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Cover image: Ngalawa (traditional dugout, outrigger canoe) being readied for a boat race in the 2018-2019 Kraken cup, Kilwa, Tanzania. © Rahim Saggaf

Valuation of harvested goods in Mida Creek with application of the TESSA approach

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Abstract

Mangroves are considered a highly productive blue forests resource providing services that are important to the community both locally and globally. In recent times there has been an increase in studies on valuation of ecosystem services provided by mangroves. However, there is need to provide a simplified approach to identify, assess and quantify ecosystem services. In this study the Toolkit for Ecosystem Services Site-based Assessment (TESSA) was used to assess the value of harvested goods provided by the mangroves of Mida Creek in the current state and under plausible alternative scenarios. Spatial methods (GIS) were used to collect data for the period 1985-2019, and household interviews were used to collect data on harvested goods. Descriptive statistics were used to summarize quantitative data. Results show that the estimated current annual value of harvested goods in Mida Creek is US$ 11.2 million. This value increased to US$ 14.3 million under the conservation scenario and reduced to US$ 10.9 million under the business as usual scenario (BAU). These findings add to the growing literature on ecosystem service valuation and the need to use site-specific non-modelling tools like TESSA.

Keywords: current scenario, ecosystem services, plausible alternative scenario, mangrove

Introduction

Mangroves are important coastal ecosystem providing numerous ecosystem services and critical ecological functions (Kauffman and Donato, 2012). These services include: provisioning services including wood products, medicine, honey and fish; regulating services such as climate regulation, coastal protection and air quality regulation (Millennium Ecosystem Assessment, 2005; Bosire *et al.*, 2008; Donato *et al.*, 2011); supporting services including primary production, nutrient cycling, and breeding and nursery grounds for marine and pelagic species (Millennium Ecosystem Assessment, 2005; UNEP, 2014); and cultural services such as recreation, spiritual enrichment and aesthetic features (TEEB, 2010; Anam and Thomas, 2017). The sustainable provision of these ecosystem services is essential for human wellbeing (Hooper *et al.*, 2012). However, approximately 60 % of the world's ecosystem services have been degraded or unsustainably used (Millennium Ecosystem Assessment, 2005).

Globally, mangrove cover has declined by 30 – 50 % over the past decades (Donato *et al.*, 2011) because of anthropogenic activities (Halpern *et al.*, 2008; Butchart *et al.*, 2010; Malik *et al.*, 2016). This degradation has led to loss of coastal protection services thus increasing coastal vulnerability to natural disasters (Alongi, 2002; Barbier *et al.*, 2008; Bosire *et al.*, 2008). With many competing uses of marine and coastal ecosystem and their services, there is need to formulate and implement policies that will inform effective management of natural resources in order to reduce the continued degradation of these important ecosystems (Owuor *et al.*, 2017).

Economic valuation of ecosystem services allows policy makers to appreciate the value of ecosystem services to society, and the cost of their imminent loss (Ruckelshaus *et al.*, 2013; Laurans *et al.*, 2013), enabling them to integrate ecosystem services into policy and decision-making processes (Fisher *et al.*, 2008; Fisher *et al.*, 2010). Valuation also contributes

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to sustainable use of natural resources which in turn leads to poverty alleviation and conservation of natural resources (Owuor *et al.,* 2017).

Although Mida Creek is globally recognized as an Important Bird Area (IBA) and is part of Watamu Marine Park and Reserve (Owuor *et al.*, 2017; Birdlife International, 2020), increasing human population and an increase in demand for natural resources has led to continued degradation and loss of the mangrove forest and associated ecosystem services (Alemayehu, 2016). Undervaluation of the benefits provided by mangrove forests has led to them being rarely considered when resource management decisions are made (Huxham *et al*., 2015). This hampers awareness creation and policy formulation processes aimed at protecting mangroves. Many studies fail to value ecosystem services that would be lost or gained under plausible alternative scenarios (Peh *et al.*, 2017).

This study was designed to assess the types, quantities and values of goods harvested from Mida Creek in the current state and how these values will change under plausible alternative states. This study adopted the TESSA toolkit because it emphasizes the importance of comparing estimates for alternative states of a site. This enables decision makers to assess the net consequences of such a change, and hence the benefits of human wellbeing that may be lost through the change, or gained through conservation (Peh *et al.,* 2017). For example, the study done by Muoria *et al*. (2015) in Yala swamp recommended that the land use and management policies and plan adopt a balance between development and conservation, to improve the socioeconomic wellbeing of the local residents while protecting biodiversity.

