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Community perceptions of the status and threats facing mangroves of Mida Creek, Kenya: Implications for community based management

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ABSTRACT

The management of forest ecosystems globally is shifting from a top-down-approach, through centralised management by the state, to a more inclusive bottom-up approach involving community participation. Increasingly, there is a realisation that sustainable management of natural resources is dependent on the inclusion of local people or institutions through actions such as Community Based Natural Resource Management (CBNRM). However, successful implementation of CBNRM depends on understanding the perception that local communities have of an ecosystem's resources. In this context, the present study examines the perceptions of local people on the status and threats facing the mangrove ecosystem of Mida Creek in Kenya. After consultation with these people, a closed ended questionnaire has been produced, investigating the perception of the local community on the degradation status of mangroves, as well as on the main threats affecting the mangroves. Furthermore, the study analysed the influence of the respondents' social characteristics on the choices they make about the degradation status and threats affecting the mangroves. Results show that 12% of the respondents consider the mangroves to be 'degraded' while 40% consider mangroves to be 'somewhat degraded'. The perceived drivers of mangrove degradation were human-induced activities such as firewood harvesting, pollution from plastics and faeces, pollution from oil spills, overharvesting for building materials and encroachment for settlements. Age, the size of the household and the location of the respondent were some of the variables that also affected the respondent's perceptions. Since problem identification is an important first step for tracing the causal chain behind resource degradation, the outcomes of this study are important for designing policies that could ameliorate problems. It also highlights the importance of involving the community in the initial stages of developing management policies, since they hold views that are necessary for policy change and improvement.

1. Introduction

Mangrove forests dominate the intertidal zone of sheltered coastlines in tropical, sub-tropical and warm temperate oceans (Weber et al., 2016). These forests provide a wide range of ecosystem services (ES) both at regional and local scales. These include provisioning services e.g. wood, fuel, and construction materials (Agardy et al., 2005; Walters et al., 2008); cultural services e.g. aesthetics and traditional shrines (MEA, 2005; TEEB, 2010); supporting and regulation services e.g. coastal protection from tsunamis (Alongi, 2008; Dahdouh-Guebas et al., 2005; Das and Vincent, 2009), as well as mitigation of climate change effects through carbon sequestration (Pascal, 2014). Mangroves also host a unique fauna, which is a critical component of coastal biodiversity (Cannicci et al., 2009).

Recently, governments and other agencies responsible for the governance of natural resources have encouraged the inclusion of local communities in the management of these resources by embracing Community Based Natural Resource Management (CBNRM) (Wily, 2002). This approach to managing common pool resources was proposed by Ostrom (1990), who showed that local communities could successfully manage natural resources through collective action. An important aspect of resource management by local communities is their interdependence and close link to the natural resources, and their commitment to conservation (Trakolis, 2001) to ensure the continued provision of ecosystem services for their livelihoods (Amin et al., 2015). In order to encourage this commitment by local communities, it is important to understand their perceptions and attitudes towards their natural resources (Allendorf et al., 2014; Meijaard et al., 2013). Berkes

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and Turner (2006) emphasize this point by stating that "Conservation is a response to peoples' perception about the state of their environment and its resources".

Despite increasing interest in participatory resource governance, few studies have assessed how levels of threats and acceptance of mitigation measures are perceived by resource users (Allendorf et al., 2014; Meijaard et al., 2013; Trakolis, 2001). Peoples' perspectives will determine the willingness of resource users to comply with management regulations for governing natural resources (Vodouhê et al., 2010) such as water, fisheries and forests (Badola et al., 2012; Coulibaly-Lingani et al., 2011; McClanahan and Maina, 2005). Thus, measuring perceptions should indicate the extent to which management practices for resources are likely to be supported by community members (Coulibaly-Lingani et al., 2011).

Studies have explored community perceptions of forest ownership and management (Badola et al., 2012; Roy, 2014). In the case of Kenya, Rönnbäck et al. (2007) and Dahdouh-Guebas et al. (2000) have studied the perception of mangroves by local communities, although there is only limited information of their perception of the threats to this ecosystem. This study of the Mida Creek mangroves in Kenya examines the perceptions of the degradation status and the threats facing the mangroves, as well as the influence of the respondents' social characteristics on these perceptions. The mangroves continue to degrade at unprecedented rates, despite the government's attempt to enhance community participation in forest management and conservation (Bosire et al., 2014). This further emphasizes the need to understand the perceptions of communities adjacent to forest who are dependent on the mangrove's resources.

