Article

Journal of Environment & Development
2016, Vol. 25(4) 396–425
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1070496516664385
jed.sagepub.com

Assessing natural resource management through integrated environmental and social-economic accounting: The case of a Namibian conservancy

Huon Morton[1], Etti Winter[1], and Ulrike Grote[1]

Abstract

Local natural resource management in its diverse manifestations holds core to its principles that the marginal and vulnerable households are empowered to manage valuable natural resources to improve social and economic equality and conserve biodiversity. Yet studies aiming to identify the impacts often show inconsistent results. Through constructing an integrated Environmental and Social Accounting Matrix (ESAM), we aim to assess how natural resources are used in different sectors and by different livelihoods, thus delivering different direct and indirect benefits to the community. The study was conducted in Namibia's Sikunga Conservancy, which manages wildlife and fish resources in the Zambezi region. Our village-level ESAM shows an economic structure that strongly disadvantages remote households and identifies a small sector of the economy that benefits significantly from the use of natural resources. The ESAM approach is able to isolate undesirable socioeconomic developments such as unequal benefit sharing, which hinders community development.

Keywords

community-based natural resource management, multiplier analysis, village economy, Namibia, social accounting matrix

[1]Institute of Environmental Economics and World Trade, Leibniz University of Hannover, Hannover, Germany

Corresponding Author:

Huon Morton, Institute of Environmental Economics and World Trade, Leibniz University of Hannover, Königsworther Platz 1, Hannover, Lower Saxony 30167, Germany.
Email: morton@iuw.uni-hannover.de

Local natural resource management (NRM) concepts, namely, community-based natural resource management (CBNRM) and comparable programs such as fisheries comanagement and community-based fisheries management continue to gather momentum as national decentralization and democratization programs sweep across sub-Saharan Africa (Blaikie, 2006; Dressler et al., 2010; Fabricius et al., 2013; Sowman & Wynberg, 2014). By transferring property rights for natural resources, CBNRM aims to provide communities with an increased incentive to sustainably manage the natural resources they depend upon and at the same time deliver equitable economic growth (Berkes, 2004; Jones & Weaver, 2008).[1]

Despite the popularity of the philosophy, the overall impact of CBNRM remains unclear (Lewins et al., 2014; Riehl, Zerriffi, & Naidoo, 2015; Silva & Mosimane, 2012). Impacts can be measured at multiple scales; at the national level, CBNRM programs appear to be having a positive impact throughout sub-Saharan Africa. Increases in wildlife headcounts (Roe, Nelson, & Sandbrook, 2009) and income (Frost & Bond, 2008; Naidoo et al., 2016) have been recorded in sub-Saharan countries with CBNRM. CBNRM programs have also been found to boost economic activity in other sectors (Muchapondwa & Stage, 2013). Social Accounting Matrices (SAMs) have been applied in Namibia to analyze the impact of hunting tourism (Samuelsson & Stage, 2007) and angling tourism (Kirchner & Stage, 2005), as well as the value of Namibia's protected areas (Turpie, Barnes, Lange, & Martin, 2010), with all studies showing CBNRM helps stimulate growth in other sectors within the Namibian economy. However, benefits at national and community level may not necessarily trickle down to individual households (Leisher et al., 2016; Nunan, 2006; Riehl et al., 2015).

Using various quasi-experimental methods, recent studies reveal inconclusive results. The impact of CBNRM on income has been statistically insignificant for the average household (Pailler, Naidoo, Burgess, Freeman, & Fisher, 2015; Riehl, 2014; Suich, 2013), whereas improvements in health (Naidoo & Johnson, 2013; Riehl, 2014) and food security (Pailler et al., 2015) have been identified. The question therefore remains: Why are the impacts of CBNRM inconsistent?

One possible reason is that particular livelihoods benefit more than others from CBNRM (Collomb et al., 2008; Scanlon & Kull, 2009; Suich, 2013). Looking primarily at the direct income and financial aspects while neglecting the indirect benefits from conservation may present another reason why impacts of NRM are conflicting (TEEB, 2012; WAVES, 2016). It is well established that the value of natural resources within CBNRM areas far exceeds the economic output from production and tourism (Turpie et al., 2010). Despite the economic value of natural resources, Humavindu and Stage (2015) identified the risk of long-term environmental sustainability due to unsustainable financing of conservancies, particularly younger conservancies, which may fail to generate revenue to cover operating expenditure of their conservation activities. In addition to waning donor funding, the challenge of sustainable financing may partly be explained by the fact that management committees use funds differently. As Mulonga and Murphy (2003) highlighted, the increased cash flows from CBNRM activities can be used for multiple purposes, shared directly across households, or invested in community funds or infrastructure. In turn, we have seen that some sectors within CBNRM are complementary, for instance, hunting and tourism (Naidoo et al., 2016), while others namely livestock and agriculture are often the source of conflict with wildlife-focused sectors (Hoare, 2015; Kahler & Gore, 2015; Mosimane, McCool, Brown, & Ingrebretson, 2014).

As a way to enhance the discussion by analyzing how economic, financial, and natural resources are distributed within a nature-dependent economy, we constructed an integrated, Environmental and Social Accounting Matrix (ESAM). The ESAM integrates economic, financial, and natural resources into a single matrix. By incorporating the different sectors, we can observe the linkages between single activities and derive the context-specific, direct, and indirect income effects of CBNRM in our study region. Analyzing the flow of resources between actors and sectors is essentially answering "who does what with whom, in exchange for what, by what means, for what purpose, with what change in the stock" (United Nations, 2009, p. 16) and is key to understanding how the economy causes different outcomes for different social groups.

By showing the linkages between resources and household, we answer the following questions:

- What is the economic contribution of environment- and non-environment-based activities to the village economy?
- What are the structural linkages between environmental and non-environment activities in the village economy?
- How is environmental income distributed across livelihoods and regions within the village economy?

We aim to demonstrate the potential of using an ESAM to show the distribution of natural resources and their benefits within a CBNRM environment. More generally, we have constructed a multisectoral SAM at the village level, including additional environmental accounts for selected natural resources. The ESAM provides a consistent data framework that can flexibly be extended and used as a point of reference for economic modeling. Our ESAM complements the few in existence from Faße, Winter, and Grote (2014); Shiferaw and Holden (2000); and San Martin and Holden (2004). We, however, go further and integrate multiple environmental resources within the single ESAM. The rest of the article is set out with a brief overview of the data for the ESAM, a detailed description of the model, and, last, the results, discussion, and conclusion.

Study Area and Data

Study Area

To demonstrate the usefulness of an ESAM in explaining the impacts of NRM, we selected a conservancy in the Zambezi region of Namibia. The study was part of the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL; see, www.sasscal.org) research portfolio on climate change and adaptive land use and took place in Sikunga Conservancy, a developing conservancy gazetted in 2009 and hosting wildlife as well as valuable freshwater fish resources. The Zambezi region has a high GINI coefficient and high levels of poverty (National Statistics Agency, 2012). Although rich in biodiversity, regional environmental issues such as overfishing, deforestation, slash-and-burn farming, and poaching continue to grow (Mendelsohn, 2006; Tweddle, Cowx, Peel, & Weyl, 2015). The region is also home to the Kavango-Zambezi (KAZA) Transfrontier Conservation Area (TFCA) and supports a number of vulnerable wildlife but also causes serious human–wildlife conflicts (Metcalfe & Kepe, 2008). Fish stocks, located yearlong in the Zambezi river and across the floodplains during the flood season, are suffering from overfishing and a lack of coordinated management with cross-border Zambia (Abbott et al., 2007; Tweddle et al., 2015). Grazing plains in the Zambezi region, which support large numbers of livestock, are slowly being eroded. Deforestation, increasing livestock headcounts, and slash-and-burn farming have contributed to the erosion and degradation of floodplains in the region (Purvis, 2002). Agriculture practices are rudimentary and are based on low-input or low-output farming, placing greater pressure on denuded land (Pricope, Gaughan, All, Binford, & Rutina, 2015). Forest resources in the area are generally undervalued and undermanaged, with few controls placed on timber and firewood collection. Other natural resources such as thatching grass and river reeds are controlled by fixed-period licenses (Barnes, MacGregor, Nhuleipo, & Muteyauli, 2010).

Economically, off-farm job opportunities in the area are limited, and the majority of households tend to eke out maize-based subsistence existences supported by natural resource extraction (Kanapaux & Child, 2011). Cash income in the region is mostly earned through a handful of high-paying tourism or government jobs in the regional capital, Katima Mulilo, with a high number of households also depending on social welfare payments such as pensions and orphan payments (Suich, 2010).

