Socio-Economic Status and Living Conditions of Coastal Communities: Impacts on the Mangrove Ecosystems in the Scarcies Estuaries, Sierra Leone, West Africa

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Abstract. This research was conducted between the periods of March 2015 to December 2015 in the Scarcies Estuary, Sierra Leone. Participatory methods such as Focused Group Discussion (FGD), Interviews and ranking exercises were used for the assessment. The objective of this study is to assess the social and economic constraints of coastal communities, and how such constraints have influenced mangrove loss in the area. Knowledge on those is scarce for this region. The study will contribute to improving sustainable management agenda for mangrove forests in the Scarcies Estuaries. Results show a more active and productive age range of respondents (31-40 years), capable enough to make decisions that could influence resource use. A Student's t-test showed no significant difference in sex at ($P>0.05$) for male (70%) and female (30%) mangrove dependents. In addition, of the various mangroves related economic activities, oyster collection and farming remained the most important with income above One Million Leones (>115USD) per week and per farming season respectively. Further, key constraints in the communities included inadequate health centers, educational facilities and lack of basic material assets. Multiple households in a dwelling unit are also a common residential arrangement in these areas. Such living conditions are in the context of the definition of poverty with such outcomes as deprived resources such as money and assets, poor health and illiteracy. Hence, it is increasingly evident that the conservation of mangroves in this region cannot be done without considering the varying impacts of poverty, gender roles and resource utilisation patterns.

Introduction

Mangroves live at the interface between land and sea in tropical and subtropical latitudes [1–4]. However, mangroves are dependent on the coast, for which humans also have a preference [5]. Nearly 120 million people will live within 10km of the remaining large mangrove habitats by 2015 [5]. This ecosystem is key for enormous abiotic and biological resources and offers a mixture of ecosystem services from which humanity benefits [6–8]. These services can be categorized into provisioning, supporting and regulating, and cultural [9–10]. Provisioning services include (i) fisheries production [11–15]; (ii) production of timber and wood [1, 16]; (iii) Medicinal purposes [17]. Supporting and regulating services include (i) carbon sequestration [2, 18, 19]; (ii) climate regulation [5, 20–22]; (iii) shoreline stabilization and coastal protection [23–25]; (iv) water filtration [26] and pollution regulation [27–29]; Mangroves also provide a suite of cultural and aesthetic services, which include: (i) recreation and tourism [30]; (ii) educational opportunities [5, 31, 32]; (iii) aesthetic and cultural values [32–33]. Cumulatively, the ecosystem services contribute to the socio-economic wellbeing of coastal communities [5, 34, 35]. [36] had also shown that the majority of people living in mangrove areas globally are fishermen, deriving their livelihood from fishing and related activities. In addition, [5] argued that the way mangroves are valued by people around the world differ greatly and are influenced by culture, heritage and the level of dependence on mangroves for local livelihoods and well-being.

Notwithstanding, despite widespread knowledge of their value, the distribution of mangroves has decreased globally. Some 2,260 nationally designated and 285 internationally recognized sites worldwide contain about 41% of the world's remaining mangroves [5]. One-third of global mangroves have been lost over a 50-year period due to anthropogenic activities [37]. Studies have

shown that mangroves have global coverage of between 10 and 24 million hectares, covering about 1% of the terrestrial surface of the earth [3]. The conflict between human needs and preferences and the conditions favored by mangroves is the fundamental driver for the loss and degradation of these ecosystems [38], and this decline continues in many regions [2, 39, 40-45]. The main threats are (i) Conversion to agriculture or aquaculture [5, 36, 43, 46-51]; (ii) Coastal development [5, 40, 46, 52-54]; (iii) Pollution, hydrological changes and indirect disturbance [44, 53, 55-58]; (iv) Exploitation [48, 59]; (v) Climate change and extreme weather events [20, 21, 60]. In Africa, the main hot spots of mangrove loss are in Mozambique and Western Africa through conversion to agriculture/aquaculture [48]. The rate of loss may be as high as 8 per cent per year in some developing countries [39]. Further, the majority of West African countries are among the least developed countries whose populations have a characteristically high dependency on natural resources [38]. Consequently, continuous degradation and deforestation as a result of uncontrolled exploitation and land conversion is taking place on a large scale [5, 47, 48, 58, 61, 62].