2. Overview of mangrove management in Kenya

Mangroves in Kenya are found in tidal estuaries, creeks and protected bays (Kairo and Dahdouh-guebas, 2004). The management of the coastal resources and environment in Kenya is highly sectoral and is governed by different legislation, focusing on different issues (Kairo and Dahdouh-guebas, 2004). Thus, the management of mangrove forests in Kenya is governed by both the Forestry Act and the Wildlife Conservation and Management Act, which are under the auspices of different state bodies. Where mangroves occur within Marine Protected Areas (MPAs), the responsibility of managing these forests is attributed to the Kenya Forestry Service (KFS), either singly, or in partnership with the Kenya Wildlife Service (KWS). Before 2005, the level of community participation in mangrove forest management in Kenya was very low (Kairo and Dahdouh-guebas, 2004; Lang'at and Kairo, 2008), as the management was carried out with a top-down approach. However, in 2005, the Forest Act (Act No. 3: Government of Kenya, 2005) made provisions for communities to be involved in forest management. Although the Forest Act has since been replaced by the Forest Conservation and Management Act (Act No. 34: Government of Kenya, 2016), this more recent Act continues to encourage participatory forest management, where all communities involved in forest management must form Community Forest Associations (CFAs) that can include individuals, self-help groups, women's groups and community-based organisations (CBOs). Upon registration, the associations are granted permission to conserve and manage forest resources. The associations are charged with obligations specified in Section 49, Sub-Section 1 of the Forest Conservation and Management Act, 2016. A few of them are listed below:

(a) Protect, conserve and manage the forest or part of the forest in accordance with an approved management agreement with the KFS and with the provision of a management plan for the forest;
(b) Protect sacred groves and protected trees;
(c) Assist the KFS or any other relevant authority in enforcing the provisions of the Forest Conservation and Management Act, including reporting events -related to illegal harvesting of forest products;
(d) Inform the KFS of any developments, changes and occurrence within the forest that are critical for the conservation of biodiversity.

3. Methodology

3.1. Study area

The study was carried out in Mida Creek (3° 22′ S 39° 58′ E), which is located 88 km north of Mombasa and 25 km south of Malindi (Fig. 1). The Creek is part of the Watamu - Malindi Biosphere Reserve and is under the jurisdiction of Kilifi County (http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=all&code=KEN+03). The Creek covers an area of approximately 31.6 km^2 (Kairo et al., 2002) where mangroves are the dominant ecosystem occupying an area of 1746 ha (Kairo et al., 2002). It supports 8 of the 9 mangrove tree species present on the Kenyan Coast, which are *Rhizophora mucronata*, *Ceriops tagal*, *Avicennia marina*, *Heritiera littoralis*, *Lumnitzera racemosa*, *Sonneratia alba*, *Xylocarpus granatum* and *Bruguiera gymnorrhiza* (Kairo, 2001). Mangroves are one of the primary sources of livelihood for the local community living around and within Mida Creek, providing them with timber poles, honey and seafood (Owuor et al., 2017).

Human density along the Kenyan coast is higher than in other parts of the country (Government of Kenya, 2009), with more than 57% of coastal residents classified as 'very poor', living on less than the international poverty line of 1.9 US $/day (Ferreira et al., 2015). As Mida Creek is part of Kilifi County, which is considered one of the poorest counties according to the Government of Kenya (2009), it is evident that many of the residents of the Creek can also be categorised as 'very poor'. The Giriama people are the ethnic origins for most of these residents.

3.2. Sampling design

This research is part of a larger study which involved: mapping the flow of ecosystem services through the Mida Creek (Owuor et al., 2017), an assessment of the perception of this mangrove ecosystem by the local community (this study), and an assessment of the willingness to pay for ecosystem services by this local community (Owuor et al.,manuscript submitted for publication).

With regard to the perception of the community, primary data was collected from community households living around and within Mida Creek in the two administrative locations of Gede and Matsangoni. The villages sampled included: Gede, Sita, Dabaso, Majaoni, Kirepwe, Sudi Island, and Uyombo (from North to South in Fig. 1). Fieldwork was conducted from June to July 2016 with the help of eight field assistants who were residents from the local villages.

