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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 visits 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.

Keywords:
Nature-based Tourism, Tropical forests, Tanzania, Producer surplus, Ecosystem Services

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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; Bookbinder et al., 1998; Walpole and Goodwin, 2000; Christ et al., 2003; Stem et al., 2003; Naidoo and Adamowicz, 2005a&b; Alpizar, 2006; Adamowicz et al., 2010; Kirkby et al., 2011; Liu et al., 2012; Peh et al., 2013). It is widely accepted 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 at 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 (WB, 2010), and boasts seven UNESCO World Heritage Sites. Tourism volume and nature-based tourism to protected areas 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 501,669 to 782,699; MNRT, 2012). Consequently, tourism has increased its contribution to GDP, from US$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, 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. Our objective is to assess the previously unquantified benefits of nature-based tourism in the EAMs (Fig. 1) in Tanzania and to explore how they might plausibly change under alternative scenarios of future development in the region.

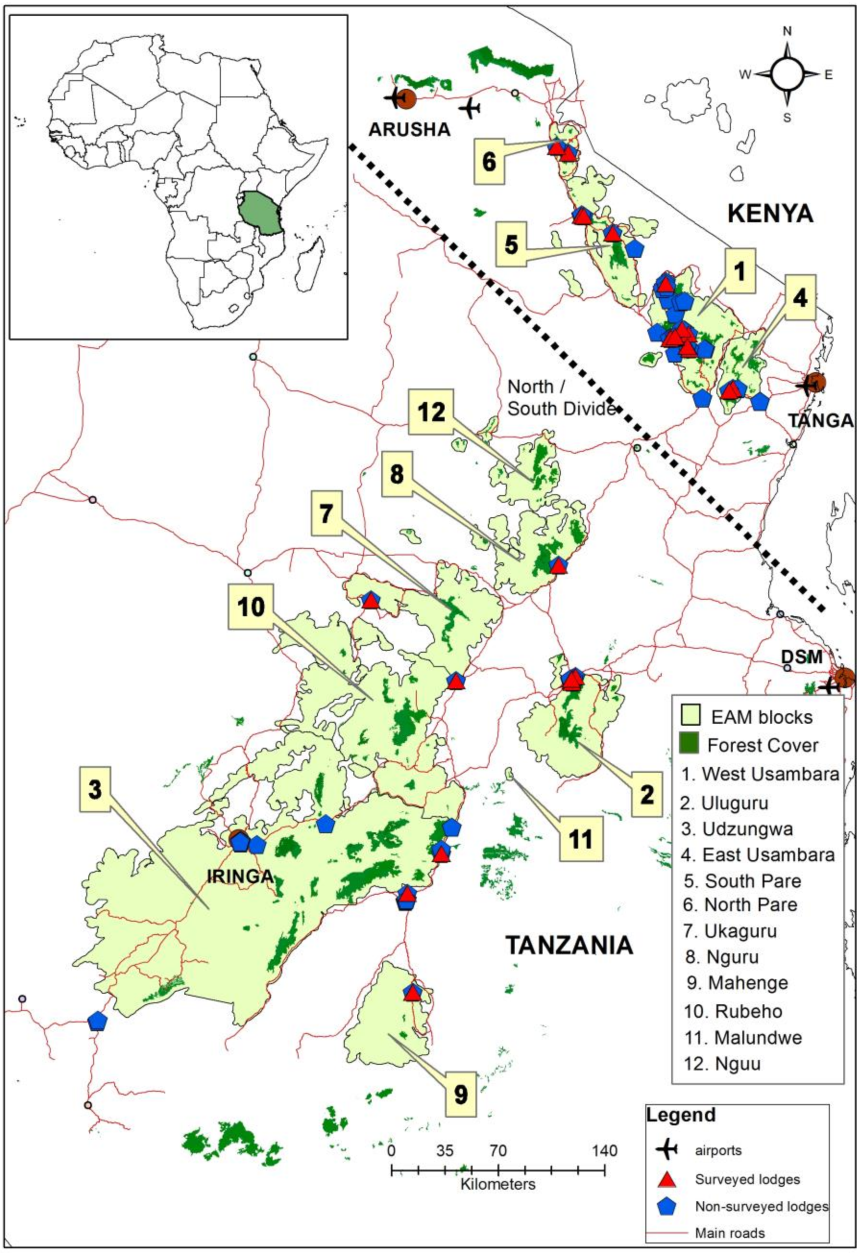

Fig. 1. The Eastern Arc Mountain blocks in Tanzania (light green), ranked according to Producer Surplus (1, high; 12, low), in terms of nature-based tourism. Map depicts mountain extent, lodge distributions, forest cover (dark green), and the north-south divide between the two main tourist circuits.

