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Land-Use Conversion, Shrimp Culture and Salinity Intrusion at the South-Western Regions of Bangladesh: The Cases of Koyra and Shymnagar

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Abstract

Bangladesh, a low-lying deltaic region, is bordered by the mighty sea, the Bay of Bengal, towards its south and hence, the south-western regions are susceptible to immense salinity intrusion due to natural disasters, sea-level rise and the disappearing mangroves. This phenomena is further aggravated in the areas of research – Koyra and Shymnagar – due to the fairly recent land use conversion as the economy migrates from the less profitable and lower tolerant crop culture to the more profitable and 'salinity thriving' shrimp culture. Hence, this research is timely and it tries to propose a Strength-Weakness-Opportunities-Threats (SWOT) analysis using the information collected from the locals (both agricultural and shrimp) farmers and key informants (like government officials and nutritionists) via focus group discussions and key informant interviews, respectively. The SWOT analysis is further used to showcase that although the shrimp culture has, for now, caused an economic boom in the area and the nation, it is leading towards the impending and irreversible disasters of increased salinity intrusion and resultant land, water and food crises. Recommendations include the gradual migration of the economy to less harmful alternative livelihoods and NGO and government interventions to sustain food, water and land security in the long run in the areas.

Keywords

South-Western Region, Koyra, Shymnagar, Shrimp Culture, Salinity Intrusion

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1. Introduction and Background

Bangladesh is part of a low-lying deltaic floodplain with a coastline of about 710km [1] and hence, salinity intrusion is a common scenario in the country, especially towards its south which is bordered by the mighty Bay of Bengal. Both natural and anthropogenic activities are increasing the rate of salinity intrusion in two such south-western coastal regions, namely Shymnagar and Koyra upazilas (sub-districts). Their geographical locations make them particularly vulnerable to many catastrophic, natural events like cyclones, sea level rise and storm surges; increased salinity level of the water in this area is a consequent of these consistent and frequent hits and these have been leading people to convert their agricultural lands into the shrimp cultivable land, resulting in an even aggravated salt-water intrusion regime and consequent destruction of the local soil and ecosystem [2]. Moreover, the increased conversion from agriculture to shrimp cultured has hampered homestead gardening resulting in jeopardized food security. This realization even has not stopped the migration because according to the area's physical characteristic of high salt in the soil water, there is higher profitability in shrimp

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culture and causing higher levels of soil quality degradation. Hence, this research aims to find out the linkage of adverse effect of salinity on vegetation and how it is hampering food security of the people of Shymnagar and Koyra upazilas, in the hopes that its findings will push the government and locals to take measures against salt-water intrusion instead of for it, as is the case now, for the long-term sustainability of the area's people and economy.

The research aims to show the linkage between salinity and food security and hence, it is significant. The salinity increase of the study area might reach an extreme point if the current shrimp cultivation continues at the same pace and this damage will be irreversible. The findings of the study may also be applicable to other areas of the country where the physical, socio-economic and cultural conditions are mostly similar to the research areas and the recommendations from this work can be applied by there too. Moreover, the findings of this study will help researchers, specialists and planners in eliminating problems faced by agricultural farmers in high salinity regions: the administrators, supervisors, field workers and others who are working in the field of vegetable production may find this study informative. It will also help to portray the fact that our geographical location is susceptible to natural disasters which is why we are in danger in terms of food production and biodiversity extinction. In addition, it will also help to raise awareness about these deadly interventions amongst the locals and beyond.

2. Literature Review

Sea level rise causes salinity intrusion. Several reports state that the salinity intrusion increased by 27% from 1973 to 2009 [2-4] in the southwest coastal areas. Saline water intrudes in soil water due to sea level rise lead by climate change mainly and it exacerbates unfavorable environment and hydrological situation that restricts normal crop production throughout the year [5]. This also alters the aquatic ecosystem. Salt stress also reduces the yield of many crops and vegetables, for example maize, broad bean, chickpea, rice and soybean leading to a severe scarcity of foods that contains large amounts of proteins, vitamins, minerals and carbohydrate [12]. The populations in Khulna, Satkhira are most affected by the increasing salinity intrusion [6]. Salinity intrusion severely affected agriculture, forestry and fisheries sectors in these areas for example, changing in native crops and biodiversity [5]. Due to salinity, water logging and drought about 30-50% of net cropped areas are still not eligible for crop production [7] Researchers found that due to this salinity rice production will fall by 8% and wheat by 32% to 2050. Salinity affected 1.1 million hectares of land in these areas [2]. In this region, groundwater aquifers are also affected by the intrusion of saline water and downward leakage resulting in to arsenic contamination of water resources. For the costal districts due to unavailability of safe water, the permissible level of contamination of ground water aquifer is set at 1,000 mg/l [13]. Through both water and various kinds of food grains people are getting saline more than they required. As a result, malnutrition, under-nutrition, water borne diseases, food borne diseases and even starvation are some obvious effects of salinity among the coastal people.