This study will provide decision makers and community members with data on how changes in mangrove cover would affect the provision of ecosystem services under current and future scenarios. It will also add to the growing literature on ecosystem services.

Materials and methods

Study area

Mida Creek is in Kilifi County on the Kenyan coast (Fig. 1). It lies at $3^{0}22^{I}0^{II}$S and $39^{0}58^{I}0^{II}$E. The Creek lies at an altitude of between 0-10 m above sea level. The total mangrove cover in Mida Creek is estimated at 1,746 ha and is dominated by *Rhizophora-Ceriops* type forest (Government of Kenya, 2017). Seven mangrove species have been identified including *Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal*, *Rhizophora mucronata, Sonneratia alba, Xylocarpus granatum* and *Lumnitzera racemosa* (Gang and Agatsiva, 1992; Kairo *et al*., 2002).

Mida Creek is an important passage and wintering area for Palearctic migrant waders. The populations of *Charadrius leschenaultii*, *Charadrius mongolus* and *Dromas ardeola* in Mida Creek are internationally important, and many other species use the site; up to 6 000 waders may be present in the Creek at any one time (BirdLife International, 2020). It is also an important spawning ground for many fish species, for example, *Spratelloides delicatulus* and *Ambassis natalensis*.

The mangrove forest ecosystem is surrounded by human settlements living in seven villages: Dabaso, Kirepwe, Uyombo, Sita, Gede, Matsangoni and Mida with approximately 4838 households (Kenya National Bureau of Statistics, 2010). The main economic activities of the people living around Mida Creek are fishing, crop farming, business activities and tourism-related ventures (Owuor *et al*., 2019). The major drivers of change include overexploitation of some mangrove species, overfishing, residential and commercial development, conservation action, climate change, lack of management plans and pollution (Alemayehu, 2016; Government of Kenya, 2017)

Methods

Land use land cover changes

To determine plausible alternative scenarios, mangrove cover changes were obtained from Landsat imagery to assess the changes in the land use characteristics of the study area for the years 1985, 2000, 2015 and 2019. The images were on the Landsat path 166 and row 062 and at a resolution of 30 m. The data was downloaded from the USGS (United States Geological Survey) Earth Explorer website and processed using remote sensing software (ArcMap 10.8).

Quantification of harvested goods

A detailed questionnaire was used to collect data for estimating amount of harvested goods. The number of households around Mida Creek was estimated from the 2009 Kenyan Population and Housing Census. The total number of people in Mida Creek in 2009 was estimated to be 30 300 occupying 4838 households. The number of people per household was estimated to be 6.26 persons with a growth rate of 2.9 % (Kenya National Bureau of Statistics, 2010). From these figures the total population currently living around Mida

Creek was estimated to be 40,327 persons. This translated to 6442 households. The sample size was then obtained by the formula:

$$n_o = \frac{Z^2pq}{e^2}$$

Where: n0 is the sample size; e is the margin of error; p is the estimated proportion of the population which has the attribute in question; q is 1 – p; and Z is the desired confidence level (Israel, 2013). The sample size was found to be 95 households at 95 % confidence level and a margin of error of 10 %. This number was then rounded off to 100 for easier computations. Heads of the families in the 100 households sampled were interviewed. The interviews were conducted in villages adjacent to Mida Creek including Uyombo, Dabaso, Dongo Kundu, Kirepwe Island and Mida.

Systematic sampling was used to select households. The main path, track or road in each village was used as sampling transects to standardize participant selection. The first household was then selected randomly, followed by selection of every fifth homestead along transects.

The data collected included the type and quantity of harvested goods, the unit of measurement, whether the product is harvested for domestic consumption, price of the commodity per unit, and production cost. Production cost comprised of annual costs of labour, tools, and marketing costs.

Data analysis

Supervised classification was conducted with the maximum likelihood algorithm (Otukei, 2010). High-resolution imagery from RapidEye was used to run the accuracy assessment for the recent years (2015 and 2019), while Google Earth imagery was used in the accuracy assessment of the years 1985 and 2000. For accuracy assessment, 100 random points were selected for the mangrove classified areas, while 25 sampling points were selected for the non-mangrove terrestrial areas (Miettinen, 2012). The random points were then used to verify the classified land cover in comparison to RapidEye and Google Earth.

