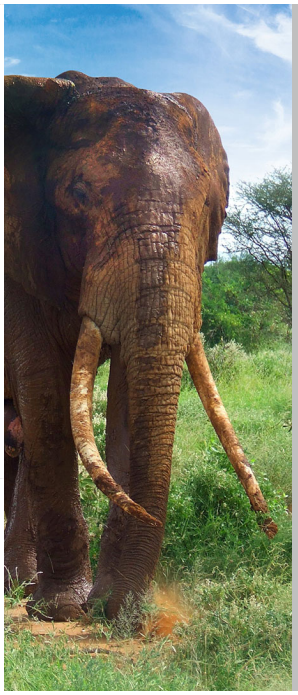

DELIBERATIVE ASSESSMENT AND MAPPING OF CULTURAL ECOSYSTEM SERVICES PROVISION IN TERRESTRIAL NATIONAL PARKS, KENYA

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ABSTRACT
The ecosystem services concept advocates for incorporation of Cultural Ecosystem Services (CES) into park management. However, challenges abound in the articulation of CES in policy ready measurements. The study aimed to trial a social deliberative GIS method to identify, map, quantify and analyse the distribution of CES in two Kenyan national parks. A sample of park staff was interviewed to identify non-material park benefits in five CES categories. Geospatial analysis was used to quantify and evaluate the benefits spatial distribution. Analysis of spatial associations between the CES found strong to moderate correlation between mapped benefits suggesting co-occurrence of the CES. The analysis revealed CES concentration around hydrological, geological and culturally significant features. These features had the highest benefits intensity and diversity indices while topographic and ecological park attributes diffused associated benefits. Except for two tourism use zones in Tsavo West, no significant difference between intensities of CES benefits was found between other zones in the parks. The study demonstrates the applicability of the deliberative method in assessing protected area CES values. Park managers can rely on the results of such a process to provide legitimate inputs into conservation decisions.

Key words: ecosystem services, cultural ecosystem services, deliberative geographic information system, terrestrial national parks

INTRODUCTION
Cultural Ecosystem Services (CES) are non-material benefits arising from relationships between society and the environment (Millennium Ecosystem Assessment (MEA), 2005). These benefits accrue through recreation and ecotourism, spiritual/religious values, artistic inspiration, heritage, cultural identity, educational values, social relations, knowledge systems, sense of place and landscape aesthetics values (Angarita-Baéz et al., 2017; Casado-Arzuaga et al., 2014; Peña et al., 2015). According to the MEA Report, ecosystems provide other services namely provisioning (e.g., non-timber products), regulating (e.g., carbon sequestration) and supporting services (e.g., pollination) (MEA, 2005).

The International Union for Conservation of Nature (IUCN) describes protected areas as the most effective way to ensure long-term conservation and sustainable provisioning of ecosystem services (Badman & Bomhad, 2008). Protected areas are important for large-scale conservation of species, habitats, cultural heritage, scenic landscapes and threatened biomes that provide opportunities for enjoyment, personal knowledge development and scientific research (Ribeiro & Ribeiro, 2016). Parks are also important for the more introspective benefits such as sense of place and spiritual values (Ribeiro & Ribeiro, 2016).

In the last decade, researchers have advocated for the mainstreaming of the Ecosystem Services (ES) concept into conservation with an eye on sustaining ES provision and their benefits to humanity (Egoh et al., 2012; Gould et al., 2019). This advocacy will continue because of the perceived relevance of the concept in new conservation paradigms. For instance, García-Llorente et al. (2018)

believe that the ES concept promotes a holistic conservation model that integrates social dimensions into hitherto scientific led conservation approaches. They argue that a conservation model hinged on ES can foster support for conservation and avoid park isolation by recognising socio-ecological processes that sustain benefit flows in and out of the parks.

Studies point to increasing recognition of CES as a powerful incentive for biodiversity conservation that provides a complementary view to the scientific perspective of natural resource management (Hernandez-Morcillo et al., 2013; Milcu et al., 2013). Milcu et al. (2013) suggest that conservation stands to gain from a philosophical alignment to the non-utilitarian perspectives inherent in the CES concept. Gould et al. (2019) support this view arguing that the CES concept offers an opportunity to consider both biophysical and social aspects of ecosystems in conservation. However, there is scholarly consensus that the intangibility, intuitiveness and non-market nature of a range of CES benefits, including religious, heritage and educational values, creates difficulties in their quantification and incorporation in conservation (Milcu et al., 2013; Pena et al., 2015). Exclusion of some CES benefits from research generates a fallacy that what is not quantifiable does not matter (Satz et al., 2013), yet society holds positive values for all CES benefits (Brown & Fagerholm, 2015).