In many studies it has been found that croplands are converted to shrimp cultivable land due to economic reasons as shrimp cultivation brings more profit than rice, paddy or other cultivation. Even then, in many areas shrimp cultivation is considered as a profit-making invention [8]. Thus, some farmers were forced to migrate and some willingly migrated from agriculture to shrimp culture. Saline water is put into fresh lands such as agricultural land to start shrimp farming and the saline water retains for a long period of time, which practically leads to percolation of salts in the surrounding soil and as a result it changes the soil chemistry. During monsoon, the shrimp cultivators keep adding extra salt into the water for better growth of the shrimp and these salts retain in the field and mixes with the soil resulting in a strongly saline area. This process hampers the microbiological system and decreases the soil fertility significantly.

Due to the increased salinity in cultivable lands, peasant household lose their income due to decline in rice productivity, loss of poultry and livestock, and erosion of homestead vegetation and social forestry [14]. Water used for shrimp cultivation also runs into ponds, rivers and nearby water bodies making them saline which affect the aquatic species. It is stretched that the inadvertent expansion of shrimp culture unfavorably affected the production of cereal crops and vegetables, trees and plantation, poultry and livestock in these areas. Shrimp farming also had negative effects on coastal environment and agro-ecosystem, which significantly changed the bio-diversity of the coastal areas [15]. Besides, due to the extra addition of salt to the logged water the salinity retains in the soil and surface water for a longer period of time resulting in hampered soil quality and affecting the biodiversity. Shrimp alone cannot fulfill the need for protein. People, especially children, need other nutrients to nurture properly both physically and mentally. This whole systemic change of the soil and ecosystem is jeopardizing the food security of people of Shymnagar and Koyra.

3. Methodology

Study Areas

The study areas are Shyamnagar upazila in the Sathkhira

district and Koyra upazila in the Khulna district of Bangladesh. Natural disasters such as cyclones, storm surges, tidal floods, saline water intrusion and water logging are prominent features of these areas. The human-induced shrimp farming initiates salinity that is seriously affecting the agricultural production and making the region vulnerable to unsafe drinking water and nutrient deficit.