The rate of change of mangrove cover was then quantitatively estimated based on procedures used by Peng *et al.* (2008) and the following formula:

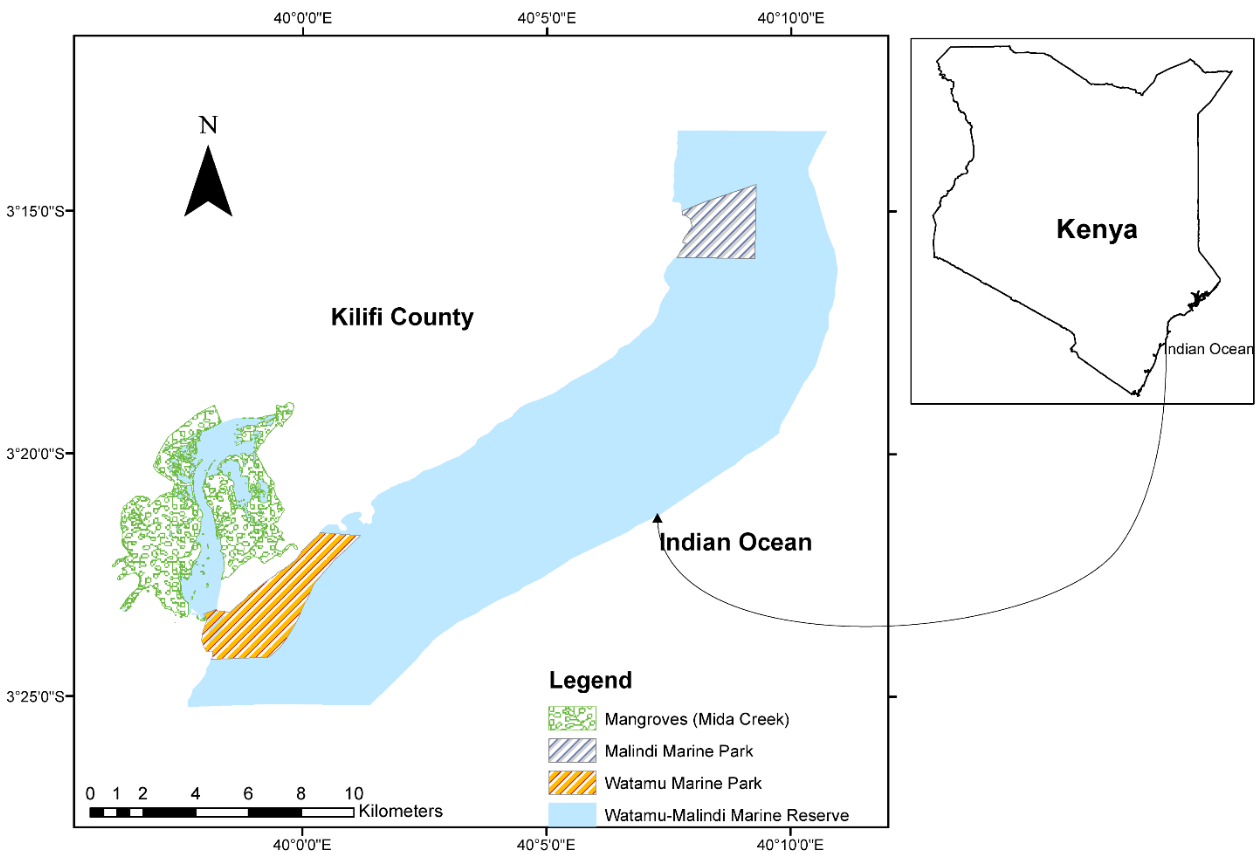

Figure 1. Location of the study area (Mida Creek) in Watamu – Malindi Reserve complex (from Owuor *et al.*, 2017).

$$K1 = \frac{Ub - Ua}{Ua} \times \frac{1}{T} \times 100\%$$

Where: K1 is land use dynamic degree; Ua and Ub are the areas of the target land use at the beginning and end of the study period respectively; and T is Study period.

From the land use dynamic degree, the rate of mangrove cover change over 15 years was estimated and the mangrove cover area under future scenarios was projected assuming that all factors remain constant. Data on harvested goods collected using questionnaires was summarized into percentages and means. Since the total number of households was estimated to be 6 442 and the sample size was 100 households, the total value of harvested goods was obtained by multiplying the values obtained from the 100 respondents by a figure of 64.42. The value of harvested goods that would be gained or lost was obtained from extrapolation of the future states based on the changes in the land cover of mangroves.