Sikunga is rich in natural resources with grassland floodplains and Mopane woodlands covering the 287 km^2 area (Mendelsohn, 2010). The conservancy consists of six main villages clustered in three locations. As can be seen in Figure 1, three villages are located close to the main road into Sikunga. Sandwiched between the only road in and out of the conservancy and the Zambezi River, Kalimbeza, Kena, and Nasisangani have the greatest access to

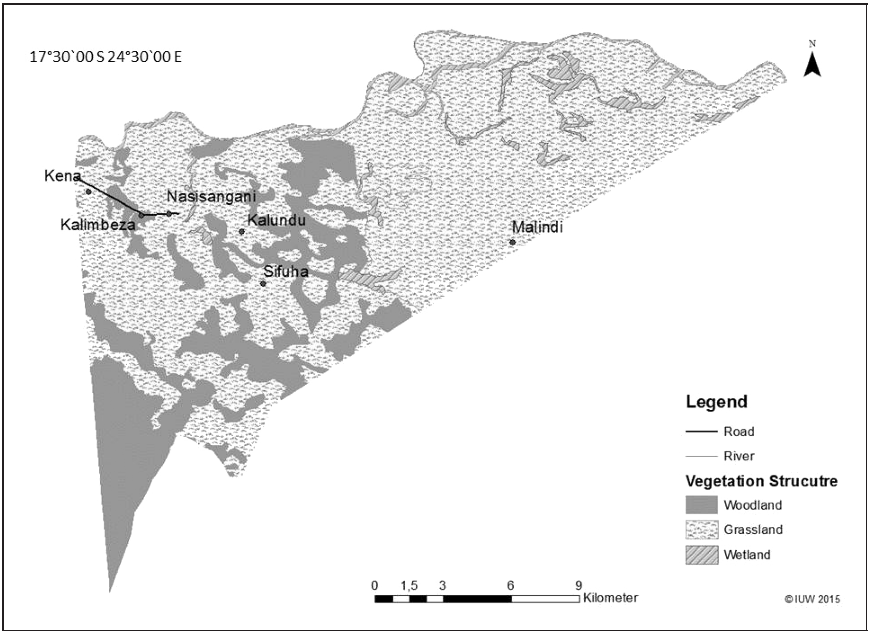

Figure 1. Map of Sikunga, its infrastructure, and villages.

transport to the regional capital. Sifuha, the largest of all villages, and Kalundu are a 5-km walk across the floodplains to the main road. The third region consists of Malindi, an isolated village that can only be reached via an 18-km journey by foot or by bike across the sandy plains. The three subareas (*main road*, *semi-isolated*, and *isolated*) are able to access different natural resources to varying extents.

Like many conservancies, Sikunga earns the majority of its income from the sale of hunting licenses; however, there are also two lodges within the area which support the highly lucrative angling tourism sector. The lodges have formal benefit sharing arrangements with the conservancy, and in this way, Sikunga is unique as it earns income from hunting as well as angling. As tourism in the conservancy is heavily focused on the unique angling in the area, the dwindling fish stocks (Tweddle et al., 2015) are putting the lucrative tourism income, as well as the livelihoods of the poorest and most vulnerable, at risk. In 2012, Sikunga established a pilot fish protected area and a fishery management plan, which, if successful, may prove a model for future freshwater fish protected areas (Tweddle, 2012).

Data

The ESAM is primarily built from household survey data collected from within the conservancy. There were approximately 440 households in Sikunga in 2012, and we sampled 200 (45%). The sample was random, based on household lists provided by the conservancy. As the sampling was nonstratified, results reflect the full population of Sikunga. Targeting the household head, the survey covered all economic activities, including the collection, consumption, and trade of all natural resources. Agricultural inputs and outputs were also recorded. For all transactions, the agent, origin, and destination of goods produced or traded were recorded. For all fish and timber data, species were recorded so as to better develop growth functions and measure changes in natural capital. Secondary data sources were used to complete information gaps from the primary data. This information was used to calculate environmental stocks and growth rates.[2]

Method

The SAM method was originally envisaged to observe national accounts in an input–output table to better inform policy development (Taylor & Adelman, 1996). Acknowledging both the impact and dependence on natural resources, the accounting framework was expanded to include the physical or financial values of natural resources (United Nations, 2003).

The ESAM is a specification of the System of Environmental and Economic Accounting (SEEA), continuously advanced to include better coverage of Ecosystem Accounting (UNSTAT, 2016). It plays an important role in policy planning and is critically needed as a monitoring and planning tool at the regional and the village level (Angelsen et al., 2014; De Anguita & Wagner, 2010; Shiferaw, Freeman, & Swinton, 2005).

The Environmentally Extended Sikunga Village Sam

The ESAM (Table 1) represents the total transactions within the Sikunga economy for a single year; it contains the links between economic activities and changes in environmental stocks. Activity columns and rows reflect different production processes that produce services and goods (commodities). Inputs, such as land, labor, and livestock, are included in Factor accounts. Institutions—encompassing households, government, and businesses—are the consumers of the goods and services produced or imported. Commodities produced, yet not consumed in the year, are considered increases in capital, as are changes in savings, and are recorded in the capital accounts. Imports and exports, as well as financial transfers from outside the conservancy, are accounted for in the rest of the village or Namibia or world accounts. For all accounts, entries in the columns represent payments made, with corresponding entries in rows reflecting payments received. To explore the extent to which natural resources are being used to develop sustainable and equitable economic growth, we hold production activities, commodities, factors of production,

Table 1. Overview of ESAM Framework.

	Endogenous accounts											Exogenous accounts		
	Activities				Commodities		Factors		Institutions	Savings			Rest of village/world	
	Activities—On-farm	Activities—Off-farm	Natural resource extraction	Natural resource growth	Commodities (Agricultural andnonagricultural)	Commodities—Natural resources	Factors	Factors—Natural resources	Institutions and conservancy	Capital—Savings and commodities	Capital—Natural	Government	Rest of village	Rest of world
Endogenous														
Activities—On-farm					$A_{1/5}$				$A_{1/9}$					
Activities—Off-farm					$A_{2/5}$									
Natural resource extraction					$A_{3/5}$				$A_{3/9}$					
Natural resource growth						$A_{4/6}$								
Commodities (Agricultural and nonagricultural)	$A_{5/1}$	$A_{5/2}$							$A_{5/9}$	$A_{5/10}$			$X_{5/13}$	$X_{5/14}$
Commodities—Natural resources			$A_{6/3}$								$A_{6/11}$			
Factors	$A_{7/1}$	$A_{7/2}$	$A_{7/3}$	$A_{7/4}$										$A_{7/14}$
Factors—Natural resources			$A_{8/3}$	$A_{8/4}$										
Institutions and conservancy							$A_{9/7}$	$A_{9/8}$		$A_{9/10}$		$X_{9/12}$	$X_{9/13}$	$X_{9/14}$
Capital—Savings and commodities									$A_{10/9}$			$X_{10/12}$		
Capital—Natural			$A_{11/1}$						$A_{11/9}$			$X_{11/12}$		
Exogenous														
Government							$L_{12/7}$	$L_{12/8}$			$L_{12/11}$			
Rest of village					$L_{13/5}$		$L_{13/7}$		$L_{13/9}$	$L_{13/10}$				
Rest of world					$L_{14/5}$		$_{14/7}$		$L_{14/9}$	$L_{14/10}$				

Source. Adapted from De Anguita and Wagner (2010) and Adelman, Taylor, and Vogel (1988).

capital accounts, and households as endogenous. Exogenous accounts are government and rest of Namibia or world. It should be noted that “A” represents the endogenous accounts, “L” are leakage values outside the conservancy economy, and “X” are exogenous injections from outside Sikunga (Agaje, 2008).

Prices have been based on market prices where possible (United Nations, 2014). In the case of forests and fish stocks, the value of the resources produced during 2012 is based on 2012 market prices. The value of future income generated from growth and regeneration, recreational, and nonconsumptive use is excluded. The prices of natural resources used in the production of other goods, for instance, trees used for the production of firewood, are based on a partitioning of the cost of labor and the end price of the produced good. This approach is similar to the partitioning of operating surpluses between natural and produced assets as outlined in the SEEA 2003[3] (UN, IMF, European Commission, OECD, & World Bank, 2003). All values in the table are reported in Namibian Dollars (NAD$) where NAD$1.00 is roughly PPP$0.60.