2. METHODS

2.1 Study region

The EAMs range in 13 blocks from south-eastern Kenya (one block; Taita Hills) to southern Tanzania (12 blocks; 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, 2000; Burgess et al., 2007). Besides biodiversity, the EAMs provide a suite of ecosystem services beneficial at local to global levels, including carbon storage 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 rural EAMs depend on the forests and woodlands for firewood, charcoal, timber and building poles (Schaafsma et al., 2012). 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, 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.

2.2 Data collection

Data were collected in 2009-2010 from 48 hotels across the EAMs (Table 1; Fig. 1). All of the mountain blocks with accommodation were sampled; no public or private 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 visitors (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 according to low or high cost accommodation within 30 km of the EAM boundary (Fig. 1), a distance beyond which median population density sharply declines (Platts et al., 2011).

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

	Mountain block	Mt. Area (ha)*	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	3,280	0	0	0	0
All Eastern Arc Mountains		***5,083,252***	***48***	***72***	***82***	***38***

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

2.3 Predicting total visitor rates

Visitor numbers from the 48 surveyed hotels were extrapolated to the 72 unvisited hotels using linear regression modelling (Fig. 2). We also tested a look-up table approach, using median values (details in Appendix A); however, regression models are preferred because they appear more robust (Appendix B) and because they can be employed to predict changes in the spatial distribution of visitors over time (see 'Scenario analysis'). We developed separate models for Tanzanian and international visitors because these groups are expected to make different choices in terms of accommodation and destination, due to having different budgets and requirements. The response variable in the models was the number of visitor bed-nights per year. Candidate predictor variables included accommodation class (low [budget] or high class according to travel guides), Euclidean distance to main roads (km), local population density (LandScan, 2008; aggregated on a 5 km x 5 km grid and then interpolated to 1km), and Euclidean distance to the nearest forest or woodland (land cover as defined in Swetnam et al., 2011). Bed-nights, distance to forest and local population were $\log_n$ transformed to correct for positive skew.

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). PS is the excess of what producers earn over their production costs for the total quantity of a good sold – i.e. the net benefit of the good to producers, it is the social benefit of the production side of tourism (see Kirkby et al. 2010). CS is the difference between the maximum that consumers would be willing to pay (reflecting the total utility they derived from a product) and what they actually paid.

For our purposes, PS can be calculated as profits (revenues minus costs) plus fixed costs (Fig. 2) because we want to know the welfare loss if a tourism business is kept from operating (Just et al., 2004). Firms are only expected to produce as long as PS is positive; otherwise, they stop. Fixed costs, which are unrelated to the volume of production, are sunk costs in the short-term, and do not affect the decision to produce. Fixed costs typically include interest on loans, salaries to contracted employees and other expenses that must be paid for some time after a business stops operating. 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. A full compensation to the hotelier would be the PS (Just et al., 2004). In our case study, if nature in the EAMs was lost, the societal welfare loss due to tourism would be at least equivalent to the PS, and higher if CS was also considered (further explanation in Kirkby et al., 2010).

We follow Kirkby et al. (2010) and derive PS from estimates of overall revenues from hotels, lodges and other types of accommodation that are connected to the EAMs. Similar visitor number functions have been used for recreation elsewhere (e.g. Jones et al., 2010; Sen et al., 2013). Using our predictions of nature-motivated visitor bed-nights, annual revenues were estimated using the median price per bed-night from surveyed hotels, separately for low- and high-priced accommodation, assuming that all visitors (Tanzanian and international) pay the same price per night within each accommodation class. We assumed a fixed-cost margin of 20% of the total revenues (Kirkby et al., 2010), and a profit margin of 10%. A sensitivity analysis was performed to examine the effects of varying the profit margin and fixed cost rates (it was not necessary to also vary fixed cost margins, since the combined effect with varying profit rate is additive).