Incorporation of the ES framework in biodiversity conservation is still at the embryonic stage and experience with it remains nascent (Ingram et al., 2012). Wangai et al. (2016) demonstrate this gap in a review of fifty-two African studies published between 2005 and 2014. The review reports that 62 per cent of ES research in Africa targeted wetlands and water catchments excluding biodiversity-rich terrestrial ecosystems. Moreover, the studies focused on easily quantifiable and market-ready ES like provisioning, leaving out CES (Wangai et al., 2016). Still, there are elements of resistance to the ES paradigm in conservation circles. García-Llorente et al. (2018) attribute this inertia to drawbacks in the operationalisation of benefits espoused in the concept and unresolved ideological conflicts between ecocentrism and anthropocentrism. There is scope to extend CES research to terrestrial protected areas, the bedrock of conservation, and refine techniques for identification, quantification and assessing a broad range of CES in order to generate research that can produce acceptable and policy-relevant results.

Quantification and mapping of CES are requirements for their inclusion in conservation strategies (Stegarescu & Partidario, 2014). There have been interdisciplinary research efforts to develop robust and acceptable metrics for CES quantification (Bieling & Plieninger, 2013). Egoh et al (2012) appraised ES indicators in sixty

Herd of Burchell's zebra (Equus quagga burchellii) in Tsavo East National Park © Mtana Safaris Limited, Kenya

-seven studies conducted between 1997 and 2011 and found that 48 per cent of the studies focused on quantifying CES. However, consistent with findings from other reviews (e.g., Hernandez-Morcillo et al., 2013), Egoh et al (2012) note that most CES indicators in the studies targeted tourism/recreation and aesthetic enjoyment. From experience in surveys using social and physical CES indicators, research is now moving to the spatialisation of CES. Crossman et al. (2013) note that this research trajectory is informed by the truism that the supply and demand of CES are spatially explicit. Geographical Information Systems (GIS) have contributed to CES mapping by automating capture, storage, analysis and communication of geospatial data. Researchers are experimenting with social assessment methods to elicit qualitative data on CES perceptions and leverage GIS capabilities to quantify and spatialise cultural services. For instance, Ribeiro and Ribeiro (2016) use participatory GIS (PGIS) procedures to map visitors', residents' and park managers' perceptions of CES provision in a Rio De Jeneiro urban park. In a similar study, Canedoli et al. (2017) map variations between citizens' and managers' perceptions of CES provision in a Milan peri-urban park. Both studies analysed the intensity and co-occurrence of CES in the parks. In a recent study, Tew et al. (2019) use data from an online survey and PGIS to generate density maps of CES in a forest plantation in the UK while Johnson et al. (2019) demonstrate the viability of crowd sourced data as input in the spatial analysis of CES in a New York park. In another example, Jones et al. (2019) use a free-listing PGIS exercise to obtain geo-referenced CES data for a Southampton Urban Park and create hotspot maps for ten CES in the park. It is noteworthy that most of the experimentation with social CES assessment methods has been in data-rich developed countries and feature urban recreational parks (Brown & Fagerholm, 2015). Notwithstanding national parks' significance as a source of CES, very limited studies have attempted to assess and map CES in these protected areas.

The study aimed to trial a social CES assessment technique to quantify and map distribution of CES benefits in terrestrial national parks. The research relies on a deliberative GIS protocol to elicit georeferenced data on park managers' perceptions of CES benefits in Tsavo East and West National Parks in Kenya. The research, adopting a case-based approach, contributes to refining techniques for identification, quantification and spatial analysis of CES by offering empirical evidence of the applicability of social assessment GIS mapping methods to assessment at the ecosystem level.

METHODS AND MATERIALS

Study area

Tsavo East National Park (TENP) and Tsavo West National Park (TWNP) measure 13,747 km² and 9,065 km² respectively. The two are part of the Tsavo Conservation Area (Figure 1), Kenya's largest continuous protected ecosystem (Akama & Kieti, 2003; Muteti et al., 2014).

The two parks are made up of a mosaic of habitats; Acacia-Commiphora woodland dominates the northern parts of TENP and TWNP. The woodlands are interspersed with strands of baobab trees (*Adansonia digitata*). Southern TENP is typified by shrubs of the yellow Gul Mohur (*Delonix elata*) and Melia (*Melia volkensii*), while open grassy plains characterise the southern parts of TWNP (Muteti et al., 2014). The parks contain diverse wildlife species notably the African Elephant (*Loxodonta africana*), an array of ungulates and a range of carnivores including Cheetah (*Acinonyx jubatus*), Leopard (*Panthera pardus*) and the African Lion (*Panthera leo*) (Okello et al., 2008). The parks are also important bird areas and host over 400 species including Palaearctic migrants.

Between 2014 and 2018, the two parks accounted for 7 per cent of tourists who visited Kenya's protected areas annually. In this period, an average of 110,153 tourists visited TENP while 52,702 visitors were recorded in TWNP annually (GoK, 2019).