In Sierra Leone, the mangrove swamps are dominated by six (6) species, *Rhizophora racemosa*, *Rhizophora. mangle*, *Rhizophora. harrisonii*, *Laguncularia racemosa*, *Avicennia africana* and *Conocarpus erectus* [64-66]. About eighty percent of the population in Sierra Leone is rural and depend heavily on biodiversity resources for their food, fibre, medicine, income and wellbeing [66]. The ecosystem serves as home for many fish and shellfish [67-68], which then serve as source of protein for many people [64, 69]. There has been a decrease in mangrove area coverage in Sierra Leone from 183,789 hectares in 1987 [70] to 90,790 hectares in 2015 [71]. In the Scarcies Estuaries where the highest threats on mangroves in Sierra Leone have been recorded by other authors, decline is from 7.1% [70] to 6.3% [71]. Key drivers of mangrove loss include conversion for rice field and salt production, overexploitation and logging for wood and timber [64-66, 69, 71]. There is scanty literature available on the linkage between the social and economic conditions of coastal communities and mangrove resource utilization in the Scarcies Estuaries. Most works have focused mainly on the ecology [67, 68, 70, 72] and services of the Mangrove Ecosystems [64, 69, 70, 73-75]. This research aimed at investigating some aspects of the social and economic constraints of coastal communities, and how those have influenced the loss of mangroves in the Scarcies Estuaries. The results of this study will contribute to improving sustainable management agenda for mangrove forests in the area by providing information on key issues responsible for the unsustainable uses and conversions of mangrove resources in the area.

Theory

Mangroves are widely recognized as being one of the most important and valuable of coastal ecosystems. On a local scale they are known to provide coastal protection, fulfill important functions in terms of providing nursery grounds and breeding sites for fish, birds, mammals, crustaceans, reptiles, and shellfish and are a renewable source of wood and food for many indigenous settlements [1, 8, 10, 19, 76]. Globally, they form part of the most important ecosystems in mitigating climate change given their considerable capacity to sequester carbon [76, 77]. However, in the past few decades, mangroves in Sierra Leone have been subject to a wide variety of threats. There has been an estimated decline of 183,789 hectares in 1987 [70] to 90,790 hectares in 2015 [71]. Greatest declined has occurred in the Scarcies Estuaries, from 7.1% [70] to 6.3% [71]. In many coastal areas of the Sierra Leone coast, the threats are mainly anthropogenic [66, 69, 78,]. It has been postulated that the conflict between human needs and preferences and the conditions favored by mangroves is the fundamental driver for the loss and degradation of these ecosystems [38], and this decline continues in many regions [2, 39, 40-45]. In addition, there has been scientific consensus that human-induced disturbances may permanently alter the ecological functioning of mangrove forests [16, 79-81]. This might affect its capacity to sustain the provision of benefits to humans [16]. A strategy to improve the Mangrove Ecosystem management agenda would be to investigate the key drivers of mangrove loss in the study areas, which form the basis of this study.

Methodology

Study Area

The specific study areas in the Scarcies Estuary are located in the Kambia District, Northern Province of Sierra Leone situated on $9^{\circ}10'N$ $12^{\circ}45'W$. The district is the main rice bowl of the country and the population is mainly farmers compared to fishing [82]. The hydrology of the district mainly constitutes the Scarcies Estuary, the Great and Little Scarcies, which merge towards their mouth before emptying into the Atlantic Ocean [67, 83]. Of the two rivers, the Great Scarcies contain most of the mangrove vegetation in this area [84]. Bordering the Great Scarcies Estuary include coastal villages of the study areas such as Rokupr, Mambolo, Kychom, Kassiri and Yeliboya (Fig. 1).

Figure 1. Map showing study locations in the Great Scarcies Estuary

Sampling and Sampling Frequency

This study was undertaken between the periods of March 2015 to December 2015 in five (5) coastal settlements in the Scarcies Estuary, including Rokupr, Mambolo, Kychom, Kassiri and Yeliboya. As a strategy, each community was divided into 5 strata from a reference point (popular point such as mosque) and eight participants were selected at random from each stratum for interviews and discussions, giving a total of 40 respondents for each settlement altogether. Care was, however, taken to have a representation of those individuals directly involved in mangrove-related activities. This is to ensure that members of the group had something in common which is important to the investigation. Further, Focus Group Discussions (FGD) and interviews comprise the participatory methods used to solicit information from participants. Ranking exercises provided information on income and emphasized the importance of the various mangrove-related economic activities in the area. The advantage of using the methods is that these allow wider participation of the local people. These methods had also been seen to be very effective by other researchers in increasing the potential of obtaining useful information particularly in remote areas [85–92].