These estimates of PS are expected to be a lower bound for nature-based tourism in the EAMs, because we use a conservative profit margin (lower than the 14% margin calculated from accounting books in Kirkby et al. 2011) and only count bed-night revenues (thus omitting restaurant or other sales). Also, we do not include CS. Since about two-thirds of the nature-motivated tourists are internationals (see Results: *Adjusting visitor rates for motivation*) this welfare does not stay in Tanzania ('they take their CS with them when they leave'). When domestic tourists make up most of the market, CS can be used to justify national or local public spending on protected areas and infrastructure improvements for nature-based tourism. When most tourists are international (and their CS is not captured), it is the PS component of the nature-based tourism industry, particularly profits, that provides most of the short-term, domestic justification for conservation actions to support tourism (Kirkby et al. 2011).

2.5 Adjusting visitor rates for motivation

Interviews with 28 hoteliers (in 2007) suggest that a proportion of visitors to the EAMs are motivated primarily by 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 (recreational activities). 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 Foreign and Tanzanian visitors who are primarily motivated to visit the EAMs by a desire to experience nature, 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 bednights, then all international tourists, and 25 Tanzanian bednights were considered to be motivated by nature. Based on this procedure, we calculated that 29% of the Tanzanian and 49% of the international visitors were motivated by nature-related amenities of the EAM.

2.6 Scenario analysis

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 A). Tourism growth rates in both scenarios are assumed to be positive, extrapolating current trends in tourism statistics, which show a steady increase in the number of international visitors, both at national level (MNRT, 2012) and to the various protected areas across Tanzania, including in the EAMs such as the Udzungwa National Park and the Amani Nature Reserve (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% y^{-1}) and is predicted to reach 67 million from the current 45 million over 25 years. 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 where no forest is lost from within protected areas, and hence an overall forest loss of only 4.7% over 25 years. Outside protected areas, however, the area under medium-large scale agriculture increases to 30%. Population growth is lower with an annual growth rate of 2% y^{-1}. 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 % y^{-1}) determines the overall increase in visitor numbers, 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.

