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Environmental Cost of Shrimp farming in Chittagong and Cox's Bazar

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ABSTRACT

During last three decades shrimp has remained one of the major export items in Bangladesh. It contributes to the development of this country by enhancing export earnings and promoting employment. Coastal wetlands and agricultural lands are used for shrimp culture, which reduces agricultural opportunity and peasants' income, and destroys the mangroves and coastal eco-system. These are the external environmental costs which are not reflected in farmers' price and output decisions. This study estimates those external environmental costs through the contingent valuation method. The calculated environmental cost of shrimp farming is $13.66 per acre per year. Findings suggest that once the external costs are internalized, current shrimp production and shrimp price will no longer be optimal. Thus alternative policy recommendations have been proposed so that shrimp farming becomes a sustainable and equitable means of aquaculture.

Keywords: Shrimp farming, costs, mangrove destruction, salt water intrusion, Decrease in agricultural land, livestock and income.

INTRODUCTION

Shrimp has remained a dominant export itemin Bangladesh since 1980. Bangladesh is involved in producing 2.5% of the entire international shrimp production regime (Anwar, 2003). In 2011, total production of marine shrimp in Bangladesh was approximately 225 thousandmillionton(Jory and Cabrera, 2012) and in FY 2010-2011 its contribution was 2.73% of export earnings in the economy (DoF).Though the shrimp farming is profitable to the coastal community and to the country, but therandom and disheveled farming is assumed to have negative impact on the environmentin that areass. Shrimp culture is a labor intensive (low capital intensive) production. Both extensive and semi-extensive shrimp farming are in practice in Bangladesh with high labor intensity. So, the impact of shrimp farming starts from the methods used in collecting the shrimp frywhich destroys other marine species and for cultivation of shrimpreduces agricultural land as well as production. During the last twenty years there was a dramatic decline in live stocks with 21% due to reduction of grazing field (Anwar, 2003) in the coastal areas in Bangladesh.