Activities. We separate the activities into four groups: agriculture, off-farm, natural resource growth, and natural resource extraction activities. Agriculture activities focus mainly on maize and livestock and commercial rice farming. Off-farm activities consist mainly of government and tourism services. Natural resource growth and extraction activities are included for each individual resource. Ecosystem services such as cultural services have been excluded from the current version of the ESAM. Only natural resources that are economically or environmentally significant to the economy have been included (UN et al., 2003). Our approach to the recording of environmental transactions is based on the SEEA 2012 framework and on the representation of livestock developed by Gelan, Engida, Caria, and Karugia (2012) for their Ethiopia SAM. The growth of timber and increases in fish biomass creates the commodities *timber* and *wild fish*, which are recorded in the submatrix $A_{4/6}$. The commodities can then be used as inputs for other production activities such as *firewood harvesting* or *fishing*. Commodities can also be taken from or contribute to existing stock levels. This is discussed further in the following sections.

Natural resource extraction activities represent the production of goods based on the extraction of natural resources, such as fishing, firewood harvesting, and so forth. Goods produced from natural resources which are sold are included in submatrix $A_{3/5}$ and those which are consumed directly by the household are recorded in $A_{3/9}$. Slash-and-burn farming produces agricultural assets, in the form of farming and grazing land, and is initially recorded as a production of the commodity *farm land* in $A_{3/5}$, before being recorded as an increase in investment recorded in $A_{5/10}$. However, this practice comes at a large environmental cost, which is initially recorded in the value of trees lost in $A_{3/5}$ and is eventually absorbed by the conservancy in $A_{5/9}$.

As with natural resource extraction, agricultural and nonagricultural goods produced and sold by households in Sikunga are recorded in $A_{1/5}$, while the goods they produced and consumed at home are recorded in $A_{1/9}$. Cell $A_{1/5}$ includes the output from the commercial rice farm run by a government-owned business within the conservancy.

Commodities. Similar to the structure of activities, commodities are separated into agricultural and nonagricultural goods and services, and natural resource commodities. Commodities used as inputs for other production activities are recorded in $A_{5/1}$ and $A_{5/2}$, with environmental commodities, such as trees and wild fish, recorded in $A_{6/3}$. Commodities purchased by households, regardless if they were produced inside or outside Sikunga, are recorded in $A_{5/9}$. Where commodities were reported as being sold within Sikunga yet were not able to be assigned to a particular institution, these values were recorded in a *rest of village* account in submatrix $X_{5/13}$. Submatrix $X_{5/14}$ also records the value of commodities exported to Namibia and the rest of the world.

Where the value of natural commodities used as inputs is less than the value of the sustainable yield, an increase in natural capital is recorded in $A_{6/11}$. Similarly, increases in storages of crops or livestock headcounts are recorded in $A_{5/10}$ as an increase in agricultural capital. Thus the ESAM is able to directly report the sustainable use of different natural resources in different activities.

Factors. The Value Added matrix consists of cells $A_{7/1}$, $A_{7/2}$, $A_{7/3}$ and $A_{7/4}$, for labour and agricultural factors, and $A_{8/3}$ and $A_{8/4}$ for natural resource factors. Where residents of the community were employed outside the boundary of the village, this is reported in $A_{7/14}$. The value for labour, where possible, was based on income reported for different activities. For on-farm activities, labour values were calculated based on reported time-use.

The distribution of payments to multiple factors for single activities is driven by payments for labor. This approach is consistent with the SEEA Central Framework 2012.[4] Capital rents are recorded for livestock and land in cells $A_{7/1}$, $A_{7/2}$, and $A_{7/3}$ along with labor. Capital rents for environmental assets are recorded in $A_{8/3}$ and $A_{8/4.}$ As with physical capital, capital rents on environmental resources can only be calculated when there is no consumption of existing capital (i.e., the use of natural resources is sustainable; United Nations, 2014).

Institutions. Institutions consist of the government, conservancy management, tourism operators, and households. Factor payments made to households from agricultural capital and labor are recorded in $A_{9/7}$, with factor income from natural resources recorded in $A_{9/8}$. This includes the net income from environmental rents for the conservancy, as the conservancy controls the environmental resources of Sikunga. Income from government pensions or other welfare is recorded in $X_{9/12}$.

Where net savings are reported by households and other institutions, these are recorded in $A_{10/9}$. However, where net losses for agricultural and financial capital are noted by households, these are put in $A_{9/10}$. Households within Sikunga also sent money to households outside of the conservancy and these transactions are recorded in $X_{9/13}$ and $X_{9/14}$. Transfers flowing in the opposite direction are put in $L_{13/9}$ and $L_{14/9}$.

We group the households by both their livelihood strategy and their geographic location. We include geographic location considering that research on CBNRM has shown the important role of geographic capital in determining access to natural resources (Blaikie, 2006; Kanapaux & Child, 2011). There are four unique livelihood strategies, which we identified using a two-step cluster analysis.[5] The four groups are as follows: *diversified low-input low-output rural workers*, *natural resource and agricultural workers*, *skilled off-farm worker*, and *asset and cash rich households*. The four groups are then further subdivided in the ESAM based on their geographic location: *main road*, *semi-isolated*, and *isolated*. A summary of the assets and resource use of these groups is provided in Table 2.

Cluster 1 households, the largest of the four groups in terms of total households (48%), have the lowest annual income ($15,026), of which forestry resources make up 16% of their total income. This group consumes more than 3,100 kg of firewood per household per year; however, it tends not to exploit fish resources.

Cluster 2 households consist of 49 households (25% of the sample) and generate most of its income from natural resources as well as unskilled employment in agriculture sector. Households in this group catch on average around 860 kg of fish per household per year, which accounts for more than 30% of the household's income. They also extract the highest amounts of firewood of all livelihood strategies.

Cluster 3 households have the second highest level of expenditure in the conservancy. Their higher expenditure is fuelled by comparatively high wage incomes from stable government jobs, mostly in military, police, or government departments in Katima Mulilo. This cluster represents around 15% of households in the community.

Cluster 4 households consist of 24 households, around 12% of the conservancy, and achieve the highest levels of expenditure through high-paying, private pensions as well as salaries from younger family members still residing in the household. Despite their wealth, households in this group are the second highest users of fish resources and cleared the second highest amounts of land through slash-and-burn farming.

Capital. The capital accounts are used to record changes in natural, physical, and financial resources. Where the consumption of commodities is greater than those

Table 2. Income Sources for the Livelihood Strategies in Sikunga.

	Cluster 1 (diversified low-input low-output rural workers)	Cluster 2 (natural resource and agricultural workers)	Cluster 3 (skilled off-farm workers)	Cluster 4 (asset and cash rich)
Number of households	97	49	29	24
Annual household expenditure (NAD$)				
Expenditure on consumption goods	$7,706^{b,c,d}	$9,874^{d}	$11,552^{d}	$17,446
Natural resources				
Net income fish % Sold	$877^{b} (35%)	$11,184^{c,d} (77%)	$120^{b} (32%)	$2,071 (64%)
Net income firewood % Sold	$2,408^{b,c} (0.4%)	$3,876 (1.4%)	$1,819 (0.9%)	$1,943 (0%)
Area slash-and-burned (ha)	2.1	3.3	2.6	3.7
Other income				
Agriculture	$2,026^{b,d}	$3,929	$3,097	$5,131
Wage and casual income	$6,499^{c}	$12,174^{c}	$24,929^{d}	$29,568
Welfare and remittances	$3,216^{c,d}	$3,144^{c,d}	$1,578^{d}	$11,538
Total income (NAD$)	$15,026^{b,c,d}	$34,307	$31,543	$50,251

Note. b,c,d indicates that the mean is statistically different at alpha = .10. b indicates significantly different to Cluster 2, c significantly different to Cluster 3, and d significantly different to Cluster 4. All continuous variables were tested with the Mann–Whitney *U* test. NAD$ = Namibian Dollars.

produced and imported, there must be a decrease in stocks. This decrease in stock, referred to as consumption of existing capital, is recorded as an input to the production activity (United Nations, 2014). In cell $A_{11/1}$, we report the consumption of existing natural capital. This occurs when consumption levels of wild fish are above sustainable yield levels. Increases in agricultural capital are distributed among the households in $A_{10/9}$. Increases in natural capital are also assigned to the conservancy in $A_{11/9}$, while increases in land from slash-and-burn farming are recorded for households in $A_{10/9}$. The financial capital account contained in $A_{10/9}$ and $X_{10/12}$ is used as a balancing account and reports the net difference between incomes and expenditures for institutions, government, and the conservancy (Round, 2003; United Nations, 2014).