Issues of the greatest concern to the community were established by a three stage engagement with the community. Based on this engagement, closed-ended questions were developed with the help of key informants, such as community and group leaders for community-based organisations, who had a detailed understanding of the study area. Information was also gathered from published and unpublished literature on mangrove studies along the coast of Kenya. The questionnaire for this present study was divided into three sections (see supplementary material for details), and the information from each section was analysed separately. **Section 1** focused on information and knowledge about the state of mangroves in Mida Creek. The respondents were asked about how they perceived the state of mangroves in Mida Creek in terms of degradation, using a Likert scale ranging from 'heavily degraded' to 'excellent state' (Table 1). **Section 2** focused on a list of threats facing the mangroves in Mida Creek identified both from existing literature (Abuodha and Kairo, 2001; Bosire et al., 2014; Government of Kenya, 2009) and from a focus group discussion held in the study area before the main study. From the list of threats, the

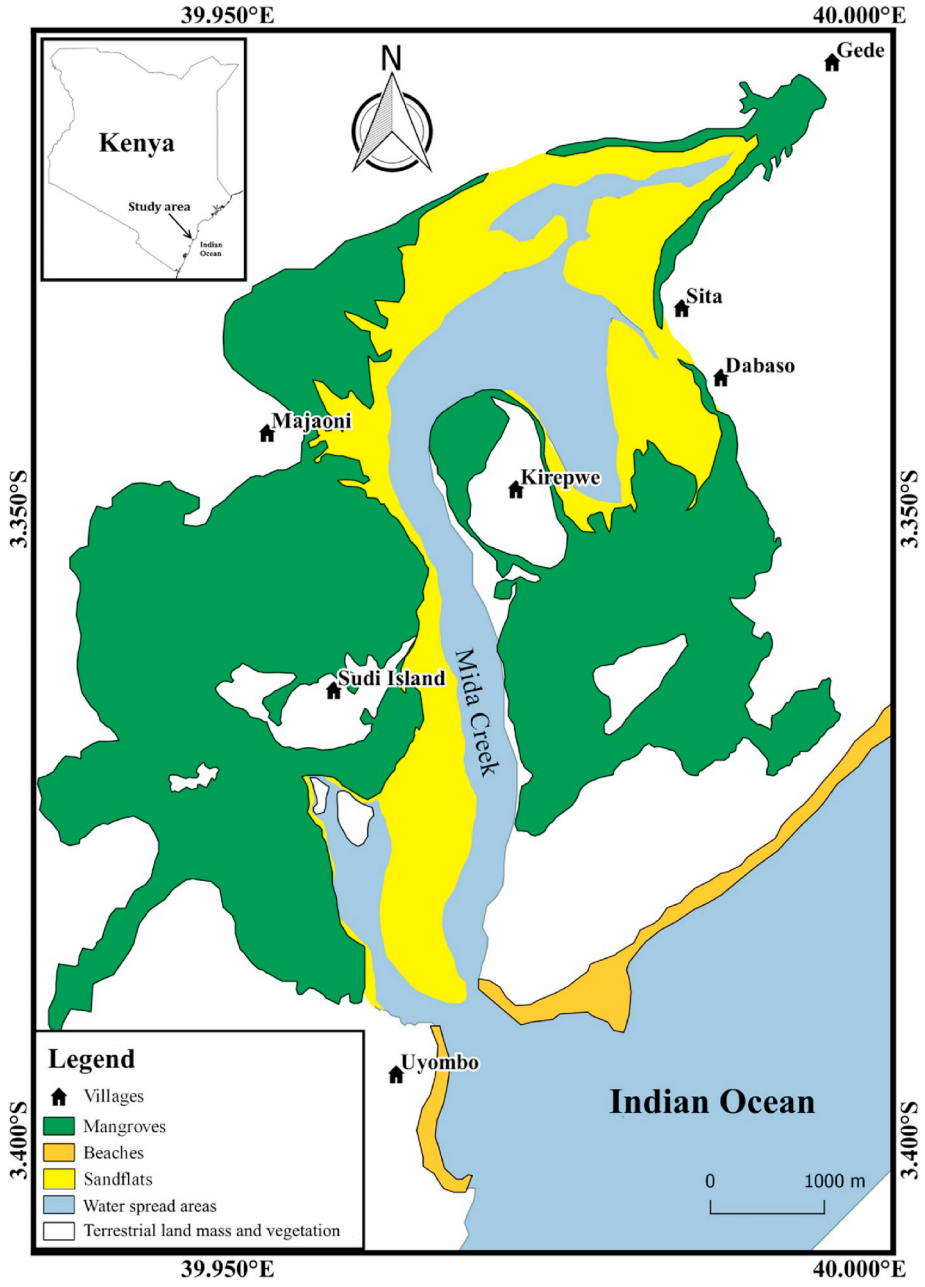

Fig. 1. Map of Mida Creek showing the villages within or next to the forest that were sampled (adapted from Kairo et al., 2002).