A ten-year plan (2008–2018) guides conservation activities in the parks and prescribes ecological, tourism, community, operations and law enforcement programmes (KWS, 2009). The plan divides the parks into zones reflecting levels of visitor use. There are three user zones in TWNP, namely Kamboyo high use zone

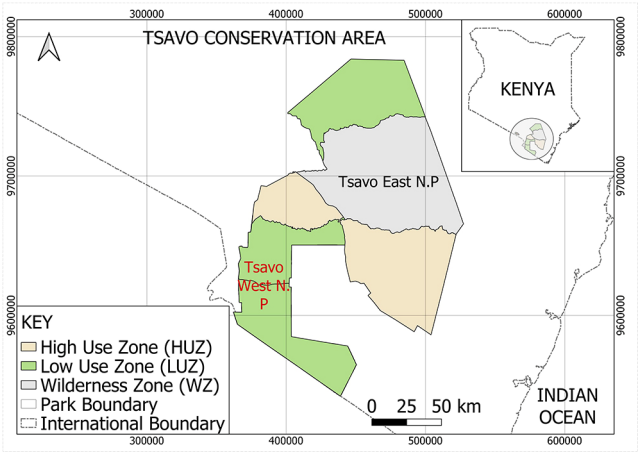

Figure 1. Tsavo West and Tsavo East National Parks

(HUZ), and Murka and Lake Jipe low use zones (LUZ), while in TENP three zones are designated, Voi HUZ, Emusaya wilderness zone (WZ) and Ithumba LUZ.

Data collection

The study collected data from the two parks selected from the country's network of national parks due to their importance for visitation and ecological relatedness (Cheung, 2012; Said et al., 2007). The study collected data on five CES benefit categories (Table 1) – ecotourism & recreation, landscape aesthetics, knowledge development & scientific research, religious & spiritual, historical & heritage between July and November 2019. Thirty indicators were used to operationalise the CES benefits.

Following Palomo et al. (2013), the study relied on deliberative mapping, a social assessment technique to elicit social values of wildlife protected areas from managers directly involved in operational activities in the parks. The study targeted three key informants from seven operational departments of the parks including administration, research, veterinary, security, community wildlife service, tourism and education. Twenty-one (n = 21) members of staff were purposively selected to participate in the survey. The study assumes that the respondents are sufficiently knowledgeable about their respective parks and could provide accurate data on CES benefits (see Brown et al., 2004; Klain & Chan, 2012; Palomo et al., 2013; Raymond et al., 2009). The study acknowledges that other stakeholders (e.g., tour operators and lodge managers) operating in the park could complement data obtained from park officials. However, the researchers excluded these stakeholder categories from the study as its focus was on trialing the deliberative CES mapping protocol in parks (see Klain & Chan, 2012).

Willcock et al. (2017) recommend site based supervised interviews for collecting data on intuitive constructs. Following this recommendation, social assessment and GIS techniques were adopted from similar studies to identify and map park CES benefits (e.g., Fagerholm & Käyhkö, 2009; Tew et al., 2019). The deliberative GIS

Table 1. Descriptions of CES benefits and indicators adopted in mapping CES benefits in the National Parks (Source: Adapted from Jones et al., 2019; Plieninger et al., 2013)

Cultural Ecosystem Services	Description	Indicators
Ecotourism and recreation	Park user well-being from participation in recreational and ecotourism activities in the park.	• Opportunities for recreation activities (campsite; sport fishing; bird watching; wildlife viewing/photography; walking; biking; boating; cave exploration and rock climbing). • Opportunities for ecotourism (mineral licks; watering pans; viewing hides; migratory routes; breeding grounds; known wildlife ranges/habitat; grazing areas; and species sanctuary).
Landscape aesthetic	User benefits from appreciation of park landscapes and features of notable aesthetic beauty.	• Opportunities for appreciation of features of natural beauty. • Opportunities for appreciation of landscapes of notable aesthetic appeal.
Knowledge development and scientific research	User benefits resulting from development of individuals' personal knowledge and research.	• Opportunities for scientific study (riverine forest; iconic species range; roosting grounds; wilderness area). • Opportunities for education (nature trail; bird walk; educational/visitor information centre).
Spiritual and religious benefits	User benefits resulting from visit to sites/feature of spiritual/religious and other forms of worship in the park.	• Shrines of spiritual importance (e.g. cave, hills, mountain, groves). • Opportunities for closeness to nature (e.g. picnic sites).
History and heritage benefits	User welfare from visit to sites/feature of particular relevance to human history and way of life.	• Historical/heritage sites. • Cultural features (e.g. hills).

mapping procedure employed individualised data collection due to the eclectic nature of the data sought. This approach allowed interviewers to supervise and interact with the respondents during the mapping process. The respondents completed a questionnaire that elicited data on their (i) knowledge and experience of the park, (ii) perceptions on the park's suitability for providing opportunities to experience CES benefits and (iii) basic demographics (see, Jones et al., 2019; Plieninger et al., 2013). On average, each respondent took 20 minutes to complete the questionnaire.

