al. 2009). Although we do not have estimates of profits and fixed costs for the Serengeti and Mt. Kilimanjaro, these revenue figures strongly suggest that these two attractions must generate PS at least an order of magnitude higher than that generated by the entire EAMs. Visitor numbers in the EAMs are also small compared with some other East African montane forest destinations, such as the Volcanoes National Park in Rwanda, which received almost 190,000 visitors in 2010 (Kasangaki et al., 2012).

Our estimates of the value of nature-based tourism in the EAMs are limited by several, mainly conservative, assumptions. For example, we may not have accounted for all of the hotels in the region, and Tanzanian visitors in particular may use accommodation not listed in international tourist guides. We had to rely on information from hoteliers to deduct how far visitation was motivated by a desire to experience nature. Also, we did not consider tourist expenditure on items such as food, transport, souvenirs, park entrance fees and tours. We applied fixed-cost and profit margins from a study conducted in the Peruvian Amazon (Kirkby et al., 2010, 2011), because to get more accurate information from Tanzania on these indicators would require detailed examination of commercially sensitive information in hoteliers' account books which were not available. To compensate for the resulting uncertainty, we estimated PS under a range of profit margins as well as discount rates. Despite these limitations, we feel that our approach gives a basically accurate impression of the spatial pattern of visitation to the EAMs and a lower bound estimate of the PS value of nature-based tourism, given that we did not include expenditures at the EAM hotels other than room fees, nor did we include profits earned by suppliers to hotels. Lastly, the total welfare associated with tourism in the EAMs is higher than calculated here, because we did not calculate CS.

Revenues of nature-based tourism in the EAM directly or indirectly contribute to the local and national economy, through local procurement, employment and taxes (Blake, 2008; Kirkby et al., 2011). It has been argued that tourism-related industries provide less income for poorer households than do other activities, such as agriculture (Blake, 2008). Tourism is often of greater benefit to the middle and upper classes within the country, or tour companies (often foreign), whilst local people living adjacent to the tourism attractions see little benefit. According to Kideghesho et al. (2006) less than 2% of the US$31 million generated by tourism to the Serengeti from 1993 to 2003 stayed with local communities. In some EAM blocks, nature-based tourism does provide an opportunity for local residents to generate income from sustainable use of forests and creates alternative jobs to farming and timber harvesting (Schreckenberg and Luttrell, 2009). In the Udzungwa National Park and the Amani Nature Reserve, for example, local groups have been set up to provide guiding services and trekking tours. However, more general support for sustainable forest management at local levels will require well-designed mechanisms for profit sharing amongst the local communities (Bookbinder et al., 1998; Walpole and Goodwin, 2000; Kiss, 2004; Sekar et al., 2014).

Encouragingly, if we compare the values calculated for current spend for conserving the existing protected areas in the EAM blocks (Green et al., 2012), we find that the mountain blocks with the highest conservation expenses also enjoy the highest PS values from nature-based tourism. For example, the annual expenditure on conservation management of protected areas in the West Usambaras is US$105,000 compared to US$64,000 for the annual value of PS for nature-based tourism. In areas such as these, nature-motivated tourism provides a substantial justification for public spending on conservation. However, over the entire EAMs, the PS of nature-based tourism covers only 5% of the annual expenditure on conservation management.

Our scenario analysis provides some insight into the possible future of nature-based tourism in the EAMs. Under the 'hopeful expectations' MM scenario, forest conservation efforts are enforced more strictly than at present, and an enhanced reputation for sustainability is assumed to allow Tanzania to enjoy a 6% per year growth in tourist numbers, compared with 4% per year under the 'business as-usual' KK scenario. This results in 16% higher PS over a 25 year period for the 120 hotels, even assuming a relatively high discount rate of 15% (the difference increases to 27% under a 5% discount rate). Under the 'hopeful expectations' MM scenario it is estimated that conservation management spending needs to increase by 2.5 times (according to Green et al., 2012) to meet the objectives of forest conservation. However, ensuring that nature-based tourism contributes to sustainable forest management in the EAMs will require well defined and properly enforced policies that generate funding for forest management, enable local profit-sharing and employment, and generate compensation for foregone forest conversion and exploitation.

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Appendix A. Estimating visitor numbers from look-up tables

We compared the estimates of visitor numbers based on our regression model analysis to a simpler look-up table approach based on sample medians (Table 2) of visitor numbers in four accommodation class categories (International-low, Tanzania-low, International-high, Tanzanian-high). Median visitor numbers were then used to determine visitor numbers for all 120 hotels (i.e. also for surveyed hotels). This results in a total of ~48,000 International, and ~50,000 Tanzanian visitor bed-nights. The estimates from the lookup approach are thus noticeably higher than those produced by the regression models, especially for International visitors.

Appendix B. Model validation

See Table B1

To choose the most appropriate approach to estimate visitor numbers, we validated the predictive ability of both methods (regression and lookup) by cross-validating the root-mean-square error (RMSE). First, the data were randomly partitioned into five non-overlapping subsets of roughly equal size. Models were then calibrated on four of the subsets and tested on the withheld fraction; this was repeated five times, each time omitting a different fraction for testing. This procedure was repeated 100 times, and the median cross-validated RMSE was recorded.