respondents were asked what they perceived as the most important threats by choosing one of the options 'Yes', 'No', or, if not aware, 'Not sure' (Table 1). These questions were based on the assumption that people who live adjacent to resources are usually aware of the potential threats facing the resource (Frank et al., 2017). **Section 3** collated information on the socio-economic characteristics of the households from which respondents provided answers to the questionnaires (Table 1).

A simple random sampling technique was used to select the households from which individuals were selected for the interviews (Louviere et al., 2000). The first household visit was to introduce the survey team, and to identify the household head. In cases where the household head was absent, adults above 18 years were selected. The project objectives and reasons for the visit were explained to the selected person in their local dialect 'Kigiriama'. The selected individuals were invited to specific locations within the village to answer the questionnaires, i.e. a school compound or locations where local *chiefs* hold meetings known as *barazas.* A total of 274 households took part in the questionnaire survey that was administered communally to individuals at the specific locations within the villages of Mida Creek. Table 1 provides a summary of the key questions submitted to the Mida Creek communities.

3.3. Data analysis

The data from the responses to the questionnaire were processed initially with the statistical package SPSS version 20, and then exported to STATA version 11 for further analysis. Measures of central tendency (mean) and dispersion (range) were computed to summarize the data on perception of the status of mangrove ecosystem in terms of degradation (**Section 1**), on perception of the threats to the mangrove forest (**Section 2**) and on socio-economic characteristics (**Section 3**) that had continuous variables such as age, distance to/from mangroves,

Table 1
Summary of the questions presented to the respondents.

Questions	Answers
Section 1 related to perception of degradation	
Think about the status of mangroves in Mida Creek. Which box do you think best describes the condition of the forest in terms of degradation? (Please tick one box)	a) Heavily degraded b) Somewhat degraded c) Good state d) Excellent state
Section 2 related to the threats to mangroves	
Do you consider the following to be the major threats to the mangrove ecosystem of Mida Creek? Choose only one	a) Yes b) No c) Not sure
1. Overharvesting for firewood	
2. Overharvesting for building materials	
3. Encroachment for settlement	
4. Plastic and faecal pollution[a]	
5. Oil spills from motorised ocean transport[a]	
Section 3 related to the socio-economic characteristics of each household	
Age (years)	18–70 years old
Gender	Male/Female
Educational level	No formal education/ Primary/Secondary/ Certificate/Diploma/ University degree/Post-graduate degree
How many people live in your household, including yourself? Please count the number of adults separately from the children.	Adults/Children (below 18 years)
Do you belong to any environment conservation groups?	Yes/No
What is your main source of income? Tick only one	Fishing/Crop farming/ Business/Salary[b]/Wages[c]
How far do you live from the mangroves? (km)	

[a] **Pollution** refers to contamination from oil spills and, also, separately to plastic and faeces.

[b] **Salary** refers to payment given monthly to an individual and is not based on working hours.

[c] **Wages** is payment given to an individual calculated based on pay rate per hour, mostly given to casual labourers. Taken from: Kenya Revenue Authority (Kenya Revenue Authority; Income Tax Department, 2005) and http://www.accountingtools.com.

and household size. Qualitative variables were described through tabulations and comparisons of the relative frequency of occurrence presented as proportions (percentages) of the total sum for the categories.

To assess the influence that demographic and socio-economic variables had on the perceptions of the respondents, the concepts were formulated as variables with ordinal and nominal values, as most of the data were qualitative. Ordinal logistic regression (Torres-Ryan, 2012) was used to assess those factors that influenced perception of degradation status of the mangrove. The question on perception of the status of mangrove had four options, these were ordered in a Likert scale from "heavily degraded" to "excellent state" for ease of analysis. Multinomial logistic regression (Park, 2003) was used to analyse data on factors that determined the respondents' perception of the state of mangroves and the threats facing this ecosystem. All seven socio-economic characteristics of the respondents were tested for significance at 90%, 95% and 99% levels, and only those that had 0.05 or less significance are reported in this study.