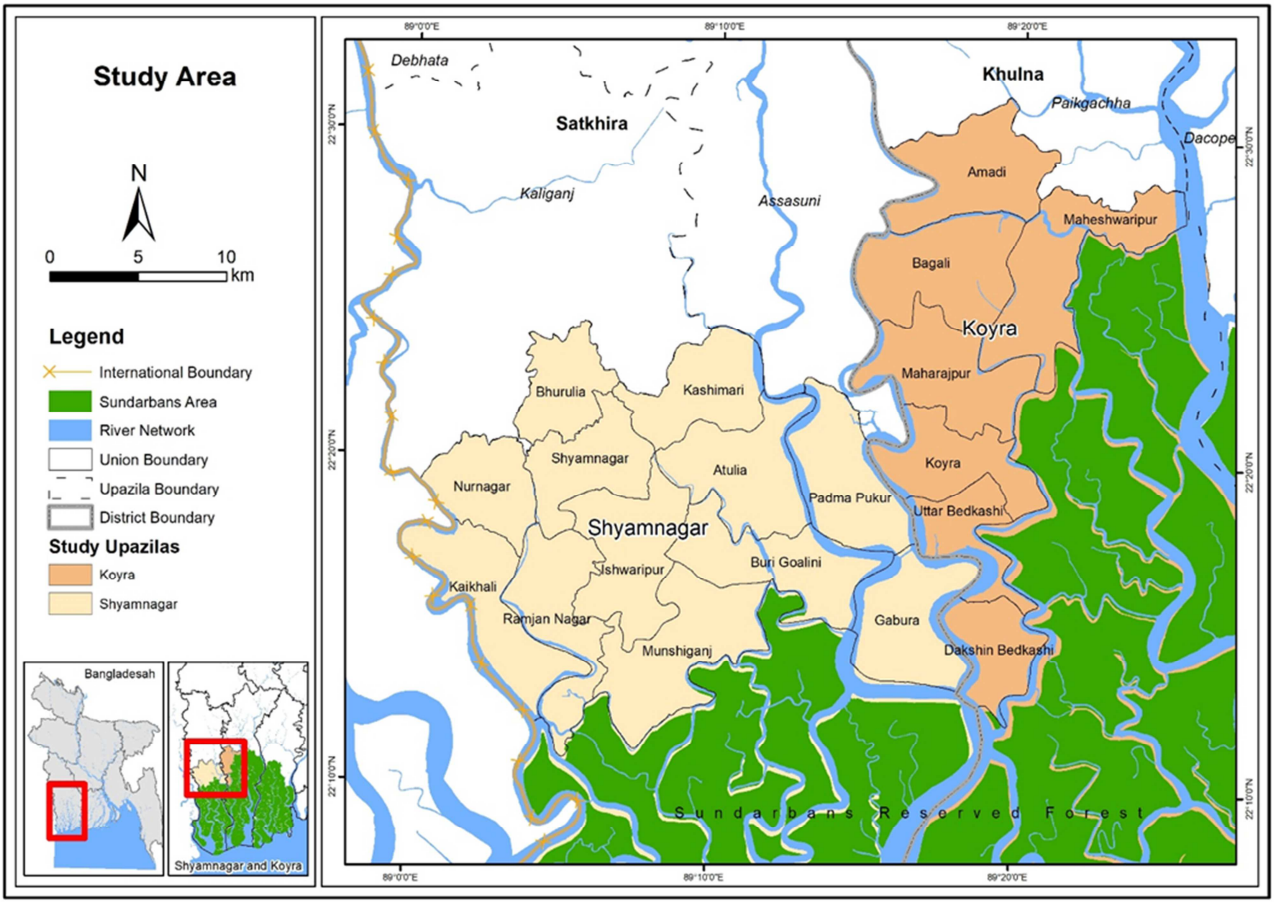

Figure 1. Study Areas – Shymnagar and Koyra.

Shymnagar is the largest upazila of Satkhira district. It has an area of 1968.24 sq. km (1968240 ha) and a total of 318,254 people. Agricultural land occupies about 5741.46 acre and this is main source of income of the area's residents; 64.98% people's livelihood is associated with It [4]. Both the areas are salinity-prone due to their geographical location. On the other hand, Koyra upazila has an area of 1775.41 sq. km. (1775410 ha) It has a total population of 192,534 and the main source of income here is also agriculture at 66.64% [9]. Out of the total area where people live and work in Koyra (26,323 ha), most (about 82%) is cultivated (21,413 ha); unfortunately, almost 81% (21,410 ha) is also affected by salinity. In Shymnagar, the cultivated area is 81% of the total livable area (37,146 ha out of 45,609 ha) and the salinity here has absolutely affected more area (80%; 36910 ha) and relatively the same as Koyra. The economies of both the upazilas are predominantly dependent on agriculture, but shrimp culture is now the second most popular cultivation for livelihood generation. Earlier, people of the area depended mostly upon the cultivation of food grains. Shrimp, thus, has replaced rice as the main crop; as traditional shrimp farming is easier and more profitable than paddy farming.

Table 1. Area* Data from Study Regions.

District	Upazila	Total area	Uncultivated Area	Cultivated Area	Total Saline Area
Khulna	Koyra	26323	4910	21413	21410
Shatkhira	Shymnagar	45609	8463	37146	36910

*Area in hectares (ha).
Source: SRDI, Ministry of Agriculture, Government of Bangladesh (2010).

Data Collection

Focus group discussions (FGDs) were conducted with 8 groups to investigate the current situation and past situation in the drier seasons of 2018. In Koyra upazila, 5 FGDs and in

Shymnagar 3 FGDs were conducted, where agricultural farmers, shrimp farmers and women were objects of focus. Key informant interviews (KIIs) were conducted with concerned experts to understand the current salinity intrusion status and its future implications. A nutritional expert was consulted to justify the linkage between salinity and food insecurity/nutrition intake.

Using the qualitative approach, the FGDs were conducted; the participants were selected using snowball sampling. The participants were asked questions regarding climate related hazards, livelihood, salinity, agricultural production, income generation and food security and adaptation techniques applied in the locality. KIIs were conducted with 1 upazila agriculture officer from each upazila of interest. An elaborative discussion was done with a climate change expert from UNDP whose area of work was similar to the topic at hand. KIIs were also conducted with a couple of nutrition specialists.

Secondary data was collected to obtain an overview of the effects of salinity on vegetation, causes of salinity intrusion and vegetation process of the study area. For producing area maps Google Maps and ArcGIS software were used; data were represented in tabular and flow chart formats for a comprehensive outlook.