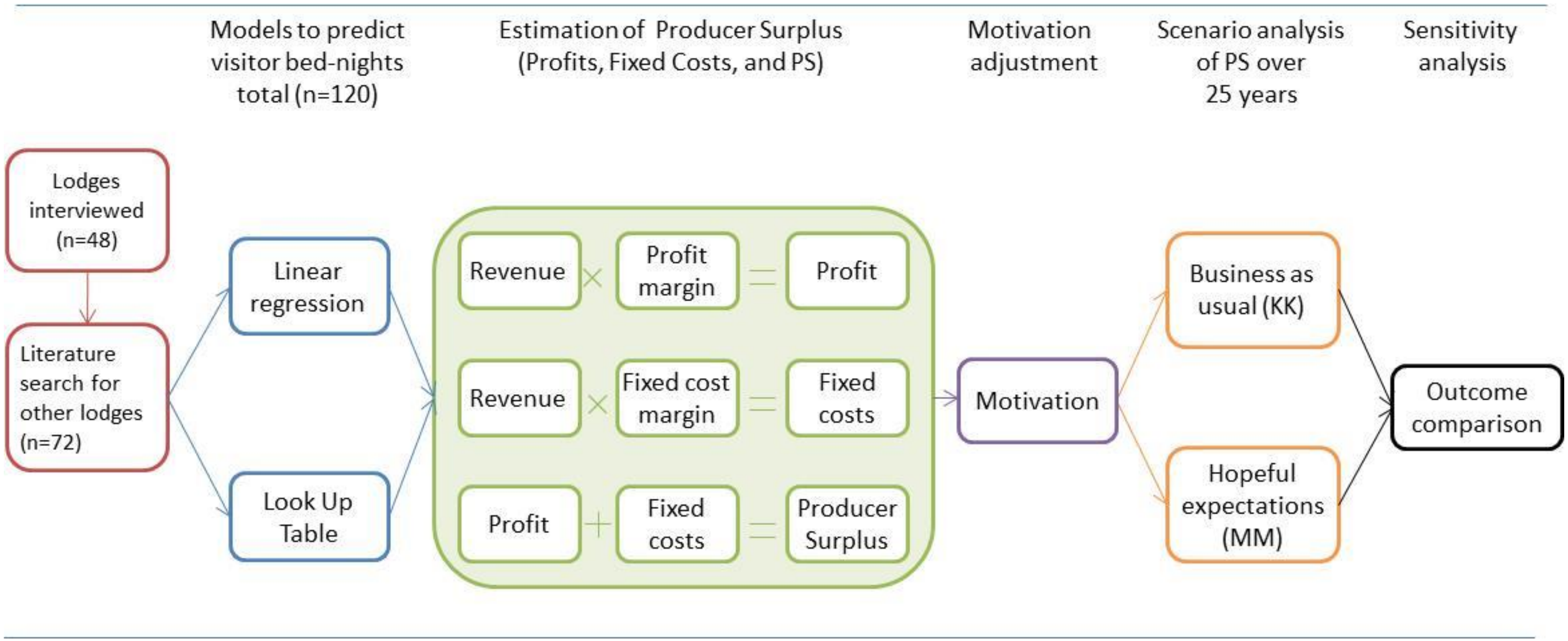

Figure 2. Schematic overview of methods.

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 is 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. The present values are estimated for the two scenarios using three 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 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). Figure 2 presents a schematic overview of our methods.

3. RESULTS

The 48 sampled hotels exhibit a wide variation in visitor numbers and prices (Table 2). Low cost hotels receive more Tanzanian visitors, whereas high cost 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 price segment. The southern circuit offers lower priced accommodation (Pearson's correlation coefficient one-tailed $r = -0.406$, $p = 0.047$) and attracts more Tanzanians (Table 2).

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

	All visitors	***Tanzanian visitors***	***Intern. visitors***	**Price per bed-night**	**Min**	**Max**
Low cost	480	431	49	TSh 12,000 (US$8)	TSh 3,000 (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)

3.1 Total visitor rates

The regression model for Tanzanian bed-nights contains two significant variables, which together explain 21% of the variance in observed visitor rates (Table 3). The first variable shows that the number of Tanzanian visitors to 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 numbers tend to be higher in areas of higher population density, indicating that proximity to amenities may be important.

International visitor bed-nights were significantly greater in high priced hotels than 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 numbers (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 69,359 annually, of which 32% can be attributed to international visitors. The total annual revenue of the hotels in the EAM from nature-based tourism is estimated to be US$1.7 million. For comparison, the Serengeti National Park generates revenue of about US$8.5million from entry fees and other levies (TANAPA, 2009).

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)*	

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

3.2 Producer surplus

The 120 hotels generate a total annual PS of US$508,029 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$194,804 for the whole of the EAMs. Tanzanian visitors account for US$74,489 annually (40% of annual nature-based PS), whilst international tourists generate US$116,315 in terms of PS by staying in accommodation in the EAM. The West Usambaras, Ulugurus and Udzungwas generate the highest values.

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 69,360 to 184,900 (KK scenario) or 297,682 (MM scenario) 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.

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.

		Scenario 1: *Kama Kawaida*			Scenario 2: *Matazamio Mazuri*			Difference (% increase under MM scenario)		
	Mountain Block	**Total**	Tanz. tourists	Intern. tourists	**Total**	Tanz. tourists	Intern. tourists	**Total**	Tanz. tourists	Intern. tourists
Northern Circuit	North Pare	**5,936**	3,424	2,512	**6,895**	4,013	2,882	**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	**3,536**	2,908	628	**4,345**	3,619	726	**22.9**	24.5	15.6
	Rubeho	**3,194**	3,121	73	**3,735**	3,646	89	**16.9**	16.8	21.9
	Ukaguru	**3,641**	3,282	359	**4,295**	3,872	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	**3,316**	2,926	390	**3,802**	3,339	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***

Here, we describe 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 percentage gain in PS in the MM scenario differs across mountain blocks, where 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 5-20%, and the profit margin from 10-20%, we found that the present value 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 NPVs are more sensitive to the discount rate than the profit rate (discount rates vary by four times while profit margins vary by two times). With the lowest discount rate of 5%, which reflects higher intergenerational equity where 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 that is projected to result from strict forest protection is generated towards the end of the 25 year scenarios. Lower discount rates thus favour more sustainable development trajectories. A similar sensitivity analysis was performed for the lookup table approach and is presented and discussed in Appendix C.