4. Results

4.1. Socio-economic profile of respondents

Responses to the questionnaires on the demographic and socio-economic profile of the respondents are summarised in Table 2. The age of the respondents ranged from 18 to 70 years with a mean age of 36.5 years. The value of the mean suggests that most of the respondents were youthful[1] (Standard Deviation [SD] = 12.33). The average adult population per household was 4 (Standard Deviation [SD] = 2.6), while the mean number of children was 8 (Standard Deviation [SD] = 3.6), signifying the existence of generally large household sizes with a significant number of dependants. Over half of the respondents were men (57%), while only 18.8% had no formal education. Concerning the membership of environmental groups, 143 respondents were members (55%), while 119 had no membership (45%). The primary sources of income for the people in this area included business activities (29%), fishing (27%) and crop farming (24%).

Table 2
Socio-economic profile of the respondents (n = 262).

Attributes	Description	Number	Percent (%)	Mean	Min (Max)
Age	18–70			36.5	18 (70)
Gender	Male	151	57%		
	Female	111	43%		
Household members	Adults			4	1 (16)
	Children-below 18 yrs			8	0 (23)
Education (highest level)	No formal education	49	18.8%		
	Primary	145	55%		
	Secondary	54	20%		
	Certificate	4	2%		
	Diploma	7	3%		
	Degree	2	0.8%		
	Post graduate	1	0.4%		
Membership of environmental group	Yes	143	55%		
	No	119	45%		
Distance from mangrove to residence	Distance in km			0.7 km	0.3 (7.0)
Main source of income	Business	76	29%		
	Fishing	71	27%		
	Crop farming	63	24%		
	Salary	24	9%		
	Wages	18	7%		
	Pastoralism	10	4%		

4.2. Perception of the community members on the status of mangrove degradation

The results on the status of the mangrove forest showed that 12%, 40%, 29%, and 19% of the respondents perceived that the mangroves were 'heavily degraded', 'somewhat degraded', in a 'good state' and in an 'excellent state', respectively (Fig. 2).

Seven socio-economic variables were tested for their influence on the perception of the level of mangrove degradation. Results showed that only three of the seven independent variables had p values less than 0.05 at 95% confidence level (Table 3). From the negative coefficient linked to the log likelihood coefficients, it can be concluded that the older respondents were more likely to consider the forest to be degraded. Given the negative coefficient, it follows that respondents who were non-members of environmental groups were more likely to consider the mangroves to be degraded than those who were members. Similarly, respondents with more years of education were more likely to consider the mangroves to be degraded.

The predicted probabilities were calculated to determine the magnitude by which the perception of the status of mangrove degradation

[1] The Constitution of Kenya, 2010 defines "youth" to mean all individuals in the Republic who have attained the age of eighteen years; but have not attained the age of thirty-five years.

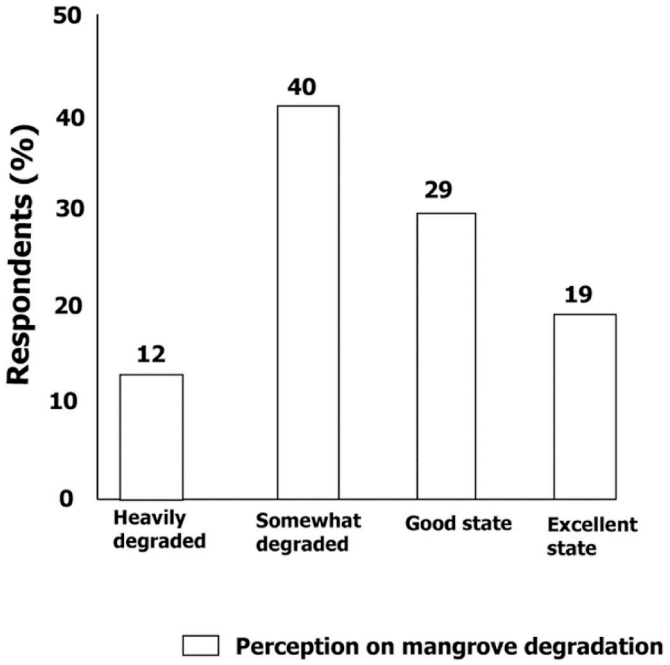

Fig. 2. Percentage response on the state of mangrove degradation (n = 262).

was influenced by the socio-economic attributes of the respondents. The probability that a respondent of average age (36.5) considered the mangroves to be 'heavily degraded' or 'somewhat degraded' was 11% and 40%, respectively (Table 4). The probabilities that members of an environmental group considered the forest to be degraded compared to respondents who were not members of an environmental group was 44% and 59%, respectively. This implied that respondents who did not belong to an environmental group considered the mangroves to be more degraded compared to their colleagues who did belong to an environmental group.