Results

Land use land cover changes

The land use changes for the 34-year period were quantified to show changes in land use and the area covered by the mangroves. Results as summarized in

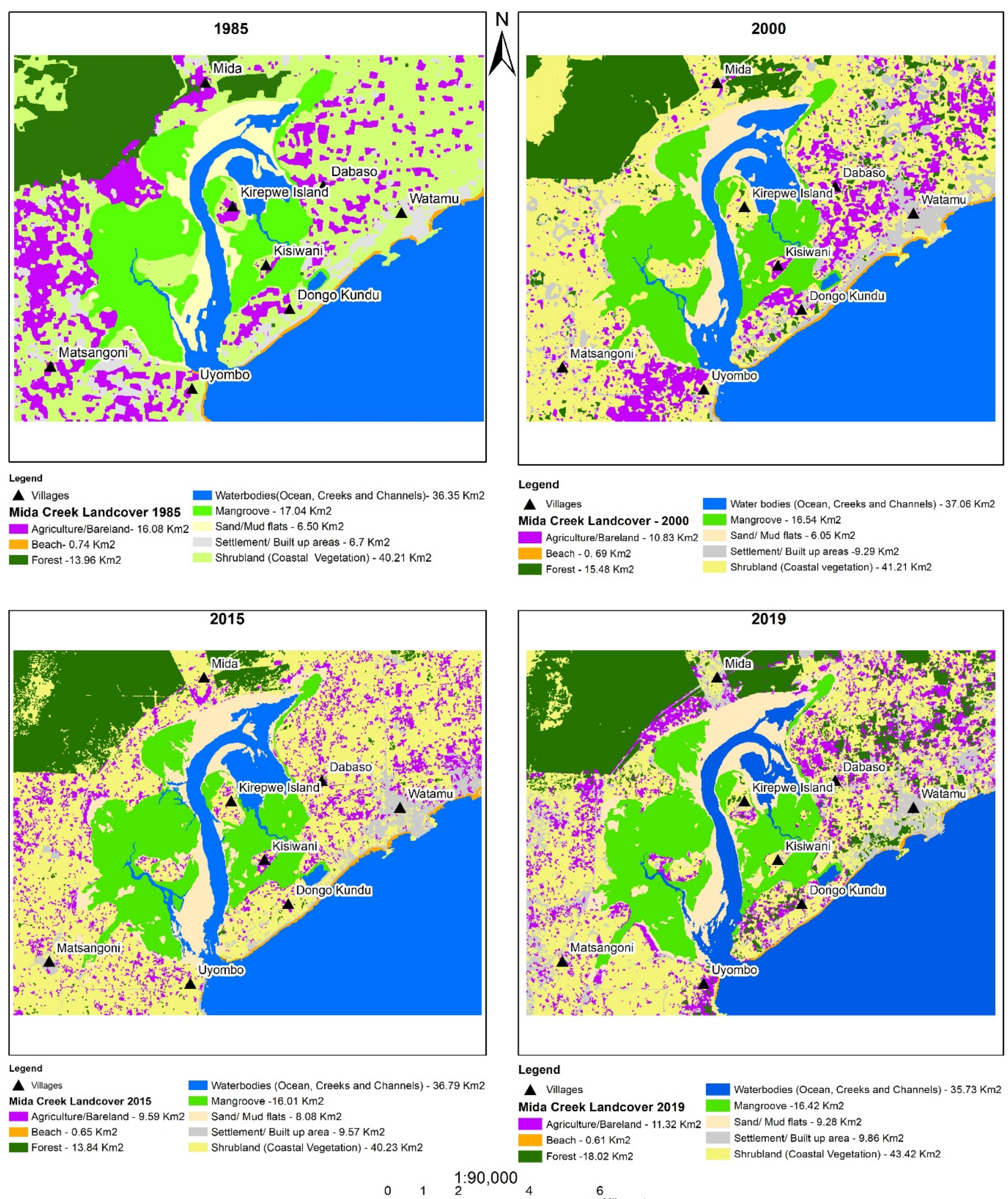

Figure 2. Maps showing mangrove cover changes for the years 1985, 2000, 2015 and 2019.