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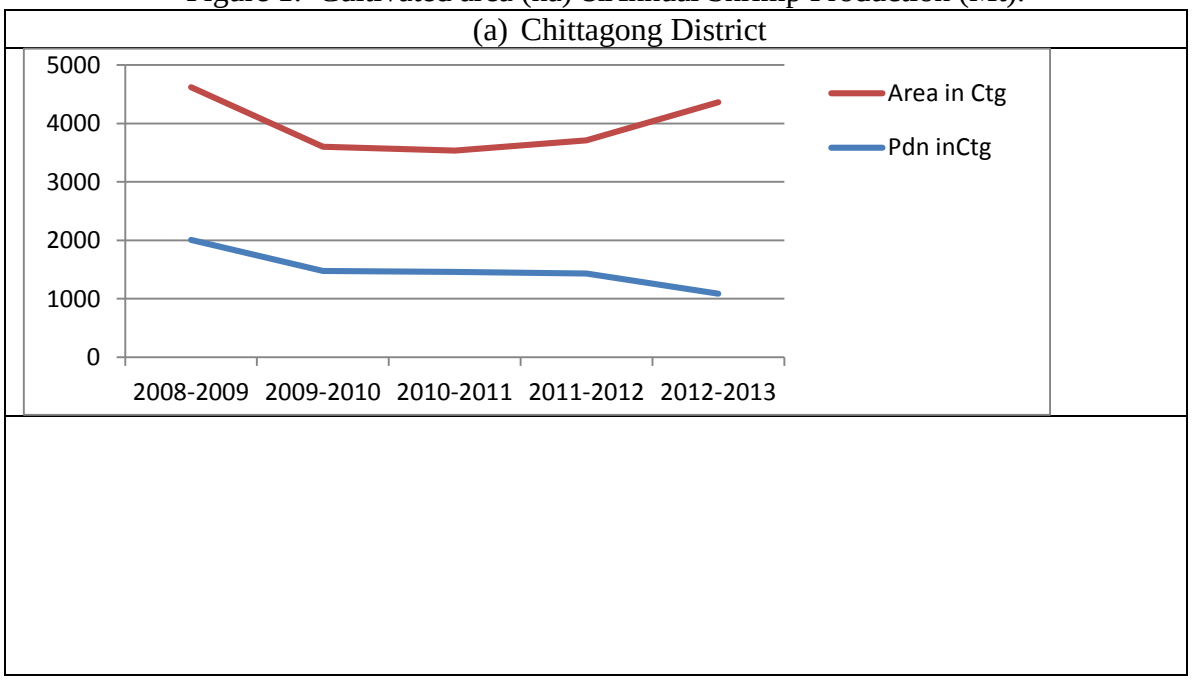
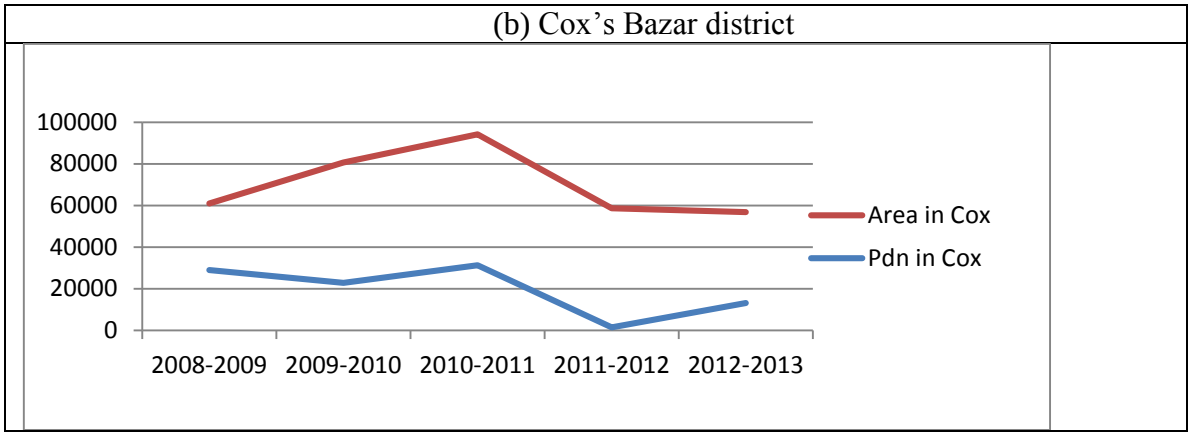
Shrimp farming craves a distinct process which forces farmers to dig ponds in the coastal area using saline water. So, it has two effects in coastal area, the former of which reduces coastal wetland by digging ponds and the latter is draining saline water inside the coastal area which hinders the eco-system and has a spillover effect on agricultural production. With the rapid increase of salinity in thecostal belt, it reduces fertility of agricultural land. The coastal areas of Shatkhira, Khulna, Bagherhat andCox'sbazar are mainly shrimp producing zones in Bangladesh. Annual shrimp & prawn production is 28,514 Mt (headless) which earns16,150 Million BDT as foreign exchange.

Since it is profitable, the land owners then migrates their cultivable land into aquaculture. Graph 1shows that the land employed in shrimp culture is increasing in Cox'sbazar district though there is a decreasing trend in Chittagong district.The main input of shrimp production, the prawn fry, which is dependent on wild postlarvae (PL), is now also produced in hatcheries. But the quality of hatchery PL is questionable since there is no regulation, though out of a total of 81, 42 hatcheries are actively in operationin Bangladesh (Ahmed, 2008).

Due to lack of authorized control or national strategy in Bangladesh, shrimp farming expanded rapidly without careful planning and strategic system. Thus, it increased from 20,000 ha in 1980 to 70,000 ha in 1985; 115,000 ha in 1989, 203071 at 2003-2004 FY and 275274 ha at 2012-2013 FY. As a result, expansion of shrimp farming / aquaculture depletes mangrove forest by a much higher rate and 50% of 18,200 ha of mangrove in coastal area were destroyed for aggressive shrimp culture.Shrimp farming also has increased salinity in the soil, reduced agricultural production; earnings of the peasants; livestock and employment. In spite of all negative impacts of shrimp farming on environment, people are employing cultivable land to shrimp farming. Figure 1 shows the trends of areas of cultivated land and yearly production of shrimp farming from FY 2008-2009 to FY 2012-2013 in Chittagong and Cox's Bazar districts. Plate (a) in figure 1 shows the trend of areas and production in the Chittagong district and plate (b) shows the trends of areas and production for Cox's Bazar district. The trends in plate (a) and (b) in figure 1 state that there is an increasing trend for employing more cultivable land for shrimp farming, though there was a slight fall in land employment in Cox's Bazar during FY2010-2011 to FY2011-2012.