4. Results and Discussion

Salinity has increased drastically in these last few years in the study areas – Shymnagar and Koyra – and it is now around 3.5% in the southwest coastal areas. Table 2 shows what amount of the area in each upazila has been affected by what amount of salinity. Most of the areas in both the upazilas fall under the categories of 'Moderately saline' or above and most land shares of the study areas are under the category of 'Very strongly saline' – 7,360 ha in Koyra and 13,920 ha in Shymnagar, which are around 28% and 38% of the liveable/workable areas of Koyra and Shymnagar, respectively.

Table 2. Upazila-wise Area's* Soil Salinity.

Salinity Class and Area					
Upazila	**S1 (2-4 ds/m)**	**S2 (4.1-8 ds/m)**	**S3 (8.1-12 ds/m)**	**S4 (12.1-16 ds/m)**	**S5 (>16 ds/m)**
Koyra	240	1310	5250	7250	7360
Shymnagar	620	2630	7380	12360	13920

*Area in hectares (ha).
Source: SRDI, Ministry of Agriculture, Government of Bangladesh (2010).
…where, S1: Non-saline with slight salinity; S2: Very slightly saline; S3: Moderately saline; S4: Strongly saline; S5: Very strongly saline and the salinity is measured in deciSiemens/metre.

According to the KIs and participants of the FGDs, the existing stressors found in Koyra and Shymnagar are mainly climate change, saline intrusion, waterlogging and shrimp farming. The stressors are interlinked and have huge impact on the study areas. Climate change is leading to sea level rise in the coasts of the Bay of Bengal, which has a severe impact on food security, health and biodiversity of the study areas. Sea level rise or storm surges causes less deposition of sediments and more erosion. If this continues, it is projected that approximately 5,800 ha of land could be lost due to the sea by 2030, which will result in the loss of food grain production of 13,750 tons.

Further analysis of the FGDs suggests that the locals believed that increasing salinity in both soil and water has had no significant impact on rice cultivation decision, although yield loss in every year has increased. Recently, the communities learnt about saline-resistant crop and have shifted to those varieties to increase production; they also now apply indigenous methods to produce vegetables. In addition, most of them mentioned that after the cyclone, Aila, it has almost become impossible to produce quality crops. Moreover, to ensure food security, saline resistant crops were introduced in the study areas by the government and many NGOs have even given the farmers trainings. Unfortunately, many farmers seemed ignorant of saline-resistant crops and others seemed dissatisfied as they stated, "…it does not fulfill our needs." Many complained that hybrid crops and saline-resistant crops are expensive and in addition they "…do not get satisfactory production even after spending more money." According to the respondents, this change in soil happened because of climate change and shrimp cultivation.

Most stated that homestead gardening is practiced in some backyards in small scale which is sometimes not sufficient to meet the locals' needs after selling in the market. They further agreed that doing shrimp cultivation in one land makes the surrounding lands saline due to intrusion and so, the rest of the farmers have no choice other than converting their land into shrimp cultivating land. It was found that poorer farmers suffer most due to shrimp cultivation since they cannot cultivate rice, paddy and other vegetables in their field like before. This is a huge downfall in fulfilling their nutrition intakes as many of them become solely dependent on the market for buying necessary vegetables and grains; they can no longer crop for themselves even, which was cheaper. According to the nutritionists interviewed, daily intake of food now contains less nutrition as crops are scarce

and the poorer cannot afford shrimp or other protein; so malnutrition among the children is persistent and increasing.

The analysis from the talks and interviews resulted in the production of a SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis (Figure 2) to further understand the impact of salinity intrusion in the study areas on food and other environmental factors. The strengths of the current scenario included the inflow of foreign aid to perform climate change adaptation activities at the area which could often be used to build capacity locally, the introduction of saline-resistant crops and reintroduction of indigenous agricultural practices and the inflow of foreign currency from shrimp exports. The weaknesses included the increasing soil degradation, destruction of several ecosystems and the coastal environment, higher levels of poverty for a certain stratum of people due to unfavorable allocation of resources and a scarcity of food crops and livestock. There were the opportunities if earning more and more foreign currency and the expansion of the local economy for the shrimp farmers, but the threats of unsustainable economic boom remained, along with land, water and food crises and the loss of biodiversity, especially the mangrove forests bordering the study areas. The SWOT analysis helped showcase that the threats and weaknesses of the shrimp culture relative to the food security and environmental protection are many more and much higher and long-term than the pros and so, it should be discontinued with the help of government and NGOs' intervention to phase it out without causing harm to the existent economy.