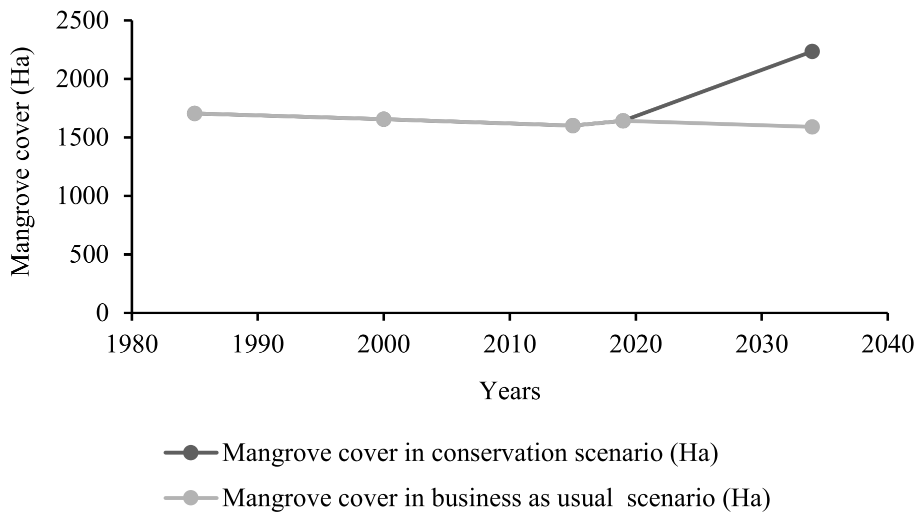

Figure 3. Mangrove cover in previous years and the projected cover in future scenarios.

Figure 2 show that the land cover for mangroves in the years 1985, 2000, 2015 and 2019 were estimated to be 1 704 ha, 1 654 ha, 1 601 ha and 1 642 ha, respectively. Based on these results, two possible future scenarios were assumed: the business as usual scenario (BAU) where the threats facing mangroves were not mitigated and mangrove cover continued to decrease; and a conservation scenario where conservation efforts are in place and mangrove cover increased.

The degree of change dynamic of mangrove cover between the periods of 1985 – 2000 was calculated to be -0.2 % while that of the periods between the years 2000 – 2015 was calculated to be -0.22 %. The average change dynamic for a period of 15 years (a period when the mangrove cover was found to be decreasing) was therefore estimated to be -0.21 %. It was then estimated that if the BAU scenario continues to take place and no measures are put in place to curb degradation, the mangrove cover area in 2034 would be 1 590.3 ha.

The degree of change dynamic between the periods of 2015-2019 was estimated to be 0.64 %. This was the period when mangrove cover was found to have increased. The degree of change dynamic in fifteen years was then calculated to be 2.4 %. This was with an assumption that all factors remained constant and the conservation efforts continued to take place. The mangrove cover area in Mida Creek in 2034 in the conservation scenario was then projected to be 2 233.2 ha. Figure 3 shows the mangrove cover in the previous years and the projected cover under the plausible alternative scenarios.

Harvested goods from mangrove forest in the current state

Demographic characteristics of the respondents of the household questionnaires

The age of the respondents ranged from 20 to 70 years with a mean age of 38.8 years (Standard Deviation [SD] = 12.0614 years). 60 % of the respondents were men while 40 % were women. Only 19 % of the respondents had no formal education. The percentage of the respondents who were members of various environmental groups within Mida Creek was 54 % while 46 % did not belong to any environmental group. The primary source of income for the respondents included fishing (32 %), business activities (29 %) and crop farming (25 %).

Types, quantities and values of harvested goods in Mida Creek in the current state

The respondents interviewed mainly harvested fish, honey, firewood and poles. Other goods like oysters, crabs and medicinal plants were harvested by very few respondents (1 %) and were excluded from further analysis. Fish was the most valuable good harvested from the Creek with an annual net value of US$ 4 892.12 / ha. It was found that most households harvested two or three goods from the mangroves.

Fish

Results as summarized in Table 1 show that 54 % of the households harvested fish with an assumption that the mangroves play a role in the fish caught from the Creek by providing breeding sites for the fish. The mean annual fish catch was estimated at 1 746.2 kg (SD = 934.23; range 155 kg to 4 320 kg) per

Table 1. Types, quantities and values of harvested goods in the current scenario (2019).