Government and conservancy. As the government and conservancy institutions have been considered exogenous for the multiplier analysis, they must be separated from the other institutions. However, the accounts are similar to other institutional accounts, such as earning factor income from land via the rice farm in $L_{12/7}$ or environmental rents in $L_{12/8}$.

Rest of the village, rest of Namibia, rest of the world. The rest of the village account is used to account for the flow of goods, services, and capital which are traded without a clearly defined producer or consumer. For example, a household may have reported that it produced 100 kg of maize and sold it within Sikunga; however, we are unable to determine which family or to which household cluster they sold it to. To include these transactions, we therefore include it in $X_{5/12}$. Other imports from outside Sikunga are recorded in $L_{14/5}$. There is a relatively small amount of hired labor in Sikunga, with the majority of labor for livestock herding imported from across the border in Zambia. Factor costs for imported labor are recorded in $L_{13/7}$ and $L_{14/7}$.

Multiplier Analysis

The economic linkages between environmental resources and their users have been analyzed by using constrained multiplier analysis, although most published SAMs apply unconstrained multipliers. Unconstrained multipliers are generally more simplified, assuming that factors and capital are unlimited and accessible at constant costs (Breisinger, Thomas, & Thurlow, 2010). In the context of an ESAM, this is rather idealistic and too removed from reality. For example, in our study area, fish resources are being used unsustainably, and fish reproduction rates cannot be ramped up or down depending on short-term demand.

To better account for this, we conduct a series of constrained multiplier analysis and place a limit on different environment sectors and resources. These constraints are also important in more accurately measuring the multiplier effects as unconstrained multipliers can often overestimate demand linkages

(Breisinger et al., 2010; Round, 2003). For a more detailed description of how the constrained multiplier is derived, see Lewis and Thorbecke (1992).

Results

The Economic Contribution of Environment- and Nonenvironment-Based Activities to the Village Economy

The village ESAM presented in Table 3 shows aggregated household clusters across the different regions, as well as disaggregated environment accounts. Gross domestic product (GDP), excluding environmental accounts, was around NAD\$3,890,000 ($A_{13/1}$:$A_{14/2}$) in 2012 or NAD\$4,215 per capita. This figure is below the GDP per capita of NAD\$6,709 for the Zambezi region (National Statistics Agency, 2012) and reflects the exclusion of income from jobs located outside the case study's production boundary. The GDP from environmental accounts is worth more than NAD\$22,000,000 ($A_{13/3}$:$A_{15/4}$) driven by the value of forest growth within the conservancy area.

The village economy is relatively closed with few leakages. The production value of NAD\$4,197,000, excluding environmental accounts, means that GDP is approximately 93% of total production. Despite 75% of households producing maize, Sikunga remains a net importer. Of the roughly 84,000 kg of maize consumed annually in Sikunga, 83% is imported from the regional capital. Livestock still holds a prominent place in the culture and economy of Sikunga and accounts for around 14% (NAD\$585,000—$A_{1/6}$) of nonenvironmental production. However, expanding livestock and maize farming is responsible for the destructive consumption of forest resources; slash-and-burn farming and land clearing currently destroys about a third of the value of annual growth in forest stocks. The analysis revealed that fish resources were harvested at unsustainable rates. As can be seen in Table 3, the natural capital consumed, here the value of unsustainable fish extraction (NAD\$66,928—$A_{23/3}$), is around 17% of the total valued growth in fish stocks (NAD\$375,546—$A_{3/7}$).

The ESAM shows that the contribution of environment-based activities is central to the village economy, more specifically, that the output of natural resource extraction and harvesting is almost double that of both agriculture and off-farm activities. Yet the distribution and utilization of natural resources appear geared toward particular institutions and groups. This can be seen across agriculture, off-farm, and natural resource extraction activities.

Structural Linkages Between Environmental- and Nonenvironment-Based Activities

To explore the structural links between environment- and nonenvironment-based activities, we look at the multiplier analysis in Table 4. Through analyzing

Table 3. Aggregate Village Extended Environmental Social Accounting Matrix of Sikunga.

		Activities				Commodities								Factors		
		1. Activities-On-farm	2. Off-farm activities	3. Natural resource extraction	4. Natural resource generation	5. Crops	6. Livestock	7. Fish	8. Trees	9. Harvested natural commodities	10. Government services	11. Tourism + Conservation services	12. Other goods and services	13. Labor factors	14. Agricultural factors	15. Environment factors
Activities	1. Activities—On-farm					2,012,783	585,547									
	2. Off-farm activities										328,921	422,440	631,330			
	3. Natural resource extraction									8,259,977						
	4. Natural resource generation							375,546	21,647,625							
Commodities	5. Crops	49,184	4,800													
	6. Livestock															
	7. Fish			375,546												
	8. Trees			7,857,369												
	9. Harvested natural commodities			92,498												
	10. Government services															
	11. Tourism + Conservation services															
	12. Other goods and services		252,587													
Factors	13. Labor factors	1,146,763	1,116,824	553,188												
	14. Agricultural factors	1,618,103	8,480													
	15. Environment factors			4,817	22,023,171											

		Activities				Commodities								Factors		
		1. Activities-On-farm	2. Off-farm activities	3. Natural resource extraction	4. Natural resource generation	5. Crops	6. Livestock	7. Fish	8. Trees	9. Harvested natural commodities	10. Government services	11. Tourism + Conservation services	12. Other goods and services	13. Labor factors	14. Agricultural factors	15. Environment factors
Institutions	16. Main road households													2,502,530	220,248	145,891
	17. Semi-isolated households													808,439	107,320	70,262
	18. Isolated households													151,936	−14,526	29,818
	19. Conservancy management														8,479	21,782,017
	20. Government														1,305,062	
	21. Others															
Savings	22. Agriculture capital															
	23. Natural capital			66,928												
	24. Savings															
Rest of village/world	25. Rest of main road households					2,760	30,270			31,149	460		58,898			
	26. Rest of semi-isolated households					2,268	1,130			9,230	2,170		29,244			
	27. Rest of isolated households						410			3,880	930		7,716			
	28. Rest of Sikunga households					2,832	33,830			51,557	30,920		44,344	8,406		
	29. Outside Sikunga					454,142	26,596			11,510	54,395		1,384,782	91,260		
	30. Outside Namibia					4,320				2,040			3,400	115,834		

Table 3. Continued.

		Institutions						Savings			Rest of village/world						
		16. Main road households	17. Semi-isolated households	18. Isolated households	19. Conservancy management	20. Government	21. Others	22. Agriculture capital	23. Natural capital	24. Savings	25. Rest of main road households	26. Rest of semi-isolated households	27. Rest of isolated households	28. Rest of Sikunga	29. Outside Sikunga	30. Outside Namibia	Total
Activities	1. Activities—On-farm	123,503	83,477	8,740													2,814,050
	2. Off-farm activities																1,382,691
	3. Natural resource extraction	406,032	192,816	91,521													8,950,346
	4. Natural resource generation																22,023,171
Commodities	5. Crops	302,300	136,139	35,441				14,060			500	600	300	900	1,934,881		2,479,105
	6. Livestock	67,026	23,810	1,400				399,003			18,933	39,938		37,241	90,222	210	677,781
	7. Fish																375,546
	8. Trees								13,790,256								21,647,625
	9. Harvested natural commodities	62,944	22,130	5,854	7,489,755			126,460			52,670	75,126	1,960	69,863	306,527	63,556	8,369,343
	10. Government services	73,320	12,673	2,882		328,921											417,796
	11. Tourism + Conservation services	4,535	3,335	610	129,670		268,890								15,400		422,440
	12. Other goods and services	825,120	357,812	92,865			111,280	-			348,106	85,440	1,800	34,944	41,600	8,160	2,159,714
Factors	13. Labor factors														861,630		3,678,405
	14. Agricultural factors																1,626,583
	15. Environment factors																22,027,988