Statistical analysis using the Student's t-test for significance in sex of participants was completed using the Microsoft Excel (ver., 2010) computer analysis package.

Results

Age and Gender

Data for this study shows that an average proportion (51.5%) of the sampled respondents generally fell within a more active and productive age range of 31–40 years (Table 1).

Table 1. Age of participants

Age Group	20-30	31-40	41-50	51-60
Rokupr	7	10	2	1
Mambolo	8	11	0.5	0.5
Kychom	5	13	1.5	0.5
Kassiri	8.5	10	1	0.5
Yeliboya	10	7.5	1.5	1
Total (%)	38.5	51.5	6.5	3.5

Generally, eighty-six per cent (86%) of the respondents are engaged in economic activities linked to the Mangrove Ecosystems. A Student's t-test (df. 4; probability, $P = 0.124$; $\alpha = 0.05$; two-tailed) however shows that there is no significant difference in sex at ($P > 0.05$) for male (70%) and female (30%) mangrove dependents of female to male sex ratio, 1:2.3 (Table 2).

Table 2. Mangrove economic activities

Sex	Farming	Fishing	Sales of mangrove products	Other occupations related to mangrove	Other commerce	Total
Male	54	39	17	11	20	141
Female	23	16	7	4	9	59
Total	77	55	24	15	29	200

From Table 2, 'Sale of mangrove products' referred to those individuals engaged in the sale of charcoal, oyster, mangrove wood, etc. while 'other occupations related to mangrove' constituted activities such as boat building; handicraft-basket, needle for weaving fishing nets. Other commerce accounted for the variety of other trades not related to the Mangrove Ecosystems.

Living Conditions

Table 3 provides an inventory of health facilities in the study areas. The figures in brackets indicate the number of items presents. Government hospitals are only found in Rokupr, Kychom and Kassiri. There is no health facility in Yeliboya, and only one health centre in Mambolo manned by community health officials.

Table 3. Inventory of Health Facilities

Letter name	Community Health Center	Government Hospital	Private Hospital
Rokupr	Yes (1)	Yes (1)	No
Mambolo	Yes (2)	No	No
Kychom	No	Yes(1)	No
Kassiri	No	Yes (1)	No
Yeliboya	No	No	No

* "Yes" means, "it is present" and "No" means, "it is not present".

Further, from Table 4, Arabic education is the dominant system of education (46%) in the study areas as compared to western education, which included primary, secondary and tertiary educational systems.

Table 4. Educational status of respondents

Status	Rokupr	Mambolo	Kychom	Kassiri	Yeliboya
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Did not go to school (Illiterate)	15 (7.5)	10 (5)	8 (4)	16 (8)	13 (6.5)
Complete primary school	4 (2)	6 (3)	7 (3.5)	5 (2.5)	6 (3)
Complete secondary School	2 (1)	3 (2)	2 (1)	3 (1.5)	3 (1.5)
Vocation	1 (0.5)	1 (1)	0 (0)	2 (1)	0 (0)
Arabic education	18 (9)	20 (10)	22 (11)	14 (7)	18 (9)
Tertiary education	0 (0)	0 (0)	1 (0.5)	0 (0)	0 (0)

*%=percentage frequency.

Similarly, Table 5 gives an inventory of educational institutions in the study areas. The figures in bracket show the number of items present. From Table 5, Yeliboya is in the worst case of educational facilities with only one primary school and no secondary school or vocational institution. There is also no vocational institution in Kassiri and Mambolo. Rokupr and Kychom are much better in terms of educational institutions. Interestingly, respondents from Rokupr are amongst the highest record of illiteracy rate during this survey.