Figure 1: Cultivated area (ha) &Annual Shrimp Production (Mt).





Source: Statistical Year Book (FY 2008-2009 to FY 2012-2013)

This study evaluates the environmental cost of shrimp farming in selected coastal areas in Bangladesh and finds out alternatives to the usual practice to minimize the cost of environment.

LITERATURE REVIEW

Shrimp culture has a great deal of environmental impact in coastal areas. Several previous studies wereconducted to find the impact of shrimp farming on environment.

Rahman et al (2009), Islam et al(2002), Kabir and Jananeva (2014), Chowdhury et al (1994) investigate environmental and socio-economic impact of shrimp culture in Bangladesh. Rahman et al(2009) findthat the soil and water, fish habitation, agricultural cropland, grazing land,indigenous fish, household vegetations, trees and plants, land fertility and mangrovesare affected negatively by the shrimp farming in the coastal area.Islam et al (2002) find shrimp farming has negative effects on the production of cereal crops and vegetables, trees and plantation, poultry and livestock, coastal environment and agro-ecosystem, which have moderately changed the bio-diversity in the study areas. Kabir and Jananeva (2014) find that "due to poor drainage system and continuous shrimp farming … salinity levels of both soil and water areincreasing (1.6 ppt and 13.4 ppt respectively). In addition PH, salinity, electricalconductivity of soil and water have been found in a very fragile condition. Differenttypes of heavy and toxic metals such as Na, Fe, Cr, Zn, Ni and Pd have been detectedin *ghers'* soil".Chowdhury et al (1994) report that coastal communities are most vulnerable to topical storms due to mangrove clearance which is caused by shrimp farming. The rapid expansion of shrimp farms also increases the level of salinity in the coastal cultivable lands and reduce the bio diversity in the coastal area (Toufiq, 2002).

Dieberg and Kiattisimul (1996) infers that shrimp culture destroys coastal zones as well as sustainable aquaculture system in Thailand. They found that from 1979 to 1993, 16 to 32% of mangrove forest was destroyed from shrimp culture.Primavera (1999) has emphasized on mangrove clearance as a cause of life and property damage in the coastal area in the Philippines. Whereas for explaining the causes of mangrove loss he has identified shrimp farming as one of the mostimportant cause of mangrove destruction. Umamaheswari et al. (2011) report a mixed result about the salinization of lands due to shrimp culture in southern India. Their finding however shows that reducing the saline level to normal level farm can gain Rs. 1000 to Rs. 5000 per hectare.

The socio-economic cost of modern shrimp farming was proven by a cost-benefit analysis (weighing the pros and cons) by Indian Supreme Court. The result shows that shrimp

culture caused more economic harm than good as the damage outweighed benefit by 4 to 1 in AndraProdesh (63 billion rupees vs. 15 billion rupees annual earnings) and 1.5 to 1 in Tamil Nadu followed by a destruction cost of mangrove, salinity and increasing unemployment (Primavera, 1997).

Gunawardana and Rowan (2005) conducted a study on calculating cost of shrimp production on mangrove ecosystem in Sri Lanka. They have calculated that 24% of mangroves were harvested for firewood, 10% for fish or prawn, 8% for construction materials and other miscellaneous products as medicine, honey, tansies for dyes and manure. These all are the direct contribution of mangrove. The indirect values they considered are protection from waves and storms to the coastal area which saves life and properties. They have used TEV (Total Environmental Value) to calculate the cost of shrimp farming on mangrove ecosystem. In calculating the TEV they added the direct use value, indirect use value, option value and existence value of mangrove forests.

The literature reviewed above showed that there is a gap in research which deals with the environmental cost of shrimp farming as a whole in Bangladesh coastal areas. Though there are many research works which considers different services of ecosystem, but no significant studies found that deal with the environmental costs of shrimp farming as a measure of foregone benefits in monetary values. This study thus estimates the environmental cost of shrimp farming in terms of forgone values of ecosystem services. But the focus is on the coastal area in Chittagong only, not to the whole coastal areas in Bangladesh.