		Institutions						Savings			Rest of village/world						
		16. Main road households	17. Semi-isolated households	18. Isolated households	19. Conservancy management	20. Government	21. Others	22. Agriculture capital	23. Natural capital	24. Savings	25. Rest of main road households	26. Rest of semi-isolated households	27. Rest of isolated households	28. Rest of Sikunga	29. Outside Sikunga	30. Outside Namibia	Total
Institutions	16. Main road households					296,600	23,400				1,000				188,680		3,378,349
	17. Semi-isolated households					114,000								900	55,530		1,156,451
	18. Isolated households					48,200	36,000								24,500		275,928
	19. Conservancy management								66,928								21,857,424
	20. Government																1,305,062
	21. Others	12,036	7,351	2,828													22,215
Savings	22. Agriculture capital	413,751	123,503	2,269													539,523
	23. Natural capital				13,790,256												13,857,184
	24. Savings	1,032,793	155,770	31,518	447,743	517,341	−417,355										1,767,810
Rest of village/world	25. Rest of main road households	700								296,972							421,209
	26. Rest of semi-isolated households									157,062							201,104
	27. Rest of isolated households									−8,876							4,060
	28. Rest of Sikunga households	2,500	630							−31,171							143,848
	29. Outside Sikunga	51,790	36,405							1,408,090							3,518,970
	30. Outside Namibia		600							−54,268							71,926

the linkages with other sectors, it can be seen how natural resource-driven growth may develop the economy, and whether growth in nonnatural resource sectors could at the same time lead to indirect negative impacts on the natural capital in the region. In terms of linkages between environmental and nonenvironmental sectors, we generally find a one-way relationship. Maize and livestock farming, two historically significant sectors, have weak linkages with extractive activities. An exogenous increase in demand for one unit of Maize or Livestock would lead to an increase in natural resource extraction of 0.03 and 0.05 units (Table 4). Off-farm activities also indicate low linkages with extractive sectors—as increases in tourism, conservation, and commercial services have few knock-on effects on natural resources—with output multipliers for natural resources all below 0.17 units (Table 4). In contrast, environmental extractive activities are strongly linked with each other. An exogenous increase in demand for 1 unit of thatching grass and river reeds would lead to an overall increase in 1.38 units for the village economy (Table 4).

Livestock is one of the traditional livelihoods indicating a positive impact on GDP and total income. An increase in exogenous demand for one unit of livestock would increase GDP by 1.02 units and income by 0.77 units. However, for each increase in livestock demand, there is an expansion in 0.22 units of land use through enhanced factor demand (Table 4).

The GDP and income multiplier for fish is low, as the sector is constrained and any increase in exogenous demand must be supplied via an increase in imports. The fishery sector has a doubly important role to play in the economy, contributing as much to GDP directly through catching and processing, as it does indirectly by attracting tourists for the tourism sector (Table 4).

In looking at the services industry within Sikunga, analysis revealed that tourism and conservation services have the largest impact on GDP. An increase in exogenous demand for tourism and conservation would result in increases in GDP by 1.25 and 1.23 units, respectively. As production for these two sectors occurs largely within the conservancy, the model concludes that growth in GDP translates into corresponding aggregate income growth. Another positive sign for the potential of tourism and conservation services is that the two sectors have very weak links with natural resource extraction. This is highlighted by increases in output of 1.48 and 1.40 units, with only 9% of the growth is due to enhanced natural resource extraction.

The Distribution of Environmental Income Across Livelihoods and Regions

The previous section identified which sectors may support sustainable growth and which sectors may escalate environmental degradation. To observe the extent to which the structure of the economy will lead to equitable economic

Table 4. Constrained Multiplier Analysis—Livestock, Slash-and-Burn, and Fish and Timber Sectors Constrained.

	Maize	Livestock	Fish	Firewood	Thatching grass + River reeds	Trade and self-employment	Tourism	Conservation	Commercial	Gov't
Factors										
Unskilled labor	0.16	0.70	0.30	0.40	1.05	0.68	0.84	0.65	0.27	0.35
Skilled labor	0.00	0.02	0.01	0.02	0.03	0.14	0.38	0.49	0.11	0.60
Land and seeds	0.13	0.22	0.01	0.01	0.03	0.02	0.03	0.09	0.01	0.02
Livestock	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural resources	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
GDP multiplier	0.29	1.02	0.32	0.43	1.17	0.84	1.25	1.23	0.39	0.97
Geographic										
Main road households	0.12	0.56	0.21	0.28	0.71	0.55	0.84	0.80	0.26	0.69
Semi-isolated households	0.04	0.21	0.07	0.09	0.23	0.18	0.27	0.26	0.08	0.22
Isolated households	0.01	0.00	0.02	0.03	0.07	0.05	0.06	0.05	0.02	0.03
Livelihood strategies										
Diversified low-input low-output rural workers	0.05	0.27	0.10	0.13	0.33	0.23	0.31	0.27	0.10	0.19
Natural resource and agricultural workers	0.05	0.22	0.08	0.10	0.27	0.19	0.26	0.22	0.08	0.15
Skilled off-farm workers	0.05	0.21	0.09	0.13	0.32	0.30	0.53	0.56	0.16	0.56
Asset and cash rich	0.02	0.07	0.03	0.03	0.09	0.06	0.08	0.06	0.02	0.04
Total income multiplier	0.17	0.77	0.30	0.40	1.02	0.78	1.17	1.11	0.36	0.94
Total output multiplier	0.33	1.05	1.02	0.76	1.33	1.48	1.40	1.36	0.44	1.08
Own sector multiplier	0.24	0.89	0.64	0.51	0.40	1.28	1.00	1.00	0.31	0.80
Linkages with other sectors	0.09	0.16	0.37	0.24	0.94	0.20	0.40	0.33	0.12	0.28
Linkages with natural extraction	0.03	0.05	0.92	0.56	1.09	0.13	0.17	0.15	0.05	0.12

Table 5. Normalized Income Constrained Multipliers.

	Maize	Livestock	Fish	Firewood	Thatching grass + River reeds	Trade and self employment	Tourism	Conservation	Commercial	Gov't
Normalized by value add										
Geographic										
Main road households	1.43	1.31	2.80	1.38	1.32	1.12	1.16	1.17	1.27	1.10
Semi-isolated households	0.47	0.50	0.90	0.45	0.43	0.36	0.37	0.38	0.41	0.35
Isolated households	0.15	0.01	0.29	0.14	0.14	0.10	0.08	0.07	0.09	0.04
Livelihood strategies										
Diversified low-input low-output rural workers	1.15	1.41	1.19	1.13	1.12	1.05	1.15	0.59	0.78	0.36
Natural resource and agricultural workers	0.99	1.15	0.97	0.93	0.92	0.86	0.94	0.49	0.64	0.30
Skilled off-farm workers	1.07	1.07	1.16	1.16	1.07	1.37	1.96	1.23	1.28	1.08
Asset and cash rich	0.41	0.38	0.32	0.31	0.30	0.27	0.28	0.14	0.19	0.07
Normalized by population										
Geographic										
Main road households	1.41	1.40	1.42	1.42	1.42	1.42	1.42	1.43	1.42	1.43
Semi-isolated households	0.47	0.53	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Isolated households	0.15	0.01	0.14	0.14	0.15	0.12	0.10	0.09	0.11	0.06
Livelihood strategies										
Diversified low-input low-output rural workers	1.16	1.24	1.18	1.18	1.19	1.13	1.06	1.00	1.07	0.89
Natural resource and agricultural workers	1.00	1.00	0.97	0.96	0.98	0.92	0.87	0.83	0.88	0.73
Skilled off-farm workers	1.08	0.94	1.20	1.20	1.14	1.47	1.80	2.09	1.75	2.66
Asset and cash rich	0.42	0.33	0.32	0.32	0.31	0.29	0.26	0.24	0.26	0.18

growth, we look at the multiplier analysis through normalized income multipliers (Table 5). Income multipliers are normalized for each of the three regions and four livelihood strategies by the weighted average for value added (Arndt, Garcia, Tarp, & Thurlow, 2012) and by population. We include the population-based weighted average, as value-added weights may partially reflect existing inequality.

The normalized multipliers show that *main road households* tend to gain between 1.3 and 1.4 times the weighted average-induced income. Households in this region gain well above the weighted average for all activities, indicating the structural imbalance in the economy. Conversely, the *isolated region* with its lack of infrastructure and limited access to markets suffer significantly when gaining from any induced income development.

The normalized multipliers for the fish and firewood sectors provide conflicting impressions, as the sectors appear to support households that are either extremely poor or extremely well-off. We find that fish resources provide households from the poorest livelihood strategy (*diversified low-input low-output rural workers*) with 1.19 times the weighted average (value added) for fish, while *skilled off-farm workers* gain double that average income. Results are similar for fish and firewood using the population weighted average. Reflecting the *main road households*' access to the river and floodplains, these households benefit 2.8 times more from fish-generated income than the weighted average (value added), indicating the highest income disparity across all normalized measures and all sectors.