The mapping exercise commenced by orienting respondents to their respective park topographic maps. A1 Maps were used for TWNP (1:500,000) and TENP (1:650,000). The process required respondents to identify CES benefits using a list of indicators (Table 1) and map benefit sites by drawing polygons, lines and point geometries on the map to show areas, routes and point features respectively. Respondents used colour coded pencils and letter codes to distinguish different CES benefits drawn and could identify multiple sites for each benefit. On average, each interviewee spent 45 minutes mapping the benefits working separately but under the supervision of an interviewer.

Data analysis

The study summarised the respondents' demographic attributes and the frequency of sites identified using descriptive statistics. Subsequently, the analysis compared pairs of respondents' ratings of the parks' suitability to provide CES using Pearson's product moment correlation.

To prepare a geospatial database, maps on which respondents had marked CES benefit indicators were scanned and georeferenced in Arc1960 (EPSG: 4210) geographic coordinate reference system (CRS). Marked point features, routes and areas were digitised into point, line and polygon shapefiles respectively and re-projected to UTM Zone 37S (EPSG: 21037) for further geospatial analysis (Sutton et al., 2009). To simplify the geometries, the analysis computed polygon centroids and mean coordinates for line CES benefit layers. These were merged with point layers to produce CES benefits shapefiles.

Heatmaps of CES benefits were created using Kernel density estimation (KDE) from the aggregated benefits shapefiles. The resultant raster surfaces displayed CES benefits concentration classified using Jenks natural breaks (see Brown & Fagerholm, 2015; Jones et al., 2019; Tew et al., 2018). To quantity benefits distribution, the analysis calculated spatial intensity and diversity indices from counts of CES benefits in 25 km^2 grid cells (see Fagerholm et al., 2012; Plieninger et al., 2013). The cell size was ideal for capturing CES variations in rapidly changing physiographical conditions. Spatial intensity considered counts per unit area while the Shannon index (H*) was computed to study the diversity of aggregated CES benefit counts (See Angarita-Baez et al., 2017; Fagerholm et al., 2012). Subsequently, the study carried out Pearson's correlation analysis on counts of benefit categories in randomly sampled sites within the parks to examine spatial associations in the CES categories (Casado-Arzuaga et al., 2014). Magnitudes of estimated Pearson's correlation coefficients were interpreted as the co-occurrence between CES categories where ($r \geq .50$) indicated strong, ($r \geq .30$) showed moderate and ($r \leq .50$) indicated weak associations (Adams & Lawrence, 2015; Fagerholm et al., 2012). Finally, the study used one-way ANOVA to uncover spatial differences in benefits occurrences between park zones designated by level of tourism use. The research used QGIS 3.8 to carry out geospatial analysis, SPSS and Ms Excel for statistical analysis.

RESULTS

Respondents' demographic and psychographic profile

Twenty-one respondents representing 214 staff from operational departments in the parks (KWS, 2009) participated in the study. Of the respondents, 76.2 per cent were male, while 23.8 per cent were female. Interviewees above 45 years accounted for 38 per cent of the sample while 5 per cent were below 30 years. The respondents were well educated; 85.7 per cent of them had attained college diplomas while 29 per cent had post -graduate degrees. Most respondents were experienced, 61.9 per cent had worked in the parks for more than 15 years. This result corroborates their self-rating of park knowledge, which ranged from 4 to 5 on a 1–5 scale. On average, the respondents were moderately knowledgeable about their park's unique values (mean = 4.14, SD = 0.36).

The results of Pearson correlation analysis of pairs of respondents' ratings of respective parks' suitability for visitor experiences indicate a significant strong association between indicators of knowledge development and scientific research ($r = .55$; $p \leq .01$) and a moderately strong association between cultural significant species and tourism activities including wildlife viewing/photography ($r = .48$; $p \leq .05$). The results show a moderately strong association between closeness to nature and opportunities for knowledge development ($r = .37$; $p \leq .05$). As shown in Table 2, there were no significant associations between other benefits indicator pairs.

CES benefits identified in the parks

Consistent with previous research findings, the results indicate that opportunities for ecotourism and recreation were the most frequently identified benefits and accounted for 63 per cent of the identified 944 features, routes and areas conferring CES benefits in the two parks. Knowledge development and scientific research opportunities accounted for 18 per cent, opportunities for landscape aesthetic appreciation 13 per cent, sites for history & heritage appreciation 5 per cent, and spiritual & religious benefits accounted for less than 1 per cent. In TENP, locations for ecotourism & recreation experiences like campsites, wildlife watering pans, bird-watching and wildlife photography sites were the most commonly identified by count and number of respondents. On the other hand, breeding areas, walking routes, roosting grounds and bird walks associated with knowledge development and scientific research opportunities were the least common. In TWNP, respondents frequently cited ecotourism and recreation opportunities at watering pans, campsites and ideal sites for wildlife photography and commonly identified landscape scenic features and areas of notable aesthetic appeal.