Attributes	Description				
Types of goods		**Fish**	**Honey**	**Firewood**	**Poles**
No. harvesting	N	54	25	35	24
Annual quantity harvested	Total	98615	4516	19296	7680
	Min	155	80	24.12	200
	Max	4320	432	1800	500
	Mean	1746.2	180.64	551.3	320
	SD	934.23	89.96	590.84	113.29
Unit price (US$)	Mean	2.31	9.09	1.03	0.97
	SD	0.19	0.924	0.43	0
Annual cost of production (US$)	Mean	1724.55	501.26	134.93	31.14
	SD	181.9	225.76	20.03	7.46
Annual gross value (US$)	Mean	4,033.72	1,642.00	565.7	310.62
	SD	1984.21	822.93	228.43	100.8
Annual net value (US$)	Mean	2,309.17	1,140.74	430.77	279.48
	SD	1,860.22	683.02	129.03	107.65
	Total	8,032,863.00	1,843,535.49	971,257.12	432,098.44
	per ha	4,892.12	1,122.74	591.51	263.15

1 United State Dollar (US $) =103.02 Kenya Shillings

respondent. The annual total amount of fish harvested by the respondents was found to be 98 615 kg out of which 20.5% was used for domestic consumption while the rest was sold. The mean market price of fish per kg as quoted by the respondents was estimated to be US$ 2.31 per kg (SD = 0.19; range US$ 1.94 to US$ 2.91 per kg). The difference in price might be due to the type of fish caught. The cost of harvesting included the annual cost of buying a canoe, fishing nets, labour, fishing lines and bait.

The cost of buying a canoe ranged from US$ 242.67 to US$ 582.41 and the canoe was expected to last for a period of at least three years. Hence the annual cost of buying a canoe was estimated to be US$ 137.52. The average annual cost of fishing nets was US$ 72.8 (range US$ 48.53 to US$ 97.07). If two people work in a canoe at a cost of US$ 5.82 per day and they are working on an average of 5 days in a week, the mean annual cost of labour per respondent was estimated to be US$ 1 514.23. The mean annual cost of harvesting fish per respondents was estimated to be US$ 1 724.55. The mean annual net value of fish was therefore estimated to be US $2 309.17 per respondent. The total net value for the 100 respondents was therefore estimated to be US$ 124 695.18 per annum. From the estimated total number of household (6 442) around Mida Creek and the land coverage of mangroves in 2019 (1 642 ha), the annual current net value of fish for the whole population was estimated to be US$ 8 032 863.00, or US$ 4 892.12 per hectare per year.

Honey

Twenty five percent of the households harvested honey as summarized in Table 1. The mean annual quantity of honey harvested per year was found to be 180.64 kg (SD = 89.96; range 80kg to 432 kg) per respondent. The total annual quantity harvested by the respondents was estimated to be 4 516 kg. Nine percent of the honey produced was domestically consumed while the remainder was sold.

The mean market price of honey per kg was estimated to be US$ 9.09 (SD = 0.924; range US$ 7.77 to 9.71) per kilogram. The cost of production included the annual cost of hives, the bee suit, and annual cost of labour, a smoker and a torch. The annual cost of equipment that lasted more than a year was obtained by dividing the buying price by the number of years the equipment was expected to last. The mean annual cost of harvesting honey was estimated to be US$ 501.26 (SD = 225.76; range US$ 184.11 to US$ 1 118.23).

The cost of production varied mainly due to the number of hives present per household; the minimum number of hives was 4 and maximum 12. This meant that the initial cost of buying the hives and the cost of maintaining each hive varied from one household to another based on the number of hives present in each household. The annual mean gross value of honey per respondent was estimated to be US$ 1 642 (range US$ 706.66 to US$ 4193.36) while the annual mean net value of honey was estimated to be US$ 1 140.74 (range US$ 452.90 to US. 3 293.5) per respondent. The total net value for 100 respondents was estimated to be US$ 28 617.44 per annum. The wide range of the value was mainly due to the number of hives per household which ranged from between 4 and 12, and the amount of honey harvested per hive which ranged from between 13 kg to 45 kg per hive per harvest.

This study also established that honey was harvested approximately 3 times year. The current net annual value of honey for the whole population was estimated to be US$ 1 843 535.49 or US$ 1 122.74 per hectare per year.