The story is slightly more positive when looking at the normalized indicators for the different livelihoods strategies. Initially, *asset and cash rich* households appear to suffer a disadvantage within the village economy; however, the low normalized multipliers are slightly misleading. The majority of income for this cluster is generated by income from outside the conservancy, either from high-return pensions or salaries outside Sikunga. In consequence, any increase in induced demand within the village economy is unlikely to have any impact on their production and thus income-generating activities.

The poorest group of households, *diversified low-input low-output rural workers*, benefit from induced demand for commodities produced from unskilled activities such as maize and livestock farming as well as natural resource extraction. This partly reflects that their production and consumption activities are driven within the village. On the other hand, households in this cluster gain little from conservation and tourism activities. Increases from conservation employment or tourism are likely to flow through to the wealthy and well-educated *skilled off-farm workers*.

Discussion

CBNRM is a local governance institution that aims to deliver locally adapted sustainable and equitable rural development (Dressler et al., 2010; Fabricius et al., 2013; Sowman & Wyberg, 2014). Our ESAM analysis shows that benefit-sharing matters. This is in line with recent research done by Mosimane and Silva (2015), who found that local governance institutions in Namibian conservancies have not yet developed fair, transparent, and accountable benefit-sharing systems facilitating participation. In a behavioral field experiment related to our ESAM analysis, Roettgers (2016) revealed the significance of institutions favoring cooperation, specifically prosocial norms, leadership, and communication.

The structural linkages between environmental and nonenvironmental activities identified in our study area indicate that the natural resource-based sectors within the CBNRM economy are strongly interconnected, while nonnatural resource-based sectors appear to be growing separately and somewhat disconnected. The ESAM analysis shows that the current structure of Sikunga's economy is neither sustainable nor equitable. Natural capital is being consumed at unsustainable rates with minimal consideration over the long-term economic and ecological consequences and may lead to regime shifts with damaging economic and environmental impacts.

However, Sikunga is an emerging conservancy with high potential for diversifying the nature-based tourism sector due to its rich aquatic and terrestrial biodiversity. Being part of a broader network that includes also transboundary natural resource management approaches (Abbott et al., 2007), the process of community development depends on external factors, local management strategies (Fabricius et al., 2013, p. 273), and the collaboration between traditional leadership, government, and external stakeholders (Mawere, Mabeza, & Shava, 2014). As pointed out by Barendse, Roux, Currie, Wilson, and Fabricius (2016), one limiting external factor is the government's inadequate implementation capacity so that local governance institutions have narrow capacity to develop natural resource stewardship. This holds for wildlife as well as for fishery management (Cox, Wilson, & Pavlovich, 2016; Lewins et al., 2014; Ngwira, Kolawole, & Mbaiwa, 2013; Nkhata, Breen, & Abacar, 2009; Nunan, 2006; Sutton & Rudd, 2014).

The ESAM tool has highlighted negative developments, associated with investments by the Sikunga Conservancy Management, that appear to advantage established elites and wealthy households and those located near the main infrastructure. In particular, the isolated village of Malindi has no clear economic development opportunities based on the current structure of Sikunga's economy. More concerning, however, is that income multipliers indicate conservancy-based economic activities such as tourism and conservation jobs are skewed to be prorich rather than propoor, findings similar to that of Elliot and Sumba (2011), who recommended the launch of transparent benefit-sharing agreements.

Geographical clustering shows the opportunity to reconsider land management and zooning in favor of remote villages. We also show that biased income allocation in favor of asset-rich households causes an unsustainable increase in demand for cattle and grazing land, explained by the cultural high value local people still attribute to owning cattle. As the Zambezi region is already at maximum carrying capacity (Mendelsohn, 2006, 2010; Pricope et al., 2015), any increase in farming land will be due to land-use change. As deforestation intensifies, the growth rate of forest stocks will decrease, which in turn may escalate pressure on households due to loss of fuel sources, shade, protection from desertification, and other ecosystem services.

Value-added sectors such as community-based tourism may increase capital rents on the natural resources without putting at risk natural capital stock levels (Van der Duim, Lamers, & van Wijk, 2015). *Conservation tourism* as promoted by the African Wildlife Foundation is one promising example for market-based conservation that might be an option for Sikunga (Van Wijk, van der Duim, Lamers, & Sumba, 2014).

Conclusion

This article contributes to existing research in several ways. It is an addition to the limited number of village-level SAM and ESAMs and provides a valuable insight into the economic and environmental linkages within a CBNRM context. By including subvillages within the ESAM, our model highlights the importance of geographic capital, particularly in the context of a region undergoing rural–urban change. Finally, the model also challenges the cultural importance of particular livelihood activities, and their future role in the livelihood strategies of rural households in northeastern Namibia.

The result indicates that the CBNRM program in Sikunga so far has done little to enhance sustainable and equitable development; rather, the transfer of property rights to the conservancy has allowed the elite and wealthy households to extract greater rents on the natural resources and put at risk the natural capital. The lack of incentives for the vulnerable *isolated* households to protect the wildlife plains that surround them could eventually jeopardize the wildlife and the hunting-based income that the governing committee members have grown to depend on.

To enhance economic development, the Conservancy Management Committee may consider prioritizing conservancy employment opportunities for disadvantaged households such as stewards for the wildlife plains or other similar activities.

Methodologically, the assumptions behind the multiplier analysis place some limitations on our conclusions and suggest that future research considers not only the greater use of village-level ESAMs across a wider number of study areas but their use as an input into more village-level computable equilibrium and agent-based models as well. Furthermore, ESAMs are only able to incorporate the flows and changes in stocks of natural resources and services. While concentrated flows of goods and services may indicate particular power balances within a community, they are insufficient to explain why different groups may be marginalized and the broader political ecology. Second, the quantification of both the volume and the value of ecosystem services is a key input into ESAMs, and there are many natural resources and ecosystem services, particularly cultural services, which though difficult are worth quantifying and valuing in this context.

The Sikunga Conservancy is unique in many ways. First, while the majority of the income for the conservancy management committee is obtained from the sale of hunting licenses, like most conservancies, however, its current tourism income is fishing and not based on wildlife. Second, it is also a comparatively young conservancy, which means that historical and cultural factors may influence the results reported within the CBNRM context.

Our results make a valuable contribution to the debate methodologically and, with a wider application, may enhance the distribution of direct and indirect benefits within the CBNRM context.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was funded as part of the German Federal Ministry of Education and Research program "Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL)": Task 230—Food Security and Biodiversity: The Socio-Economic and Environmental Value of Natural Resources for Rural Livelihoods.

Notes

1. In the literature, the term *CBNRM* is often used in the broader context of natural resources management or management of the commons, including wildlife, fish, forest, and water resources, involving some degree of comanagement between the government and communities (Roe et al., 2009; Turner, 2004). In our article, we apply this broader definition of CBNRM.
2. Secondary sources used to calculate fish growth rates were Hay et al. (2002) and Downing and Plante (1993). Secondary sources used to calculate tree growth were Barnes et al. (2010), Kamwi (2003), and Laamanen, Otsub, and Tubalele (2002).
3. See page 51 of the SEEA 2003 for more details.
4. For more information, see section *V Asset Accounts* (United Nations, 2014, p. 153).
5. Two-step cluster analysis is a subjective way to group the households into groups with common mixes of livelihood strategies using both categorical and continuous variables. It is preferred to hierarchical techniques due to its ability to integrate categorical and continuous variables and its ability to group clusters based on the objective AIC and BIC indicators (Mooi & Sarstedt, 2011). Cluster analysis is commonly used in livelihood strategy analysis. For more information regarding the use of cluster analysis in identifying livelihood strategies, see Brown, Stephens, Ouma, Murithi, and Barrett (2006).

References

Abbott, J., Campbell, L., Hay, C., Naesje, T., Nduma, A., & Purvis, J. (2007). Rivers as resources, rivers as borders: Community and transboundary management of fisheries in the upper Zambezi river floodplains. *The Canadian Geographer*, *51*(3), 280–302.

Adelman, I., Taylor, J. E., & Vogel, S. (1988). Life in a Mexican village: A SAM perspective. *Journal of Development Studies*, *25*(1), 5–24.