4.3. Perception of the community members on the threats to mangroves

The results of the factors that were considered by the respondents as the main threats facing the mangroves of Mida Creek are presented in the subsections below. Respondents were asked to state whether they considered each of the factors to be a threat, not a threat, or not sure.

4.3.1. Perception of overharvesting for firewood as a threat to the mangroves

Out of the 262 respondents who answered the question on overharvesting for firewood as a threat to mangroves, 78% agreed that it is a threat to the mangroves,18% did not consider it as a threat while 4% were not sure.

A number of socio-economic variables were tested for their influence on the respondents' perception of firewood harvesting as a threat to the mangrove ecosystem using the multinomial logit model. The presence of children in a household and the level of education were the only demographic characteristics that were statistically significant. Respondents with more children were less likely to consider overharvesting of firewood as a threat to the mangroves of Mida Creek (Table 5). In contrast, respondents with more years of education were more likely to consider overharvesting of firewood as a threat to the mangroves.

Table 3
Results from an ordered logit on the perception of the degradation status of mangroves.

Variable	Coefficient	Standard error	p-value	Odds ratio
Age	−0.0280	0.010	0.005	0.972
Membership of environmental group[a]				
No	−0.6071	0.235	0.010	0.544
Education in Years	−0.0634	0.028	0.024	0.939
Cut 1	−3.888	0.558		
Cut 2	−1.731	0.507		
Cut 3	−0.296	0.501		
Number of observations	260			
Log Likelihood	−329.431			
LR chi-square (3)	15.13			
Prob > chi-square	0.0017			
Pseudo-R^2	0.0225			

[a] It is important to note that for this analysis, 'Yes' was used as the reference for membership of the environmental group.

4.3.2. Perception of plastic and faecal pollution as a threat to mangroves

Plastics and faecal matter were also identified as pollutants that are a threat to the mangroves. 262 respondents filled in the questionnaires, out of which, 78% of the respondents considered plastic and faecal pollution as a threat, 13%, did not consider it a threat, and 9% of the respondents were not sure.

For plastic and faecal pollution, location was the only statistically significant predictor of perception. Relative to the sub location of Dabaso that has a market centre and several hotels, respondents from Matsangoni and Mida-Majaoni sub-locations (Table 6) considered that plastic and faecal pollution was not a threat to the mangroves.

4.3.3. Perception of oil spills from motorised ocean transport as a pollution threat to mangroves

In the case of oil spills from motorised ocean transport, 75% of the 262 respondents who completed this question, considered oil spills from motorised ocean transport as a threat,12% did not while 13% were not sure.

Based on the multinomial analysis, location of the respondents was found to affect their perceptions about oil spills. Results show that respondents from the Uyombo sub location considered oil spills as a significant threat compared to those from other sub locations of Mida-Majaoni, Matsangoni, and Dabaso (Table 7).

5. Discussion

5.1. Factors affecting decisions taken by respondents

The questionnaires on the perception of the state and of the threats facing the mangroves of Mida Creek have provided data that can contribute to CBNRM. However, effective use of the data requires a deeper understanding of the factors influencing the decisions taken by the respondents. With respect to the state of mangrove degradation, responders can be affected by both experiential and transformative knowledge (Armitage et al., 2008). In the case of experiential knowledge, responders over 30 years old are more likely to consider the mangroves to be degraded, as they have witnessed more changes in the mangroves over the years than the younger responders. In terms of transformative knowledge, many of the community members living around Mida Creek have been involved in the several conservation projects taking place in the area, which might change their perception of mangrove condition. Through these projects, community members attend capacity building courses, mangrove rehabilitation programmes and in most instances, they have been told the reasons for these actions i.e. that, "mangroves are degrading, therefore, there is a need for replanting". Certainly Infield and Namara (2001) have shown from their study in Lake Mburo National Park, Uganda, that when the majority of the respondents are from focus areas where conservation projects have been undertaken, the projects influence the respondents' thinking about natural resources.

An analysis of the threats selected by the respondents, shows that most of the threats relate to the livelihoods of the respondents. People

Table 4
Results from an ordered logit on the perception of the degradation status of mangroves in percentages.