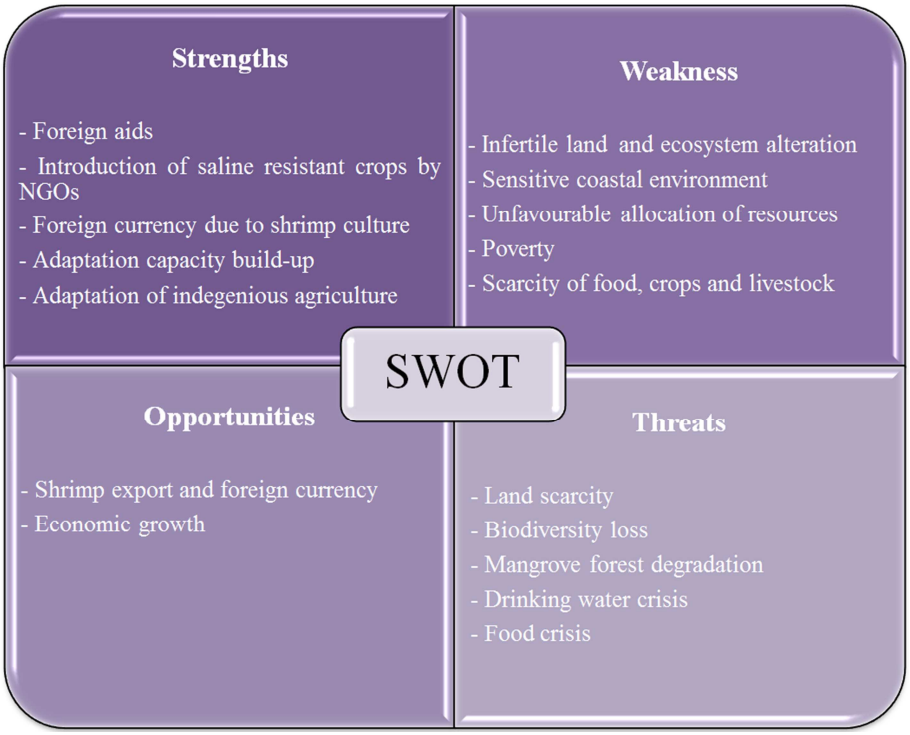

Figure 2. SWOT Analysis for Shrimp Culture in the Study Areas.

5. Findings and Recommendations

The ongoing shrimp culture is helping in the alleviation of poverty for many people of the study areas and boosting the overall economic growth of the nation, but at the same time it is increasing salt water intrusion which is leading towards an impending disaster. Huge downfall in the cultivation of major local crops like rice, paddy and other vegetation's resulting into nutrition deficit and it hurts the poorer strata of the locals. Some incidences of the contamination of the ground water due to saline intrusion have been reported and are leading to the scarcity of drinking water in the area; this is also leading towards the spread of water borne diseases. The biodiversity and ecosystem of the area is getting impaired along with the degradation of soil quality due to the current shrimp culture practices and sea level rise causing exacerbated salinity intrusion.

Some appropriate recommendations and adaptation strategies from the findings to be planned and introduced for the locals by the government and associated NGOs could be:

a) To construct an embankment across the bank of the sea.

b) The provision of sluice gate on the embankment.

c) Reducing the ground water levels by constructing a proper drainage system below the soil surface.

d) Harvesting of rainwater for irrigation.

e) Introducing saline-tolerant crops at subsidized rates and training farmers (especially the poorer ones) to use them.

f) Changing the manner of shrimp cultivation to ensure more sustainable agriculture.

g) Introducing fast growing and improved varieties fish which can resist excess amount of saline and help secure food for the community.

h) The plantation of the appropriate varieties of vegetables considering the situation of the coastal zone can help to meet the nutrition needs of the households.

6. Conclusion

This study found that Shymnagar and Koyraupazila are prone to land use changes due to shrimp farming and natural disasters. Most residents have moved from cropping to shrimp culture, which is further worsening the salinity condition and leading to poverty alleviation in the short-run, but impending disasters like land, water and food crises in the long-run. So, poverty, unemployment, illiteracy and malnutrition are all existent conditions within the people of these coastal areas due to the rising condition of salinity, which is further being aggravated by the farming practices of the locals. This entails for government and NGO intervention to better manage the areas and push the locals towards alternative livelihoods that would help to sustain the land and biodiversity for their own good and the Nature's.

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