METHODOLOGY

This study aims to identify the environmental cost of shrimp farming in coastal area of Bangladesh. This cost is projected as the loss of total environmental value of the coastal ecosystem derived by the introduction or practice of shrimp farming in this area. That is the total environmental cost is considered as the loss of total value of the environmental services. Thus, in calculating the total environmental value (TEV) the monetary value of i) direct use value ii) indirect use value iii) option value and iv) existence value were summed up (Gunnawara& Rowan, 2005). As a result, the total environmental cost of shrimp farming stands for the environmental value lost associated with the shrimp culture. That is,

$$TEC(=TEV) = Cost\ of\ direct\ use\ value + Cost\ of\ indirect\ use\ value +$$
$$Cost\ of\ existence\ value + Cost\ of\ option\ value \quad ---------- (1)$$

Whereas the cost of direct use value involves forestry and fishery products that were possible to collect for households firewood support andloss of agricultural products harvestedin the coastal area due to destruction of mangrove forest for shrimp production.The cost of indirect value for environmentrefers the loss of amenity services due to destruction of the mangrove forest in the coastal area. On the other hand, the cost of option value is the individuals willingness to pay (WTP) to preserve the resources for future uses and the cost of existence value is the individual's concernabout the future use and existence of the resources(Perman et al. 2004).The total environmental cost thus stands for,

$$TEC = TEV = \sum_{i=1}^{n} MTWTP \ = MTWTPxNHhs \quad ---------- (2)$$

Here, NHhs stands for number of households, MTWTP stands for mean total willingness to pay. On the other hand, mean total willingness to pay is calculated as the sum of mean willingness to pay for four types of ecosystem services provided by the nature. That is,

$$MTWTP = \sum (MWTP_{DV} + MWTP_{IdV} + WTP_{OV} + MWTP_{EV}) \text{ ---------- (3)}$$

Here, the mean willingness to pay for each category of ecosystem services is calculated as follows,

$$MWTP = \frac{\sum WTP}{n} \text{ ---------- (4)}$$

Here n refers to sample size for each category of services. Finally, to calculate the environmental cost of shrimp farming, number of households for each unit of area or locality will be used from secondary sources.

The data has been collected from both primary and secondary sources. The primary data has been collected using a questionnaire based random sampling from the coastal area in Cox's Bazar (two upazilasi.e.,sub-districts) and Chittagong (one upazila) Districts.To collect primary data, a set of three different questionnaires were prepared based on Contingent Valuation Method (CVM). The questionnaires were then used tocollect information from different stakeholders like peasants, coastal households, coastal villagers and inhabitants of the coastal villages.Respondents were asked to state their willingness to pay for different services provided by the mangrove forest with a specified questionnaire and at the same time they were asked to assess the loss of their current profession or activity due to the presence of shrimp farming. In addition to this, fewsamples were collected from the owner of the shrimp farms to gather information in assessingthe cost function for the shrimp farming. For collecting secondary data,Upazila statistics department, fishery department, Bangladesh Bureau of Statistics (BBS), and Statistical Year Books were used along with different published articles.

In primary data section, information collected from the coastal peasants was considered for assessing the direct cost of shrimp farming. The people who are living close to the coastal belt receive the indirect support of mangrove forests by protecting their homes and wealth from flood and cyclone. Their information was considered as the indirect cost of shrimp farming since mangrove forest was destroyed due to increase in shrimp farming in the coast line. Finally, the information of the inhabitants of those areas was used to assess the cost of option value and the existence value. Total sample size was 327 (69 from one upazilla of Chittagong, and 138 and120 respectively from two upazilla of Cox's Bazar district).

DISCUSSION OF VARIOUS COSTS

The result is shown in two different systems. Firstly, the Yes/No answers of the CVM from the questionnaire is shown in the following tables and discussed the individuals willingness to pay to avoid the environmental effects of shrimp farming by which environmental cost has been estimated.

Direct cost of shrimp farming

Thissection discusses individual's attitudes towards the environment almost 80% respondents are male while there is only 8% female respondents in the survey.On the other hands, 63% male respondents replied that they are involved in shrimp farming while the rate is also very poor for female workers. Among the respondents about 60% respondents replied that they have the knowledge about the environmental costs of shrimp farming. But only, 9% respondents replied that they tried to do some sort of negotiation with the shrimp farmers though most of them (89%) informed that shrimp farming is available in their locality.