Agaje, T. F. (2008). *Growth linkages and policy effects in a village economy in Ethiopia: An analysis of interactions using a social accounting matrix (SAM) framework*. Antwerp, Belgium: University of Antwerp, Faculty of Applied Economics, Department of Economics.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., ... Wunder, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. *World Development*, *64*(Suppl 1): S12–S28.

Arndt, C., Garcia, A., Tarp, F., & Thurlow, J. (2012). Poverty reduction and economic structure: Comparative path analysis for Mozambique and Vietnam. *Review of Income and Wealth*, *58*(4), 742–763.

Barendse, J., Roux, D., Currie, B., Wilson, N., & Fabricius, C. (2016). A broader view of stewardship to achieve conservation and sustainability goals in South Africa. *South African Journal of Science*, *112*(5/6), 15.

Barnes, J. I., MacGregor, J. J., Nhuleipo, O., & Muteyauli, P. I. (2010). The value of Namibia's forest resources: Preliminary economic asset and flow accounts. *Development Southern Africa*, *27*(2), 159–176.

Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology*, *18*(3), 621–630.

Blaikie, P. (2006). Is small really beautiful? Community-based natural resource management in Malawi and Botswana. *World Development*, *34*(11), 1942–1957.

Breisinger, C., Thomas, M., & Thurlow, J. (2010). Social accounting matrices and multiplier analysis: An introduction with exercises. Retrieved from https://www.ifpri.org/publication/social-accounting-matrices-and-multiplier-analysis

Brown, D., Stephens, E., Ouma, J., Murithi, F., & Barrett, C. (2006). Livelihood strategies in the rural Kenyan highlands. *African Journal of Agricultural and Resource Economics*, *1*(1), 21–36.

Collomb, J.-G., Kanapaux, W., Mupeta, P., Barnes, G., Saqui, J., & Child, B. (2008). *Assessing the success of community-based natural resources management through the integration of governance, livelihood and conservation attitude indicators: Case studies from Caprivi, Namibia* (pp. 14–18). Paper presented at the International Association of the Study of the Commons, Caprivi, Namibia.

Cox, M., Wilson, M., & Pavlovich, T. (2016). The challenges of local governance: Gear-based fragmentation in Dominican fishing of Buen Hombre. *Marine Policy*, *63*, 109–117.

De Anguita, P. M., & Wagner, J. E. (2010). *Environmental social accounting matrices: Theory and applications*. New York, NY: Routledge.

Downing, J. A., & Plante, C. (1993). Production of fish populations in lakes. *Canadian Journal of Fisheries and Aquatic Sciences*, *50*(1), 110–120.

Dressler, W., Büscher, B., Schoon, M., Brockington, D., Hayes, T., Kull, C. A., ... Shrestha, K. (2010). From hope to crisis and back again? A critical history of the global CBNRM narrative. *Environmental Conservation*, *37*(1), 5–15.

Elliott, J., & Sumba, D. (2012). Conservation enterprise: What works, where and for whom? In D. Roe, J. Elliott, C. Sandbrook, & M. Walpole (Eds.), *Biodiversity conservation and poverty alleviation: Exploring the evidence for a link* (pp. 206–221). Chichester, England: John Wiley & Sons, Ltd.

Fabricius, C., Koch, E., Turner, H., & Sisitka, L. (2013). What we have learnt from a decade of experimentation. In K. Fabricius & T. Magome (Eds.), *Rights, resources & rural development—Community-based natural resource management in Southern Africa* (pp. 271–281). London, England: Earthscan.

Faße, A., Winter, E., & Grote, U. (2014). Bioenergy and rural development: The role of agroforestry in a Tanzanian village economy. *Ecological Economics*, *106*, 155–166.

Frost, P. G. H., & Bond, I. (2008). The CAMPFIRE programme in Zimbabwe: Payments for wildlife services. *Ecological Economics*, *65*(4), 776–787.

Gelan, A., Engida, E., Caria, A. S., & Karugia, J. (2012). Integrating livestock in the CAADP framework: Policy analysis using a dynamic computable general equilibrium model for Ethiopia. Retrieved from http://cgspace.cgiar.org/handle/10568/16936

Hay, C. J., Naesje, T. F., Kapirika, S., Koekemoer, J., Strand, R., Thorstad, E. B., & Harsaker, K. (2002). *Fish populations, gill net catches and gill net selectivity in the Zambezi and Chobe Rivers, Namibia, from 1997 to 2000* (Vol. 17). Retrieved from http://www.nina.no/archive/nina/PppBasePdf/nnProjectReport/017.pdf

Hoare, R. (2015). Lessons from 20 years of human–elephant conflict mitigation in Africa. *Human Dimensions of Wildlife*, *20*(4), 289–295.

Humavindu, M. N., & Stage, J. (2015). Community-based wildlife management failing to link conservation and financial viability. *Animal Conservation*, *18*(1), 4–13.

Jones, B., & Weaver, C. (2008). CBNRM in Namibia: Growth, trends, lessons and constraints. In H. Suich, B. Child, & A. Spenceley (Eds.), *Evolution and innovation in wildlife conservation: Parks and game ranches to transfrontier conservation areas* (pp. 224–242). London, England: Earthscan.

Kahler, J. S., & Gore, M. L. (2015). Local perceptions of risk associated with poaching of wildlife implicated in human-wildlife conflicts in Namibia. *Biological Conservation*, *189*, 49–58.

Kamwi, J. M. (2003). Woody resources report of Kwando Community Forest. Windhoek, Namibia: Ministry of Environment and Tourism, Directorate of Forestry.

Kanapaux, W., & Child, B. (2011). Livelihood activities in a Namibian wildlife conservancy: A case study of variation within a CBNRM programme. *ORYX*, *45*(3), 365–372.

Kirchner, C. H., & Stage, J. (2005). *An economic comparison of the commercial and recreational line fisheries in Namibia*. Windhoek, Namibia: Directorate of Environmental Affairs, Ministry of Environment and Tourism.

Laamanen, R., Otsub, M., & Tubalele, M. (2002). *Inventory report on the woody resources in the Salambala conservancy core area*. Windhoek, Namibia: Finland Forestry Programme.

Leisher, C., Temsah, G., Booker, F., Day, M., Samberg, L., Prosnitz, D., . . . Wilkie, D. (2016). Does the gender composition of forest and fishery management groups affect resource governance and conservation outcomes? *Environmental Evidence*, *5*, 6. doi:10.1186/s13750-016-0057-8

Lewins, R., Béné, C., Baba, M., Belal, E., Donda, S., Lamine, A., . . . Raji, A. (2014). African inland fisheries: Experiences with co-management and policies of decentralization. *Society & Natural Resources*, *27*(4), 405–420. doi:10.1080/08941920.2013.861564

Lewis, B. D., & Thorbecke, E. (1992). District-level economic linkages in Kenya: Evidence based on a small regional social accounting matrix. *World Development*, *20*(6), 881–897.

Mawere, M., Mabeza, C., & Shava, T. (2014). Traditional authority in community based natural resource management (CBNRM). *Fish Aquaculture Journal*, *5*, 93. doi:10.4172/ 2150-3508.1000093

Mendelsohn, J. (2006). Farming systems in Namibia. Retrieved from http://agris.fao.org/agris-search/search.do?recordID=US201300123895

Mendelsohn, J. (2010). *Atlas of Namibia: A portrait of the land and its people*. Cape Town, South Africa: Sunbird.

Metcalfe, S., & Kepe, T. (2008). 'Your elephant on our land' the struggle to manage wildlife mobility on Zambian communal land in the Kavango-Zambezi transfrontier conservation area. *Journal of Environment & Development*, *17*(2), 99–117.

Mooi, E., & Sarstedt, M. (2011). *A concise guide to market research—The process, data, and methods using IBM SPSS statistics*. Berlin, Germany: Springer-Verlag Berlin Heildelberg.

Mosimane, A. W., McCool, S., Brown, P., & Ingrebretson, J. (2014). Using mental models in the analysis of human–wildlife conflict from the perspective of a social-ecological system in Namibia. *Oryx*, *48*(1), 64–70.

Mosimane, A., & Silva, J. (2015). Local governance institutions, CBNRM, and benefit-sharing systems in Namibian conservancies. *Journal of Sustainable Development*, *8*(2), 99–112. doi:10.5539/jsd.v8n2p99

Muchapondwa, E., & Stage, J. (2013). The economic impacts of tourism in Botswana, Namibia and South Africa: Is poverty subsiding? *Natural Resources Forum*, *37*(2), 80–89.