Table 5. Inventory of educational institution

Institution	Rokupr	Mambolo	Kychom	Kassiri	Yeliboya	Total
Pre-school	Yes (3)	Yes (1)	Yes (1)	Yes (1)	No	6
Primary school	Yes (8)	Yes (3)	Yes (5)	Yes (3)	Yes (1)	21
Secondary school	Yes (4)	Yes (2)	Yes (2)	Yes (1)	No	9
Vocational school	Yes (1)	No	Yes (1)	No	No	2
Tertiary Education	No	No	No	No	No	0

* "Yes" means, "it is present" and "No" means, "it is not present".

Further, more than five different families residing in the same dwelling unit are very common residential arrangements in the study areas as given in Table 6 below.

Table 6. Respondent's Households (HH)

Household Size	Rokupr	Mambolo	Kychom	Kassiri	Yeliboya
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
1-3	1(0.5)	0 (0)	2 (1)	0 (0)	1 (0.5)
4-6	25 (12.5)	30 (15)	35 (17.5)	37 (18.5)	33 (16.5)
7-9	14 (7)	10 (5)	3 (1.5)	3 (1.5)	6 (3)

*% = percentage frequency

Table 7 also provides the income category of the commercially viable mangrove products in the coastal communities and range from amounts less than Le200, 000 (<\$30) to that greater than Le1, 000,000 (>\$115) obtained weekly or per farming season in the case of rice farming. The Sierra Leone Leones-United States Dollars exchange rate is taken at, USD1 = Le8, 500.

Table 7. Ranking income category

	Mangrove Oyster collection	Wood cutting	Other occupations related to mangroves	Fishing	Farming	Salt production
<Le200,000	1	1	1	1	1	2
Le201,000– Le400,000	1	2	2	2	1	3
Le401,000– Le600,000	1	3	1	2	1	1
Le601,000 – Le1million	2	1	1	1	2	1
>Le1million	3	1	1	2	3	1

*1 = less common; 2 = common; 3 = very common and important

The figures (ranks) show the commonality of the income categories for economic activities. A rank of “3” indicates the most common income category obtained for economic activity by the locals. It also emphasizes the importance of economic activity. The reverse is true for the rank “1”. Fig. 2 also reveals the material assets of respondents for the total sample population (N). Assets such as television, generator and bicycle were not owned by any of the respondents.

Figure 2. Total percentage frequencies of household assets

Discussions

Age and Gender

Data for this study elucidates that an average proportion (51.5%) of the sampled respondents generally fell within a more active and productive age group. Such age group, probably with more economic and social demands in life, may be capable enough to make decisions that could influence resource use. In addition, a female to male sex ratio of 1:2.3 suggests high involvement of men in mangrove-related economic activities than the women in the study areas. The men are usually considered “bread winners” of families in this part of the world, and the quest of these for sustained livelihood could in turn have its negative impact on the Mangrove Ecosystems where it is a readily available option for livelihood in the area. [93] inferred that access to resources and knowledge about those resources are influenced by a range of factors including age and gender. However, the difference in sex of mangrove dependants is not significant at ($P>0.05$). This further suggests that mangrove resource exploitation is independent of gender. It could be that women play pivotal role in supporting men in other economic activities such as farming, fishing and salt production, aside their involvement in the sale of oyster and cockles. The involvement of both men and women in mangrove-related

economic activities for local livelihood provide additional pressures on the ecosystem's resources in the Scarcies Estuary. [16] had indicated that the cumulative effects of men and women on mangroves through repetitive and higher harvest frequency not only affect the population dynamics of mangroves but also have the potential to undermine mangrove ecosystem sustainability. Other studies have shown that combined actions of men and women might transcend mangrove stands structural impairment to influence soil quality, forest productivity and physio-chemical properties of nutrient cycling [94–95]. It has also been revealed that persistent human involvement in the mangrove forests can lead to alteration and interference with recruitment of macrofauna assemblages significant to the structure and functioning of mangrove ecosystems [96–97]. Other researchers have concluded that conflict between human needs and preferences and the conditions favored by mangroves is the fundamental driver for the loss and degradation of these ecosystems [38], and this decline continues in many regions [39–45].