Firewood

Thirty five percent of the respondents harvested a total of 19 296 bundles of firewood annually with a mean annual quantity of 551.30 bundles (SD = 590.84; range 24.12 bundles to 1800 bundles) per respondent. Most of the firewood collected (71.41 %) was used for domestic consumption while the excess was sold. The annual cost of harvesting firewood per respondent was estimated to be US$ 134.93 which included annual cost of the tools used (axe and machete) and labour. The price of a bundle of firewood was estimated from the 28.59 % of the respondents who sold firewood and was found to be US$ 1.03 (SD = 0.43).

The annual gross value of firewood per respondent was therefore estimated to be US$ 565.70 while the annual net value of firewood per respondent was estimated to be US$ 430.77, or US$ 15 076.95 for 100 respondents. The current net value for the whole population was therefore estimated to be US$ 971 257.12 or US$ 591.51 per hectare per year.

Poles

Finally, Table 1 shows that 24 % of the respondents harvested poles. The poles were mainly harvested when there was need to construct a house. The mean annual quantity of poles harvested per respondent was estimated to be 320 pieces (SD = 113.29; range 200 to 500 pieces). The total number of pieces harvested by the respondents was estimated to be 7 680 with each piece estimated to be worth US$ 0.97. The annual mean gross value of poles was therefore estimated at US$ 310.62.

The mean annual cost of harvesting poles was estimated to be US$ 31.14 and it included annual labour paid and the cost of buying a machete. The mean annual net value of poles per respondent was estimated to be US$ 279.48 or US$ 6 707.52 for 100 respondents. Therefore, the annual net value of poles for the whole population was estimated to be US$ 432 098.44 or US$ 263.15 per hectare per year.

Table 2. Annual net value of harvested goods in 2019 and in future scenarios.

Attribute	Annual Net Value (US $)		
	Current (2019)	Business as Usual Scenario (2034)	Conservation Scenario (2034)
Fish	8,032,863	7,743,680	10,924,694
Honey	1,843,535	1,777,168	2,507,208
Firewood	971,257	1,006,222	621,605
Poles	432,098	447,654	276,543
Total	11,279,754	10,974,725	14,330,050

Value of harvested goods in the future alternative scenarios

From the projected mangrove cover in 2034, it was found that in the BAU scenario mangrove cover would decrease by 3.6 %, while in the conservation scenario the cover would increase by 36.0 %. The values of harvested goods in the future scenarios have been summarized in Table 2. In the BAU scenario, the value of fish and honey were projected to decrease to US$ 7.7 million and US$ 1.8 million respectively, while that of firewood and poles were projected to increase to US$ 1 million and US$ 447 654, respectively. The overall value of harvested goods in the BAU scenario was expected to decrease from US$ 11.3 million to US$ 11.0 million annually.

In the conservation scenario, the net value of fish and honey were expected to increase to US$ 10.9 million and US$ 2.5 million respectively, while that of firewood and poles were expected to decrease to US$ 621 605 and US$ 276 543, respectively. The overall net value of harvested goods was therefore projected to increase to US$ 14.3 million per annum in the conservation scenario.

Discussion

Change in mangrove cover

The spatial analysis found that the area coverage of mangroves decreased from the years 1985 to 2015 by about 103 ha and then increased from the year 2015 to 2019 by 41 ha. Mangrove coverage area reduced in the earlier years mainly due to conversion from one land use to another. Between the years 1969 to 2010 there was the emergence of urban centers, expansion of settlements, and increase in private holiday houses and hotels (Alemayehu, 2016).

Kirui *et al*. (2013) also found that the highest loss of mangroves in Kenya occurred between 1992 and 2000 during which mangroves in Kilifi County where Mida Creek is found experienced the highest loss of approximately 76 %. The lowest rate of loss was witnessed between 2000 to 2010 which coincided with the presidential ban on harvesting mangroves for domestic markets (Kirui *et al*., 2013). Various conservation groups (Government of Kenya, 2017) attribute the increase in mangrove cover between 2015 and 2019 to conservation efforts initiated on the Creek.

The slight variation in the results of the mangrove cover area in this study to those of other studies, for example, Alemayehu (2016), may be attributed to the tidal variation during the capture of satellite imagery. Findings of Xia *et al*. (2018) show that only high stands of mangroves will be captured by satellite imagery during high tides, while the low stands will be submerged.