Variable		Predicted outcomes at means in percentages			
		Heavily degraded	Somewhat degraded	Good state	Excellent state
Age		11	40	30	19
Education	In years	11	41	30	18
Membership of environmental group	Yes	8	36	33	23
	No	14	45	27	14

will most probably notice a decline in a specific resource based on the importance that they place on this resource (Vodouhê et al., 2010). Thus, overharvesting of mangroves around the Creek is considered a threat as the community uses mangrove as firewood for cooking and as poles for construction (Dahdouh-Guebas et al., 2000; Kairo et al., 2002).

In the case of pollution, the perception of the threat depends on the location of the responder. Thus Dabaso, close to Watamu town, is associated with many hotels and resorts offering employment opportunities (Fig. 1). The high number of job seekers has given rise to informal settlements with poor waste management facilities. Thus, the community has identified plastic bags and faecal matter as the main source of pollution, resulting from the use of mangroves as “make shift washrooms” by some community members (Warui, 2011). However, another source of pollution identified by the community is oil spills from motorized ocean transport resulting from the use of boats for local transport, fishing and tourist excursions. For example, local people travel from Kirepwe Island to mainland Dabaso (Fig. 1), where they can access amenities like schools and hospitals, while tourists have sight-seeing tours around the Creek and hire boats to visit Sudi Island for canoeing and picnics.

5.2. Socio-economic influences on decisions taken by respondents

The perception of threats to the mangroves is also affected by socio-economic influences. Response indicated that the presence of children in a household is one variable that affects people's perception about overharvesting for firewood. The households with children did not perceive that harvesting of mangroves for firewood was a threat to the system, a fact that could be related to their dependence on mangroves as a source of fuel. Therefore, by declaring that this was a threat, this group of respondents might fear the implementation of measures denying them access to the services associated with the mangroves.

Another example is the difference in responses between people who are members of environmental groups from those who are not. The respondents who belong to environmental groups tended to view mangroves as not degraded, possibly, because they obtain many benefits from the community conservation projects; these groups receive funding from the projects as well as from the subsequent legacy of the projects. Thus, the boardwalk funded by initiatives such as the Kenya Coastal Development Programme (KCDP) enables conservation groups to carry out ecotourism activities. In many cases revenue collected from these activities is used to pay school fees for the members' children. Infield and Namara (2001) found that community members who benefit from conservation programmes are more likely to recognize positive aspects of the natural system being conserved. However, the kind of perception voiced by the respondents who are not members of environmental groups corroborates the findings of Allendorf et al. (2006) who conclude that long time ethnic inhabitants of a habitat (e.g the Giriama in Mida Creek) may not support conservation activities, possibly, due to lack of awareness about the environment and lack of participation in conservation programmes.

5.3. Implications for management

Although the findings of this study are specific for Mida Creek and other regions within Kenya, the study has relevance to other geographical regions. Many resource management problems, such as degradation, are complex problems that require approaches suitable for dealing with complex socio-ecological systems like mangroves and their use (Defries and Nagendra, 2017). The scientific evidence provided by the present study applies to both decision makers and resource managers and is summarized below.

5.3.1. Many inhabitants are aware that they are degrading their natural resources

The results of our study show that many people of Mida Creek understand that the resource they depend on is degrading. According to Berkes and Turner (2006), this is the basis for conservation; i.e. it is only through knowing that a resource is depletable that individuals or communities can devise and employ conservation efforts. If people realise that their resource is degrading, then they are likely to join local conservation initiatives. This insight can be used by the mangrove managers to strengthen conservation and rehabilitation activities. However, there may be a problem with law enforcement, as the mangroves continue to degrade despite a licensing protocol that is supposed to prevent overexploitation. There is a need to check on the limitations of the governance system. For example, whether officials are awarding licenses illegally.

5.3.2. Transformative knowledge increases awareness

Many households in Mida Creek are part of environmental groups, showing that the inhabitants of Mida Creek are concerned about their environment. Through their membership, they have been able to learn

Table 5
Results from a multinomial logit on the perception of overharvesting for firewood as a threat to mangroves.

Variables	Considered a threat (Yes)		Not considered a threat (No)		
	Coef.(*p*-value)	Odds ratio (RRR)	Coef.(*p*-value)	Odds ratio(RRR)	
Household children	−0.101 (0.237)	0.910	−0.199 (0.049)	0.820	
Education in years	0.178 (0.019)	1.195	0.188 (0.023)		1.207
Constant	2.588 (0.000)		1.476 (0.063)		

Log likelihood at 95% (−153.1939).
Log Ratio (LR) chi-square (4) = 10.96; Prob > chi-square = 0.0270; Pseudo R^2 = 0.0345.
The base outcome is (Not sure).