Among the respondents 76% replied that they have noticed the change in the production of agricultural goods, though only 46% male wanted to remedy the effects showing their Willingness to pay. Interestingly, 81% respondents opined that they want the shrimp farms to be continued and only 8% of those respondents showed their willing to pay any kind of taxes or fees to avoid environmental cost.

Though only 9% respondents have replied that they are concerned about the environmental costs of shrimp farming but 83% of them have replied that they have noticed the changes in their productions. In connection to this change noticed in the production they want to avoid the adverse effects of shrimp farming through any policies under taken by the government. To pursue the policies the respondents have shown their willingness to pay if the government asks them to contribute for the avoidance of adverse effects of shrimp farming and it is about 49% . Though the respondents wanted to avoid the adverse effects of shrimp farming but 73% of them (allow the shrimp farming to be continued in their localities. This has been also proven by only8% respondents reply of paying taxes to stop the shrimp farming in their areas.

Indirect cost of shrimp farming (loss of mangrove forest)

The indirect cost of shrimp farming is considered as the loss of mangrove forest in the coastal area which can protect lives and assets from the damages of floods and cyclones.

This section is associated with the survey findings for indirect cost of shrimp farming. Respondents were asked about the benefits of mangrove forests and surprisingly96% of them replied that they are aware of the benefits of mangrove on their lives. Those who are aware of the benefits of mangroves also replied (59%) that it helps saving the properties from the storms and floods.

In this connection, 96% of the respondents expect that the mangrove exists for the future. To fulfill their desire of existence of the mangrove 72% respondents showed their willingness to pay.The finding also shows that almost 79% respondents know the number of shrimp farms in their locality and 54% of them noticed the changes in the mangrove forest after the installation of the shrimp farms in their villages or unions. In protecting the mangrove forest 67% of the respondents showed their willingness to pay if there is any demand for it. Though some of them did not notice mangrove destruction but 94% of the respondents want to protect the mangrove from the destruction.

Cost of option value and existence Value

This section summarizes the findings of cost of option and existence values from the survey data.In calculating the option cost and existence cost, the consideration was only the option value and existence value of mangrove forest lost due to the shrimp farming. In asking questions to the respondents, a scenario has been described on shrimp farming which created a threat to coastal mangrove forest which has the option value and existence value.

It turns out that 90% respondents have the knowledge about the importance of mangrove forest. Mangrove forest in the coastal area has a tourist value as well and 62% of the respondents have replied that they have visited the mangrove forest as a place of tourism. There are 38% respondents who replied that they have a plan to visit the mangrove forest very soon, though 36% of the respondents replied that they will visit the mangrove forest in the future. In connection to their visit plan, 32% respondents showed their willingness to pay for the conservation for the mangrove forest. For the existence of the mangrove, 65% of the

respondents showed a positive desire whereas, 66% respondents showed a willingness to pay for the conservation of the forest either for existence or option values it creates for us.

EMPIRICAL RESULTS

To calculate mean willingness to paythe total value of each category is divided by the total number of respondents. Then all mean willingness to pay is added to get the mean total willingness to pay as a proxy of per acre of mean total environmental cost of shrimp farming. The mean total environmental cost of shrimp farming then transformed into USD to make it more convenient for comparison with other countries.

Table 1: Calculating Mean WTP (Mean Cost) Per acre/year

	Direct Cost in BDT	Indirect Cost in BDT	Existence cost in BDT	Option cost in BDT	Mean Total in BDT	Total in USD
Mean WTP/Acre	285.6	339.71	187.33	228.48	1066.64	$ 13.67
Median WTP/Acre	100	200	200	120	620	$7.95

Note 1USD= BDT 78

Now considering the mean total cost of shrimp farming (mean total willingness to pay) from the above table the total environmental cost of shrimp farming has been calculated in the following table. For simplicity, the mean total willingness to pay as environmental cost of shrimp is multiplied by the number of households in each level of area. The rest of the information was collected from BBS Census 2011.