Value of harvested goods in the current state and future scenarios

Locals harvest several products from the mangroves which are of great economic value. According to this study, fish was the most valuable good harvested from the Creek. Mukherjee *et al*. (2014) also established that fisheries were the highest ranked in terms of provisional services. Consultation with the local fishermen indicated that fishing is carried out both in the Creek and the open sea.

The annual net value of fish was found to be US$ 8 million (US$ 4 892 per hectare per year). This value is within the range of the value of fish in similar ecosystems. A review on the role of mangroves in fisheries enhancement by Hutchison *et al.* (2014) found that the mean value of fish in similar wetland to this study was US$ 3 114.8 per hectare per year. The slight difference in the value might be due to time differences between the periods of study. In addition, the cost of production varied from one fisherman to another due to the types of fishing vessels used.

The respondents who used canoes and nets for fishing had a higher cost of production and a larger catch as compared to those who used fishing lines and bait, and realized more proceeds from fishing. The value of fishing was expected to increase in the conservation scenario due to increased area for breeding and feeding for fish, while the value was expected to decrease in the BAU scenario due to the continued destruction of the breeding and feeding grounds of the fish. Assuming that all factors remain constant, it was projected that the value of fish will increase by the same percentage (36 %) that the mangrove cover would increase in the conservation scenario, and decrease by the same percentage (3.6 %) that the mangrove cover would decrease in the BAU scenario.

Honey was the second most valuable harvested good at US$ 1.8 million (US$ 1 123 ha per year). This value is higher than that reported by UNEP (2011) in Gazi Bay, Kenya, which recorded a value of US$ 14.7 ha per year.

The quantity of honey harvested by each respondent depended on the number of hives an individual owns. There is a potential increase in the value of honey in the conservation scenario since there would be controlled cutting of mangroves and increased breeding and feeding grounds for the bees. Since beekeeping is considered a conservation-friendly activity and requires minimum labour and financial inputs (Field *et al*., 2018), the locals should be encouraged to engage in apiculture. Where beekeeping is practiced, the forest ecosystem will be conserved as the beekeepers will discourage cutting down of mangroves for timber and poles. People will also be afraid of frequenting areas close to the hives for fear of being stung. The beekeepers should therefore be supported financially and technologically to fully exploit the potential of beekeeping in forest conservation to contribute to sustainability. The value of honey was expected to increase in the conservation scenario but decrease in the BAU scenario.

Harvesting of firewood and building poles is expected to increase in the BAU scenario as the human population around the Creek increases. However, this increase is temporary as the land cover of mangroves continues to decline. The value of firewood was higher than that of poles because the frequency of harvesting the firewood was greater than that of poles which were only harvested when there was a need to construct a house.

The number of respondents harvesting firewood was also higher than those harvesting poles. The total value of both firewood and poles was estimated to be US$ 855 ha per year which is within the range reported by Spalding *et al*. (2010) for global timber and wood fuel of US$ 10 - 1093 ha per year. The value of poles and firewood obtained in this study might not be very accurate since some respondents were not willing to give details on wood harvesting for fear of being arrested owing to the ban on harvesting of mangroves by the Kenyan government. The value of both poles and firewood in the conservation scenario is expected to decrease as there would be controlled cutting of mangroves.

The total overall value of harvested goods was expected to increase in the conservation scenario since the mangrove cover is expected to increase, and reduce in the BAU scenario as the mangrove cover was expected to decrease. Muoria *et al*. (2015) projected a decline in the amount of harvested goods from Yala swamp if development continued, as opposed to a scenario where there was a balance between development and conservation. Additionally, Field *et al*. (2018) reported an increase in the value of goods in a scenario where conservation and development coexist as opposed to a scenario where commercial development was allowed.

Conclusions

The value of harvested goods was projected to decline from US$ 11.3 million to US$11.0 million annually in the BAU scenario due to a decrease in mangrove cover, while conservation efforts in the conservation scenario would lead to an increase in the value of harvested goods to US$ 14.3 per annum by the year 2034. This shows that Mida Creek has a high realized and potential monetary value, emphasizing the need for an effective resource management plan to ensure sustainability.

There is also a need to develop a Land Use Plan for Mida Creek accompanied by a Strategic Environmental Assessment to ensure that all ecosystem services provided by the creek are adequately recognized and protected.

It is recommended that a detailed assessment on the value of other ecosystem services such as carbon sequestration and tourism in the current and future states be carried out on Mida Creek to establish the full value of the Creek under future scenarios.

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