For Tanzanians, the RMSE is slightly lower for the regression model than for the lookup approach, although the latter is more stable under cross-validation. Conversely, for International visitor predictions, the lookup is marginally more accurate on the training data, whilst the regression approach provides more robust predictions on unseen data. Choosing one approach for both Tanzanian and International visitor predictions, we favoured statistical regression in the main text, because the difference between lookup and regression for Tanzanians is (proportionally) small, and because there are fewer Tanzanian visitors motivated by nature (leading to a lower contribution of Tanzanians to accommodation-related PS, compared with International visitors, for whom the regression method is more robust). For comparison, in Appendix C we present the impact of instead using the lookup approach to estimate PS values under our different scenarios.

Table B1
Model validation of regression and look-up methods using the root-mean-square error (RMSE).

	Regression model		Lookup model	
	RMSE	Cross-validation	RMSE	Cross-validation
Tanzanians	1520	1617	1575	1589
Internationals	574	604	549	645

Appendix C

Scenario results for the lookup approach

Based on a profit margin of 10% and a discount rate of 15% the lookup approach again shows that the MM scenario results in higher present values of producer surplus adjusted for visitor motivation than the KK scenario (Table C1). The results of the sensitivity analyses are presented in Table C2.

Comparison of results between the regression model and lookup approaches

Because of the higher visitor numbers generated by the lookup approach, the present values are ~1.7 times higher than those derived from regression models. The differences between the two approaches exceed those between the scenarios (which are mainly due the different exogenous growth rates in tourism they involve). For example, at a 10% profit margin and 15% discount rate, under KK the total PS value for all mountains blocks combined is US $2,845,573 and US$1,633,659 based on the lookup and regression models respectively. Thus the lookup approach results in estimates

Table C1
Adjusted present values (US$) of producer surplus for KK and MM scenarios.

Scenario	KK			MM		
Mountain Block	**Total**	Tanzanian	International	**Total**	Tanzanian	International
North Pare	12,780	10,721	2059	14,781	12,399	2382
South Pare	192,128	52,952	139,176	222,202	61,241	160,961
W. Usambara	1,271,270	267,698	1,003,572	1,470,262	309,601	1,160,661
E. Usambara	152,609	38,724	113,885	176,797	44,785	131,711
Nguru Mts	4521	3792	728	5228	4386	843
Rubeho	4999	4193	805	5781	4849	932
Ukaguru	8827	7405	1422	10,209	8564	1645
Uluguru	654,943	115,896	539,048	757,462	134,037	623,425
Udzungwa	536,028	132,689	403,338	619,933	153,459	466,473
Mahenge	7469	6266	1204	8638	7246	1392
Total	*2,845,573*	*640,336*	*2,205,238*	*3,290,993*	*740,568*	*2,550,425*

Note: present values of PS over 25 year scenarios, based on 10% profit and 15% discount rate, adjusted for visitor motivation.

Table C2
Sensitivity analysis (look-up table results).

Discount (%)	Profit (%)	KK	MM
20	10	2,069,232	2,323,370
20	14	2,345,130	2,633,152
20	20	2,758,977	3,097,826
15	10	2,845,573	3,290,993
15	14	3,224,983	3,729,792
15	20	3,794,098	4,387,991
5	10	7,246,881	9,107,558
5	14	8,213,131	10,321,899
5	20	9,662,507	12,143,410

Table D1
Present day forest cover in base year and change over 25 years under the three scenarios.

Mountain (as defined by Platts et al. (2011))	Area (ha)	Area (ha) in Scenario KK	Area (ha) in Scenario MM
North Pare	2882	1506	2882
South Pare	16,986	13,849	16,909
East Usambara	24,431	11,687	19,010
West Usambara	35,588	21,293	30,001
Nguu	23,228	15,617	23,228
Nguru	32,414	16,376	29,037
Rubeho	50,699	25,323	50,032
Ukaguru	18,094	14,666	18,067
Uluguru	30,848	23,930	28,988
Udzungwa	168,190	116,213	165,926
Mahenge	2023	1116	2023
Malundwe	234	234	234
TOTAL	405,617	261,810	386,337
		64.50%	95.30%
Forest loss (as % of present day area)		35.50%	4.70%

of PS that are roughly double those of the regression method. Across all blocks the combined NPV of PS for Tanzanian visitors is approximately the same for both approaches, and the main differences lie in the present values from International visitors. The relative contribution of different EAM blocks is similar across approaches, with the same ranking of the top three mountain blocks (Table C1 cf Table 5).

Appendix D. Forest cover change in scenarios

Table D1 gives more information about the forest cover changes under the two scenarios. Total forest cover in the base year for the whole of the EAMs was 405,617 ha, out of which the Udzungwa mountain block contained the most (168,190 ha), followed by Rubeho (50,699 ha), and the West Usambaras (35,588 ha). Under KK, relative forest loss is highest in the East Usambaras (52%), followed by Rubeho (50%), and then Nguru (49%). Under MM the forest loss is greatest from the East Usambaras (22%), followed the West Usambaras (16%), and then the Ngurus (10%).

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