Table 2: Total Environmental Cost of Shrimp Farming

Union Parishad			**Union Parishad**			**Union Parishad**			
Gandamara	Baghmara/ Katharia	Saral	Magnama	Rajakhali	Bara Bakia	Kutubjom	BoroMaheshkhali	Hoanak	Kalarmarchara
6.88 M	4.03M	7.66 M	4.25 M	4.86M	3.88 M	5.72	8.69M	10 M	9.53 M
Banshkhali Upazila 89.82 M ($1.152 M)			Pekua Upazila 34.07 M ($4.37)				Moheshkhali Upazila 62.054 M ($7.955 M)		
Chittagong District 1634.11 M ($20.95 M)						Cox'sbazar District 443.67 M ($ 5. 688)			

The calculated results (Table 2) for environmental cost of shrimp are shown for union level, upazila level and later on district level. For ethical ground of view divisional level environmental cost is not calculated since shrimp farming and coastal area is not available in all the districts in Chittagong division. The result shows that yearly environmental cost of shrimp in BanskhaliUpazila is $1.152 M where is it it $4.37 M and $7.955 M in PekuaUpazila and MoheshkhaliUpazila respectively. It is clearly seen that environmental cost is very high in the upazila's in Cox'sbazar district comparing to aupazila in Chittagong district. It is quite likely and expected as there are many shrimp culture in different upazilas

in Cox'sbazar district. In contrast, district level environmental cost is very high in Chittagong comparing to Cox'sbazar district.One probable cause of this dissimilar result might be for the higher number of households in Chittagong division.

RECOMMENDATIONS TO RECOVER THE ENVIRONMENTAL COSTS

Shrimp culture has been profitable in Bangladesh as it earns foreign exchange, generates employments, and uses natural resources. Though it has some negative effects on environment in the coastal areas but with proper policies, monitoring and enforcement of law and order can help it to remain a sustainable aquaculture. In view of this, some recommendations are proposed and discussed to make the shrimp farminga sustainable and profitable occupation.

Property rights and willingness to pay

Property right is an important tool to reduce the negative externality of an activity, especially for the environmental services as property right is poorly defined here. If property right is well defined for shrimp farming, the environmental cost of shrimp firming could be minimized with the help of Coasian-theorem (1960) since it satisfies the Coasian condition of costs outweighing the polluter's returns. For example, say, the property right goes for shrimp farmers, and thenhe/she will have the right to produce. In this situation the coastal community may come to a negotiation and will be willing to pay the shrimp farmers not to produce shrimp in a large scale. By this negotiation community can reduce the destruction of mangrove forests, save agricultural land from salinity and unproductive. It will also lower the riskof damages from natural disasters like tidal waves and cyclones. Assessing all the costs of shrimp farming the coastal communitywill show their desire of how much to pay (WTP) not to produce shrimp in unplanned and hazardous way.

On the contrary, if the property right is defined in favor of coastal area peoples, then the shrimp farmers will have no right to impose negative externality on the environment which makes the coastal peoples worse off. Thus to continue their present activities, the shrimp farmers will be asked to pay (WTP) to the coastal peoples so that their (coastal people's) cost becomes minimum. This study suggests that the marginal damage of shrimp farming as a compensation is equivalent to $13.66 per acre per year (Table 1).

Permit/ license

One of the best solutions to control shrimp farming could be introducing Permit or Licensing. Permit can help sustainable shrimp farming as well as reduce destruction of other marine species while collecting wild fry.

Tax on Shrimp production

Another alternative of controlling shrimp farming could be environmental tax on shrimp production. However, if environmental tax is imposed, production will decrease and price of shrimp will increase. The rise of shrimp price may inverselyaffect exports of Bangladesh shrimp.

Best Management Practices (BMPs)

According to NACA (Network of Aquaculture Centers in Asia-Pacific) Best Management Practices can be used to make shrimp culture sustainable. They found that well designed and implemented BMPs help to increase efficiency and productivity by reducing shrimp health problems, reducing or mitigating the impacts of farming on environment, improving food safety and quality and improving the social benefits from farming and social acceptability and sustainability.