Concentration of CES benefits in the parks

The results in Figure 2 show that CES benefits in TENP clustered in seven locations of very high and high concentration labelled A–G: opportunities for wildlife viewing and photography were located along the Galana River at Sobo and Lugard's Falls, Voi River in the Ndololo-Kanderi circuit, pipeline area, and at Aruba Dam. However, ecotourism and recreation benefits occurred widely in the Voi area because of numerous waterholes, saltlicks, grazing areas and migratory routes. The results indicate that Lugard's Falls on Galana River and Mudanda Rock were important for landscape aesthetic appreciation, spiritual & religious benefits, experiences of closeness with nature and heritage appreciation. A focal point for knowledge development benefits was at the Voi gate education/ visitor information centre. On the other hand, diffusion of scientific research opportunities in the southern sector was due to research potential in species ranges and riverine forests found in the area. The results reveal moderate concentration of opportunities for scientific research in the wilderness habitats characterising the northern sector of TENP.

Results presented in Figure 3 show that opportunities for appreciation of various CES benefits were ubiquitous in TWNP albeit to varying degrees. Notable locations with very high concentration of tourism benefits in the park were at Ngulia Rhino sanctuary, a Black Rhino intensive protection zone (IPZ) ideal for wildlife viewing, Kamboyo, Mzima Springs and Lake Jipe. The results show landscape appreciation benefits concentration at Mzima Springs, Kichwa Tembo and Shetani Lava Flows corresponding to notable natural features. On the other hand, Lake Jipe, rhino valley and

Table 2. Pearson correlation coefficients (r) of parks' suitability to provide Cultural Ecosystem Services ratings (*$P \leq .05$; **$P \leq .01$)

CES Benefits	1	2	3	4	5	6	7	8	9	10
1. Ecotourism	1									
2. Recreation	-.200	1								
3. Scenic appreciation	.032	.241	1							
4. Scientific research	.210	.201	.061	1						
5. Knowledge development	.202	.358	.338	.545**	1					
6. Spiritual/religious	-.073	-.018	.174	-.089	.280	1				
7. Closeness to nature	.045	.165	.032	.374*	-.005	-.073	1			
8. Human history	.186	.000	.243	.000	.101	.197	-.279	1		
9. Cultural species	.475*	-.030	-.072	.265	.090	-.140	.330	.282	1	
10. Cultural features	.151	.246	-.263	-.147	-.323	-.243	-.061	.069	-.076	1

Ngulia Hills diffuse opportunities for landscape aesthetics appreciation over a wide area. A concentration of CES benefits in Kamboyo area is due to opportunities for knowledge development and scientific research at the visitor education centre and it is a known wildlife habitat. Also identified was a focal point for spiritual & religious benefits around Shetani Lava Flows, while heritage & historical benefits were prominent at the Rhodesia War bridge on Tsavo River and at the Man-eaters cave, accounting for the moderate CES benefits concentrations in these areas.

Heatmaps were useful in showing the concentration of CES within parks (e.g., Jones et al., 2019; Tew et al., 2019). However, they could not generate quantitative measures of the distributions. The study computed alternative quantitative indices to study the aggregated distribution of CES benefits in the parks.

Intensity and diversity of CES benefits

The benefits intensity and diversity indices show that in TENP, Mudanda Rock, a 1.6 km inselberg ideal for wildlife viewing and heritage appreciation had the highest intensity of CES benefits (I = 0.44–0.78/km2) while Lugard's Falls and Sobo Rock on the Galana River were second with intensities between 0.24–0.44km2. These three sites had the highest diversity of benefits (H* = 0.48–0.58). Other notable locations with a high

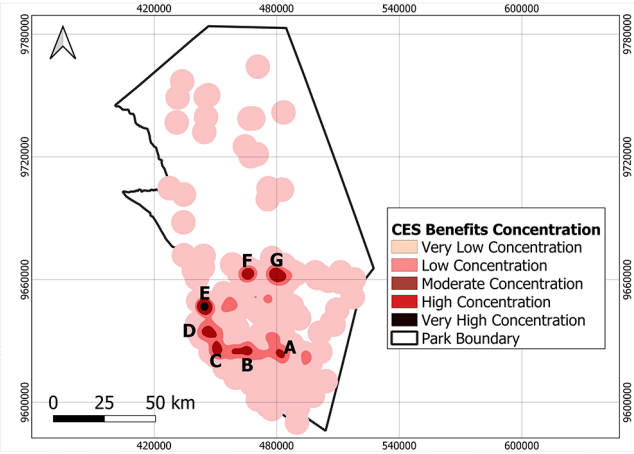

Figure 2. Concentration of Cultural Ecosystem Services in Tsavo East National Park.
*KEY: A = Aruba Dam; B = Kanderi-Ndololo; C = Voi Gate; D = Pipeline; E = Mudanda Rock, F=Lugard's Falls; G = Sobo Rock.