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

4. DISCUSSION

This study is the first to value nature-based tourism across the Eastern Arc Mountains of Tanzania. Based on interview and logbook data from almost half of all hotels identified in the area, we calculate that the EAMs receive 69,360 total bed-nights per annum. The annual Producer Surplus (PS) that can be attributed to nature-motivated visitors to the EAMs is US$194,804 per year. Nature-based tourism 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 birdwatching, 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 & Adamowicz, 2005a&b). 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 the savannah game parks and Mt. Kilimanjaro in Tanzania. The largest protected area in the EAMs, the Udzungwa Mountains National Park, received about 2,500 visitors in 2007 (Okayasu, 2008), which increased to around 5,000 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$1.7million revenue of the hotels in the EAMs from nature-based tourism. Similarly, our results are dwarfed when compared to the revenue generated through visitors to 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$50million, 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 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 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 did not consider tourist expenditure on items such as food, transport, souvenirs, park entrance fees and tours, nor did we include the possibility that owners pay themselves above-market-wage salaries, which is a method of extracting profits from tourism businesses. We also assume that we have accounted for all hotels in the EAMs, and the book-keeping of those hotels sampled was accurate. Moreover, the total social welfare associated with tourism in the EAMs is higher because it includes consumer surplus (not considered here) – i.e., the benefits that visitors derive from their trip over and above what they have paid. We also 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 on these would require detailed examination of commercially sensitive information in hoteliers' account books. To compensate for the resulting uncertainty, we estimated PS under a range of profit margins (as well as discount rates). Last, we had only limited information on how far visitation to the area was motivated by a desire to experience nature. Despite these limitations, we feel that our approach gives a first impression of the extent of visitation to the EAMs and a lower bound estimate of the value of nature-based tourism.

Some of the 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 the tour companies (often foreign), whilst local people living adjacent to the tourism attractions see little benefit. 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). Elsewhere in Tanzania, the Maasai have received few benefits from high visitor numbers to savannah parks, and there are significant problems of land tenure conflict and loss of traditional lands and culture (Salazar, 2009; Nelson et al., 2009; Sachedina and Nelson, 2010). To avoid such issues becoming major problems in the EAMs, further development and enforcement of land tenure rights and protection of cultural assets may also be necessary. There are three, often complementary mechanisms by which tourism profits can lead to conservation: tourist operators find that costly conservation actions are worth undertaking privately because those actions ultimately result in higher profits (Damania & Hatch, 2005); there is local benefits sharing, which changes local incentives such that habitat conversion is deterred (Kirkby et al., 2011); and finally there is taxation, which motivates and funds government to protect natural habitats, which could easily result in exclusion and thus in net loss of welfare in local populations, even if taxation and conservation result in higher benefits for the Tanzanian population as a whole.

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$104,650 compared to US$64,078 for the current value of PS for nature-based tourism. From a national planning point of view, the management costs for this mountain block are therefore partly justified based on nature-based tourism accommodation alone. Therefore annual nature-motivated PS and annual conservation expenditure in the EAMs are of comparable sizes, and thus, nature-motivated tourism (1) provides a substantial justification for spending public on conservation in the EAMs, and (2) provides a substantial source of funds for conservation in the EAMs. However, the PS of nature based tourism covers only 5% of annual conservation management expenditure over the entire EAM area.

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% y^{-1} growth in tourist numbers, compared with 4% y^{-1} under 'business as-usual' (KK). 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). 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 forest conversion and exploitation foregone.

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-budget, Tanzania-budget, International-moderate, Tanzanian-moderate). 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 47,718 International, and 49,896 Tanzanian visitors. 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

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.

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

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.

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.

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

Scenario	KK			MM		
Mountain Block	**Total**	Tanz.	Intern.	**Total**	Tanz.	Intern.
North Pare	12,780	10,721	2,059	14,781	12,399	2,382
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	4,521	3,792	728	5,228	4,386	843
Rubeho	4,999	4,193	805	5,781	4,849	932
Ukaguru	8,827	7,405	1,422	10,209	8,564	1,645
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	7,469	6,266	1,204	8,638	7,246	1,392
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

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 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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