Table 6
Results from a multinomial logit on the perception of plastic and faecal pollution as a threat to mangroves.

		Considered a threat (Yes)		Not considered a threat (No)	
		Coef. (*p*-value)	Odds ratio	Coef. (*p*-value)	Odds ratio
Sub- location[a]	Mida-Majaoni	0 .740 (0.357)	2.100	1.974 (0.041)	7.200
	Matsangoni	−0.434 (0.542)	0.648	2.128 (0.012)	8.400
	Uyombo	−0.526 (0.295)	0.590	0.336 (0.654)	1.400

Log likelihood = −161.04936; Logs ratio (LR) chi-square (6) = 26.77; Prob > chi-square = 0.0002; Pseudo R^2 = 0.0767.
The base outcome is (Not sure).
[a] For this analysis, Dabaso sub-location was used as the reference and hence not included in the table.

Table 7
Results from a multinomial logit on the perception of oil spills from motorised ocean transport as a threat to mangroves.

		Considered a threat (Yes)		Not considered a threat (No)	
		Coef. (p-value)	Marginal effect	Coef. (p-value)	Marginal effect
Number of Children		0.130 (0.101)	0.008	0.178 (0.049)	0.007
Sub- location	Dabaso		0.078		0.144
	Mida-Majaoni	−0.100 (0.877)	0.804	−0.382 (0.634)	0.112
	Matsangoni	−0.666 (0.318)	0.691	−0.314 (0.691)	0.182
	Uyombo	−1.353 (0.004)	0.692	−2.108 (0.003)	0.061

Log likelihood = −178.57583; Logs Ratio (LR) chi-square (8) = 18.85; Prob > chi-square = 0.0157.
Pseudo R^2 = 0.0501.
The base outcome is (Not sure).

from projects that have taken place in Mida Creek; thereby, providing an opportunity to create networks and partnership between national institutions and non-governmental institutions to promote the conservation of mangrove forests.

5.3.3. Need to provide alternative livelihood sources

An analysis of socio-economic attributes shows that the communities adjacent to the forests of Mida Creek are dependent on natural resources for their livelihood and that there is a need to find alternative sources of timber and firewood. The governance agencies could support the community members through financing the development of woodlots from other tree species, as well as educating them on how to make charcoal briquettes. Indeed, previous studies have found that the communities living within and around the Mida Creek mangroves prefer to use other sources of wood for fuel and construction; for example, *Casuarina equisetifolia* and palm trees (Owuor et al., 2017; Frank et al., 2017).

5.3.4. Gender issues and the role of women

The disparity in gender representation, though not apparent in this study, may be a matter of concern; the male representation (57%) is higher compared to the female (43%). Notably, there were women in most of the households visited, yet most of them declined to take part in the survey, insisting that one of the male members of the family take the survey. This happens even in cases where women are the household heads. Nonetheless, some women were willing to take part in the survey. In natural resource management, this lack of female participation would reduce female representation in conservation groups. For example, the community forest associations, which are a legal requirement from the Kenya Forest Conservation and Management Act 2016 (Government of Kenya, 2016). Agarwal (2009) argues that the proportional strength of women affects group policy formulation. Therefore, concerned institutions should enable activities that will empower women and enhance their participation in future surveys.

5.3.5. There is a link between education and sustainable management

The results reveal low levels of education in the area. Education enables people to understand better the relationship that exists between natural resource conservation and human well-being and, indeed, there is a probable link between education and sustainable management (Vodouhê et al., 2010). When people are educated, they are likely to be involved in successful businesses, or they have good quality jobs with the county government, or other national institutions, or non-governmental organisations; all providing an alternative source of income, thereby reducing a direct dependency on natural resources.

6. Conclusion

In conclusion, coastal resources play an essential role in human well-being and social and economic development (Bosire et al., 2014; Dahdouh-Guebas et al., 2000; Frank et al., 2017; TEEB, 2010; Walters et al., 2008). Therefore, it is important to ensure that they are sustainably used and managed in order to achieve the Sustainable Development Goal number 14. The results of this research will contribute to the CBNRM (Community Based Natural Resource Management) of Mida Creek as they provide support for the improvement of existing management strategies through defining and integrating the concerns of local people into policy and planning.

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Appendix A. Supplementary data

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