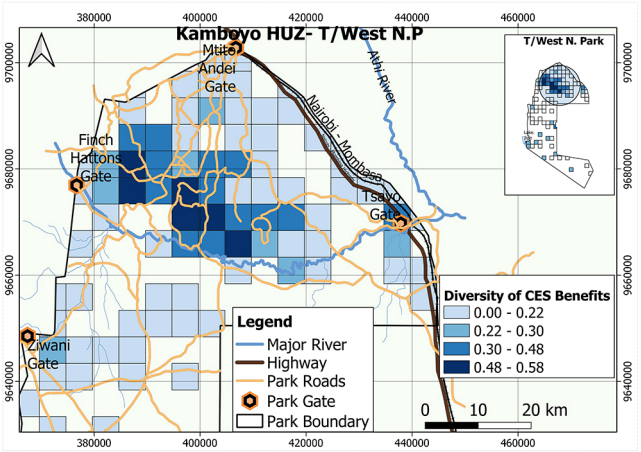

Figure 4. Diversity of Cultural Ecosystem Services Benefits in Tsavo West National Park.

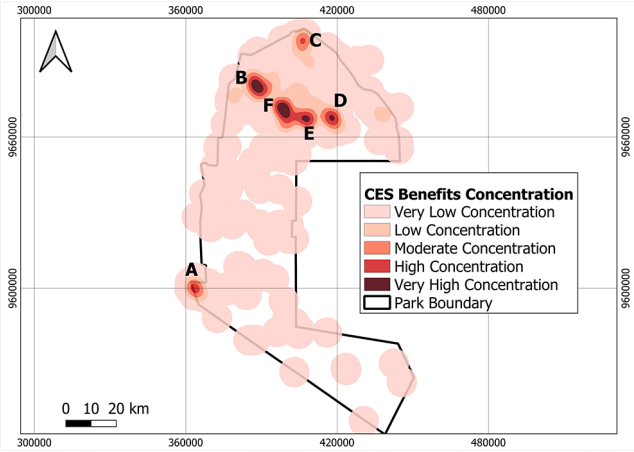

Figure 3. Concentration of Cultural Ecosystem Services benefits in Tsavo West National Park
*Key: A = Lake Jipe; B = Shetani Lava; C = Kamboyo; D = Ngulia Rhino Sanctuary; E = Kichwa Tembo, F= Mzima Springs

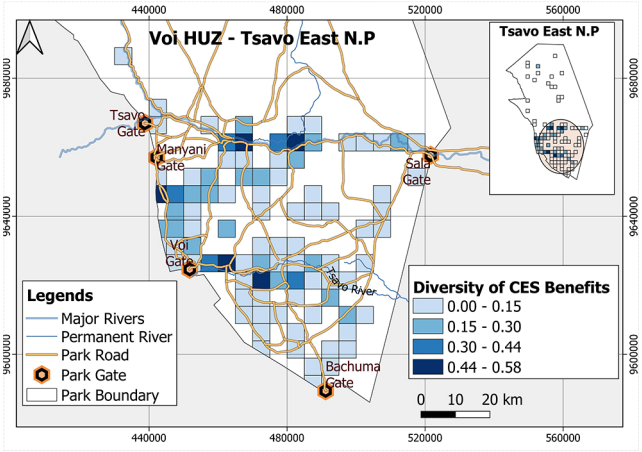

Figure Diversity of Cultural Ecosystem Services in Tsavo East National Park.

diversity of CES benefits were in the riparian vegetation along Voi River and the *Kanderi—Ndololo* wildlife viewing circuit. In TWNP, the results show that Ngulia sanctuary, Mzima springs, rhino valley and Lake Jipe had the highest CES benefits intensity (I = 0.44–0.72/km^2) and diversity (H^*= 0.48–0.58). Figures 4 and 5 show the diversity of CES distribution in TWNP and TENP respectively.

Results of Pearson's correlation analysis of CES benefits in randomly selected locations shows that in TWNP, opportunities for landscape aesthetic appreciation strongly correlate with sites for religious & spiritual benefits and with sites for recreation & ecotourism. The findings reveal a moderate positive association between religious & spiritual benefits and ecotourism & recreation opportunities and between landscape aesthetic appreciation and opportunities for knowledge development and scientific research in TWNP. In TENP, the results suggest a strong correlation between landscape aesthetics appreciation and history & heritage appreciation benefits opportunities as well as between opportunities for landscape aesthetics appreciation and places for spiritual & religious benefits. Evidence was found of strong correlation between sites for spiritual & religious benefits and historical & heritage sites in the park.