Mulonga, S., & Murphy, C. A. (2003). *Spending the money: The experience of conservancy benefit distribution in Namibia up to mid-2003*. Windhoek, Namibia: Directorate of Environmental Affairs, Ministry of Environment and Tourism.

Naidoo, R., & Johnson, K. (2013). Community-based conservation reduces sexual risk factors for HIV among men. *Globalization and Health*, *9*, 27.

Naidoo, R., Weaver, L. C., Diggle, R. W., Matongo, G., Stuart-Hill, G., & Thouless, C. (2016). Complementary benefits of tourism and hunting to communal conservancies in Namibia. *Conservation Biology*, *30*(3), 628–638.

National Statistics Agency. (2012). Namibia Household Income & Expenditure Survey (NHIES) 2009/2010. Windhoek, Namibia: National Statistics Agency.

Ngwira, P., Kolawole, O., & Mbaiwa, J. (2013). Community based natural resource management, tourism and poverty alleviation in Southern Africa: What works and what doesn't work. *Chinese Business Review*, *12*(12), 789–806.

Nkhata, B., Breen, C., & Abacar, A. (2009). Social capital, community-based governance and resilience in an African artisanal river fishery. *Water SA*, *35*(1), 45–53.

Nunan, F. (2006). Empowerment and institutions: Managing fisheries in Uganda. *World Development*, *34*(7), 1316–1332.

Pailler, S., Naidoo, R., Burgess, N. D., Freeman, O. E., & Fisher, B. (2015). Impacts of community-based natural resource management on wealth, food security and child health in Tanzania. *PLoS One*, *10*(7), e0133252.

Pricope, N., Gaughan, A., All, J., Binford, M., & Rutina, L. (2015). Spatio-temporal analysis of vegetation dynamics in relation to shifting inundation and fire regimes: Disentangling environmental variability from land management decisions in a Southern African Transboundary Watershed. *Land*, *4*, 627–655. doi:10.3390/land4030627

Purvis, J. (2002). *Fish and livelihoods: Fisheries on the eastern floodplains, Caprivi* (DEA Research Discussion Paper 51). Windhoek, Namibia: Ministry of Environment and Tourism.

Riehl, B. (2014). Effects of community-based natural resource management on household welfare in Namibia. Retrieved from http://circle.ubc.ca/handle/2429/50015

Riehl, B., Zerriffi, H., & Naidoo, R. (2015). Effects of community-based natural resource management on household welfare in Namibia. *PLoS One*, *10*(5), e0125531. doi:10.1371/journal.pone.0125531

Roe, D., Nelson, F., & Sandbrook, C. (2009). *Community management of natural resources in Africa: Impacts, experiences and future directions*. London, England: IIED.

Roettgers, D. (2016). Conditional cooperation, context and why strong rules work—A Namibian common-pool resource experiment. *Ecological Economics*, *129*, 21–31.

Round, J. (2003). Social accounting matrices and SAM-based multiplier analysis. In F. Bourguignon & L. Pereira da Silva (Eds.), *The impact of economic policies on poverty and income distribution: Evaluation techniques and tools* (pp. 301–324). Washington, DC: World Bank.

Samuelsson, E., & Stage, J. (2007). The size and distribution of the economic impacts of Namibian hunting tourism. *South African Journal of Wildlife Research*, *37*(1), 41–52.

San Martin, O., & Holden, S. (2004, September 2–4). *Food and trees in the village–Economic development strategies based on food production and forest resources: A social accounting analysis*. Paper presented at Input-Output and General Equilibrium Modeling: Data, Modeling and Policy Analysis Conference, Brussels.

Scanlon, L. J., & Kull, C. A. (2009). Untangling the links between wildlife benefits and community-based conservation at Torra Conservancy, Namibia. *Development Southern Africa*, *26*(1), 75–93.

Shiferaw, B., Freeman, H. A., & Swinton, S. M. (2005). *Natural resources management in agriculture: Methods for assessing economic and environmental impacts*. Oxford, England: CABI.

Shiferaw, B., & Holden, S. (2000). A social and environmental accounting analysis: An extended village SAM for household-farms in Ethiopia. Retrieved from http://agris.fao.org/agris-search/search.do?recordID = NO2001000354

Silva, J. A., & Mosimane, A. W. (2012). Conservation-based rural development in Namibia: A mixed-methods assessment of economic benefits. *The Journal of Environment & Development*, *22*(1), 25–50. Retrieved from http://dx.doi.org/10.1177/1070496512469193

Sowman, M., & Wynberg, R. (2014). *Governance for justice and environmental sustainability: Lessons across natural resource sectors in sub-Saharan Africa*. New York, NY: Routledge.

Suich, H. (2010). The livelihood impacts of the Namibian community based natural resource management programme: A meta-synthesis. *Environmental Conservation*, *37*(01), 45–53.

Suich, H. (2013). Evaluating the household level outcomes of community based natural resource management: The Tchuma Tchato Project and Kwandu Conservancy. *Ecology and Society*, *18*(4), 25.

Sutton, A., & Rudd, M. (2014). Deciphering contextual influences on local leadership in community-based fisheries management. *Marine Policy*, *50*, 261–269.

Taylor, J. E., & Adelman, I. (1996). *Village economies: The design, estimation, and use of village wide economic models*. New York, NY: Cambridge University Press.

TEEB. (2012). *The economics of ecosystems and biodiversity in local and regional policy and management*. London, England: Routledge.

Turner, S. (2004, August 9–13). *A crisis in CBNRM? Affirming the commons in southern Africa*. Paper presented at the 10th IASCP Conference, Oaxaca, Mexico.

Turpie, J., Barnes, J., Lange, G. M., & Martin, R. (2010). *The economic value of Namibia's protected area system: A case for increased investment* (Report commissioned by the MET with funding from the UNDP/GEF supported strengthening the Protected Area Network [SPAN] Project). Windhoek, Namibia: MET.

Tweddle, D. (2012, March). Green light for first 'Fish Protected Area'. *Traveller Zambezi, 8*. Retrieved from http://www.zambezitraveller.com/caprivi-kavango/conservation/green-light-first-%E2%80%98fish-protection-areas%E2%80%99

Tweddle, D., Cowx, I. G., Peel, R. A., & Weyl, O. L. F. (2015). Challenges in fisheries management in the Zambezi, one of the great rivers of Africa. *Fisheries Management and Ecology*, *22*(1), 99–111.

United Nations. (2003). *Studies in methods: Handbook of national accounting. Integrated environmental and economic accounting 2003*. Luxembourg: Eurostat.

United Nations. (2009). *System of national accounts 2008*. New York, NY: United Nations Publications.

United Nations. (2014). *System of environmental-economic accounting 2012 central framework*. New York, NY: United Nations Publications.

UN, IMF, European Commission, OECD, & World Bank. (2003). *Handbook of national accounting: Integrated environmental and economic accounting* (Studies in Methods Series F, No.61). Retrieved from http://unstats.un.org/unsd/envaccounting/seea2003.pdf

UNSTAT. (2016). SEEA experimental ecosystem accounting. Retrieved from http://unstats.un.org/unsd/envaccounting/eea_project/default.asp

Van der Duim, V., Lamers, M., & van Wijk, J. (2015). *Institutional arrangements for conservation, development and tourism in eastern and southern Africa: A dynamic perspective*. Dordrecht, The Netherlands: Springer.

Van Wijk, J., van der Duim, V., Lamers, M., & Sumba, D. (2014). The emergence of institutional innovations in tourism. *Journal of Sustainable Tourism*, *23*(1), 104–125. doi:10.1080/09669582.2014.927878

WAVES. (2016). *Wealth accounting and the valuation of ecosystem services* (Annual Report). Retrieved from https://www.wavespartnership.org/sites/waves/files/kc/WAVES%20Annual%20Report%202016_6.6.16.pdf

Author Biographies

Huon Morton's research focuses on how communities manage their natural resources and the socioeconomic drivers and consequences of management decisions. He is currently a graduate research fellow and a PhD candidate at the University of Hannover.

Etti Winter is a senior researcher at the Institute for Environmental Economics and World Trade. She received her PhD from the University of Bonn, Institute for Food and Resource Economics. She has previously worked for the Centre for Development Research in Bonn (ZEF).

Ulrike Grote is professor at the School of Economics and Management and heads the Institute for Environmental Economics and World Trade and the Leibniz University of Hannover. Her research focuses on international agricultural trade and environmental and development economics. She is also an Senior Editor of the international journal *Food Security*.