Living Conditions

The study further shows the socio-economic constraints in the Scarcies Estuary, which also include the lack of basic material assets. Multiple households in a dwelling unit suggest increased population and probably less financial capacity of inhabitants to own or rent a house in the area. Such living conditions connote poor wellbeing defined by other authors as “the resources people have, such as money and other assets [98]; how people feel about their lives [99–100]; and what people are able to be and to do [101–102]. In addition, such way of life is in the context of the definition of poverty, understood as a deprivation of basic needs, low wellbeing with such outcomes as lack of basic material assets, poor health and illiteracy [103]. Studies in Sierra Leone had also shown high poverty rate in the study areas [104]. Poor living conditions and low level of western educational attainment have been shown to render the Mangrove Ecosystems vulnerable to unsustainable exploitation where there are no stringent laws governing resources use [16]. In addition, it is possible that the high financial cost attached to some material assets such as bicycle, television and generator is what is making them less preferred or unaffordable. This clearly suggests poor financial capacity by individuals in these communities. Studies have shown that material poverty of coastal communities in the absence of an alternative means of livelihood could trigger a widespread dependence on mangrove products to meet basic subsistence and income needs in the area [16, 95]. Also, where the ecosystem cannot adequately provide food and income, locals might resolve into more destructive forms of economic activities such as the conversion for farming and salt production as dominantly practiced in the study areas. This, therefore, increases the vulnerability of the mangrove ecosystem. A related study had shown that the world's poorest people depend primarily on environmental goods-and-services for their livelihoods, which make them particularly sensitive and vulnerable to environmental changes [105]. [5] concluded that reduction in household income, lack of basic educational facilities as well as other material needs might result in communities forced into unsustainable forms of income generation where these are available. The unsustainable use of mangrove resources through ecosystems conversion, probably as a result of increasing population size and poverty is fragmenting and depleting this system on a large scale in the Scarcies Estuary. [106] concluded that the conversion of mangrove forests forces the alteration of flora, soils and biodiversity loss.

However, data also shows that 86% of the respondents are engaged in economic activities linked with the mangrove ecosystems. Such incentives for income, where they provide readily available options, may tremendously affect the ability and willingness of these communities to conserve their local mangrove forests. Studies have proven that mangroves are widely recognized as being one of the most important and valuable of coastal ecosystems [76–77]. A work done by [107] had shown that alternative livelihood opportunities are required in order to replace unsustainable practices, which could foster positive attitudes towards mangrove conservation among local communities.

Notwithstanding, some of the social and economic challenges faced by the current generation of coastal dwellers in the Scarcies Estuaries may be the long term effects of the vices of unsustainable

exploitation and conversion of the mangrove ecosystem for farming and salt production. [61] revealed that continuous degradation and deforestation because of uncontrolled exploitation and land conversion is taking place on a large scale across West-Central Africa. Other studies further affirmed that Conversion to saltpans [49], and agriculture [51, 75, 108] are key drivers of mangrove loss in some parts of Africa. In consequence, the benefits derived from the mangrove would drastically reduce as these provide opportunities for education [47]; provide access to basic material for good life [5]; play a key role in supporting human well-being [109]. [16] also argued that as mangroves dwindle, the livelihoods and well-being of vulnerable coastal communities that directly or indirectly depend on their resources are at risk. Other researchers have concluded that continuous loss of mangroves could lead to a reduction in fish catch, property loss, and an increase in poverty levels and hence human suffering [110–111]. Economists have also predicted that excluding the income from collecting mangrove forest products would significantly raise the number of people in coastal villages in poverty [112]. In addition, well-managed mangroves could provide employment and income for coastal communities [113]; provides food and materials for trade [114]. The ecosystem services mangroves provide contribute significantly to human well-being [4, 8, 9, 12].

Conclusions

The study highlights key challenges facing the coastal communities in terms of poor health facilities, education, material assets as well as poor residential arrangements. There is a high reliance on mangrove resources for income, which suggests limited options for revenue generation in the study areas. In essence, there is pressure on the Mangrove Ecosystems and where the ecosystem cannot adequately meet basic subsistence and income needs, locals resolve into more destructive forms of economic activities such as conversion for farming and salt production. In addition, the cumulative effects of men and women engaged in mangrove-related economic activities have the potential to undermine the mangrove ecosystem's sustainability. Hence, it is increasingly evident that the conservation of mangroves in this region cannot be done without considering the varying impacts of poverty, gender roles and resource utilisation patterns. In addition, to help sustain mangroves in this area, communities need to be provided with alternative sources of livelihood and educated on the values of mangroves and regeneration techniques.

Conflict of Interest

The publication is self-sponsored and the authors declare that there is no conflict of interest.

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