African Elephant (*Loxodonta africana*) in Tsavo West National Park © www.mtanasafaris.com

The study compared means of the intensities of CES benefits in the parks' tourism use zones. A one-way between samples analysis of variance (ANOVA) was conducted to compare means of the intensity of CES benefits from sites in Mzima HUZ (n = 71), Murka LUZ (n = 43) and Lake Jipe LUZ (n = 29) in TWNP. The results of the Welch test show that there was a significant difference between the intensities of CES benefits in the three zones; Mzima HUZ (mean = 0.16, SD = 0.16), Murka LUZ (mean = 0.09, SD = 0.11) and Lake Jipe LUZ (mean = 0.10, SD = 0.115). However, the Scheffe post-hoc analysis revealed a significant difference between CES benefits intensities in Mzima HUZ and Murka LUZ (p = 0.03), no statistically significant difference in CES benefit intensities between Mzima HUZ and Lake Jipe LUZ (p = 0.10) and between Murka and Lake Jipe LUZ (p = 0.10). In TENP, the ANOVA test returned no significant difference between the means of intensities of CES benefits in Voi HUZ (n = 89; mean = 0.13, SD = 0.13), Emusaya (WZ) (n = 29; mean = 0.10, SD = 0.121) and Ithumba HUZ (n = 8; mean = 0.05, SD = 0.02); ($F(2,123) = 1.8$, p = 0.14).

DISCUSSION

CES in the Tsavo Conservation Area

The study aimed to trial a deliberative GIS mapping technique for capturing stakeholders' perceptions of CES benefits, identifying and analysing the benefits' spatial distribution. The research focused on CES associated with park visitation excluding ex-situ intrinsic benefits such as artistic inspiration, sense of place and cultural identity. The results demonstrate in a case-based study the utility of social methods in assessing subjective non-material benefits in national parks.

The results of the respondents' rating of the parks' suitability to provide CES suggest that they were able to distinguish CES by their benefits, demonstrating the viability of a consideration of the social dimensions of ecosystems in park management plans as recommended in the literature (e.g., Garcia-Llorente et al., 2018). However, as in other jurisdictions, park management plans in the study areas do not explicitly consider the range of CES benefits.

The results affirm previous research findings in urban parks that ecotourism and recreation were readily recognised and the most frequently cited CES benefits (Canedoli et al., 2017; Muller et al., 2019; Raymond et al., 2009; Ribeiro & Ribeiro, 2016; Tew *et al.,* 2019). On the other hand, fewer respondents recognised and mapped the more introspective benefits like heritage and religious benefits. The results support the view that

park managers less readily appreciate the latter CES benefits. Consequently, they may underplay their importance to other park users.

Spatial distribution of CES

The spatial distribution of CES benefits in the two parks confirm the axiom that ES are not scattered randomly but occur in patterns that coincide with natural features, socially significant sites, hydrological features and ecological habitats (Fagerholm et al., 2012; Plieninger et al., 2013; Muller et al., 2019; Ribeiro & Ribeiro, 2016). In TWNP, prime areas for scenic appreciation correspond to geological features like Shetani Lava Flows, a 40-km2 expanse of solidified lava formed some 500 years ago; Mzima Springs which are fountains of crystal-clear waters teeming with aquatic fauna, and Kichwa Tembo. In TENP, focal points for ecotourism and recreation were around water features viz., Galana River, Voi River and Aruba Dam that attract large concentrations of wildlife species.

On the other hand, low CES endowments correspond to areas characterised by vegetation types not suitable for visitor activities including habitats dominated by dense Commiphora spp, Delonix spp and Melia sp in the northern sector of TENP (Ngene et al., 2011). In TWNP, low CES benefits density corresponds to habitats with low wildlife populations, sparse fodder, limited cover and water scarcity in the drylands of Murka LUZ. Ngene et al. (2011) report a high concentration of dry water pans and high incidences of livestock incursions in this area.

Examination of the CES benefits intensity and diversity indices confirmed clusters and co-occurrence of particular combinations of benefits. In TWNP, correlation results show co-occurrence of ecotourism & recreation, knowledge development & scientific research, landscape aesthetics, and religious & spiritual opportunities. These results are similar to the findings by Ribeiro and Ribeiro (2016) who observed very weak associations between cultural heritage and ecotourism & recreation, religious & spiritual benefits and knowledge development in an urban national park. In TENP, the results imply strong associations between scenic appreciation, spiritual, and heritage appreciation benefits that have a higher emotional dimension compared to ecotourism & recreation and knowledge development & scientific research that occur together. This observation suggests a distinction between abstract and relatively tangible CES as suggested by Ament et al. (2017).

Co-occurrence of benefits is attributable to indirect relationships between the benefits derived from underlying biophysical and social factors as suggested by Vallet et al. (2018). The results of this study support the notion that biodiversity and habitats like riparian vegetation, migratory routes, breeding grounds, grazing areas and species sanctuaries provide opportunities for ecotourism and serve as areas for scientific research. At the same time, natural features like rivers, hills, inselbergs and viewpoints are sites for recreation activities, spiritual reflection, and are vantage points for scenic appreciation. Because of their relevance to the host communities, such features are associated with historical/heritage and spiritual/religious benefits.

CES benefits and visitor use zones

The results show no difference between visitor use zones in TENP according to their CES benefit endowment. However, in TWNP, differences in the user zones are attributable to dissimilarities in one paired comparison out of the three possible comparisons. These findings confirm that the visitor zonation scheme used in the parks does not reflect user benefits derived from ecosystem services. The Protected Area Planning Framework (PAPF) used to guide conservation planning in the parks adopts a zonation scheme based on current visitor use patterns and ecological sensitivity to zone the parks (KWS, 2007).

CONCLUSION

Because of the study's design, it did not assess CES perspectives from all park stakeholder categories. However, the study demonstrates the practicability of the CES framework and the utility of deliberative GIS techniques in capturing diverse subjective values of protected areas in a manner that is amenable for use in conservation decisions. Experience from the case study should motivate future research to incorporate diverse stakeholders' perceptions of non-material values arising from their interactions with and local knowledge of the environment using the CES framework. At the same time, park managers have an opportunity to leverage social ES assessment techniques like the more inclusive PGIS to promote wider stakeholder engagement in protected area management, benefit from the social capital created in the inclusive process and create broader acceptability of conservation programmes.

The study confirmed that CES in protected areas were not scattered randomly but occur in high and low concentration areas that coincide with topographic, hydrological, socially significant features, and ecological habitats. The spatial variability of CES can support an alternative park zonation framework based on assessed park values instead of the often-used inorganic zonation schemes that rely on administrative regions and tourism

use levels. Such a zonation can support prescription of targeted park management initiatives based on explicit social values to augment conservation programmes informed purely by biophysical ecosystem condition indicators (e.g., ecological sensitivity).

The research found strong associations between CES benefit categories occurring jointly in particular locations. Park managers can exploit synergies that exist in the supply of recreation and tourism, personal knowledge development and scientific research, and scenic/aesthetic appreciation benefits to develop and package tourism experiences that offer diverse experiences and appeal to different market segments. Although the study's findings allude to an association between ecosystem characteristics and CES provision, the study did not establish specific one-on-one correspondences between CES and park features. There is scope for future research to clarify the links between ecosystem characteristics such as topographic or ecological features and CES supply. The outcomes of such an investigation can better inform park managers about the effects of marginal changes in ecosystem characteristics on their capacity to provide CES.

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RESUMEN

El concepto de servicios de los ecosistemas aboga por la incorporación de los servicios culturales de los ecosistemas (SCE) en la gestión de los parques. Sin embargo, abundan los obstáculos inherentes a la articulación de los SCE en las políticas. El estudio tenía por objeto poner a prueba un método SIG de deliberación social para identificar, mapear, cuantificar y analizar la distribución de los SCE en dos parques nacionales de Kenia. Se entrevistó a una muestra del personal del parque para identificar los beneficios no materiales del parque en cinco categorías de SCE. Se utilizó el análisis geoespacial para cuantificar y evaluar la distribución espacial de los beneficios. El análisis de las asociaciones espaciales entre los SCE halló una correlación de fuerte a moderada entre los beneficios mapeados que sugiere la coocurrencia de los SCE. El análisis reveló una concentración de SCE en torno a características hidrológicas, geológicas y culturales significativas. Estas características tenían los mayores índices de intensidad y diversidad de beneficios, en tanto que los atributos topográficos y ecológicos del parque dispersaban los beneficios asociados. Con excepción de dos zonas de uso turístico en Tsavo West, no se encontró diferencias significativas entre las intensidades de los beneficios de los SCE entre otras zonas de los parques. El estudio demuestra la aplicabilidad del método deliberativo en la evaluación de los valores de los SCE en las áreas protegidas. Los administradores de los parques pueden confiar en los resultados de dicho proceso para proporcionar aportes legítimos a las decisiones de conservación.

RÉSUMÉ

Le concept de services écosystémiques préconise l'incorporation des Services écosystémiques culturels (CES) dans la gestion des parcs. Toutefois, les défis abondent dans l'articulation des CES dans les mesures stratégiques. Notre étude visait à tester une méthode de SIG délibérative sociale pour identifier, cartographier, quantifier et analyser la distribution des CES dans deux parcs nationaux kenyans. Un échantillon de personnel a été interviewé afin d'identifier les avantages non-matériels de cinq catégories de CES. L'analyse géospatiale a été utilisée pour quantifier et évaluer la distribution spatiale des avantages. L'analyse des associations spatiales entre les CES a révélé une corrélation forte à modérée entre les avantages cartographiés, suggérant la cooccurrence des CES. L'analyse a révélé une concentration des CES autour des éléments hydrologiques, géologiques et culturellement significatifs des parcs. Ces éléments présentaient les indices d'intensité et de diversité d'avantages les plus élevés, tandis que les attributs topographiques et écologiques des parcs présentaient des avantages associés. A l'exception de deux zones d'utilisation touristique à Tsavo Ouest, aucune différence significative n'a été constatée entre les intensités des avantages des CES dans les autres zones des parcs. L'étude démontre l'applicabilité de la méthode délibérative à l'évaluation des valeurs CES dans les aires protégées. Les gestionnaires des parcs peuvent compter sur les résultats d'un tel processus pour fournir des contributions légitimes aux décisions de conservation.