CONCLUSION

Shrimp farming has been reported as an important economic activity all over the world in the last thirty years despite its negative externality on environment, in particular coastal ecosystems in the farming areas. This study concludes that we should take necessary initiatives to make the shrimp farming as an optimal, sustainable and an environmental friendly means of aquaculture since it is the third export earnings item in Bangladesh, contributes 9% of national exports (Hoque, 1999) enhances employment and uses of natural resources . Thus to internalize the environmental costs associated with shrimp farming the government of Bangladesh could encourage proper management practices, impose new policies (like property right or permit) and strengthen the monitoring activities so that this sector comes environment friendly means of production which may also play an important role in contributing the economy.

However, a sample of size of 327 seems comparatively small in each category of the Contingent Valuation Approaches. In addition, the people in the coastal area are not aware of the approaches used in this study. The limitation that the study faced is to consider the family size or the population size in calculating the total cost through the total environmental value. So, the recommendations of the study should be considered with caution.

REFERENCES

Ahmed, N. (2008). Freshwater prawn hatcheries in Bangladesh: Concern of broodstock. *Aquaculture Asia*, Vol. XIII(3), pp. 22-26

Anwar, S.M. (2003). Effect of Shrimp firming on Ecology in Coastal areas in Bangladesh. An unpublished Term Paper.

Banglapedia: www.banglapedi.org (National Encyclopedia of Bangladesh)

Bangladesh Statistical Year Book, 2012

Bangladesh Statistical Year Book, 2011

BBS, National Census Report, 2011

Billie R. D. (2000). Shrimp aquaculture, people and environment on the Gulf of California. A report to the World Wildlife Fund.

Chowdhury,A.M, Quadir D.A. and Islam M.J. (1994). Study of Chokoria Sundarbans Using Remote Sensing Techniques. ISME Mangrove Ecosystems Technical Report 4:1-22

Coase, R. H. (1960). The Problem of Social Costs, *Journal of Law and Economics* 3(1): 1-44.

Dierberg, F.E & Kiattisimukul, W. (1996). Issues, Impacts and Implications of Shrimp Aquaculture in Thailand. *Environmental Management* Vol-20, No.5, PP 649-666.

DoF. (2003). Brief on Department of Fisheries Bangladesh. Department of Fisheries,Ministry of Fisheries and Livestock, Dhaka, Bangladesh.

FAO, (2009). Bio-Physical, Socio-Economic and Environmental Impacts of Salt-affected Soils. FAO, Web 1(date accessed 11/5/13) Retrieved from http://www.fao.org/fishery/countrysector/naso_bangladesh/en

FAO, Web 1 , Date accessed 11/05/2013 , also available at http://web.archive.org/web/20090505155742/http://www.fao.org/AG/AGL/agll/spush/topic3.htm

Gunawardena, M & Rowan, J.S 2005. Economic Valuation of a Mangrove Ecosystem threatened by Shrimp Aquaculture in Srilanka. *Environmental Management* Vol-36, No.4, PP 535-550.

Hoque M. E. (1999). Environmental Socio-economic impact of shrimp culture in South western Bangladesh. Tropical Agricultural Research and Extension, 2(2): 111-117.

Hoque M. Z. and Saifuzzaman, M. (2002). Social and Environmental Effect of Shrimp Cultivation in Bangladesh: Notes on Study Methods. Chapter 13 of Globalization, Environmental Crisis and Social Change in Bangladesh, Edited by MatiurRahman

Islam, M.S., Wahab,M.A., and Miah, A.A., (2002).Socioeconomic and Environmental Impacts of Alternate Shrimp-crop Farming in Bangladesh, Bangladesh *Journal of Agricultural*. Economics. XXV, 1 (2002) 63-76

Jory, D and Cabrera T. (2012). Marine Shrimp. Ch-21, p-477. Aquaculture: Farmimg Aquatic Animals and Plants, Edt. By John S. Lucas, Paul C, WILEY Publications.

Kabir, M.H,.and Jahanera, I., (2014). Environmental Impacts of Shrimp Aquaculture: The Case of Chandipur Village at DebhataUpazila of Satkhira District, Bangladesh, *Journal of Asiatic Society*, Bangladesh, Sci. 40(1): 107-119, June 2014

Karim M.R. (2006). Brakish-Water Shrimp Cultivation Threatens Permanent Damage to Coastal Agriculture in Bangladesh. Environment and livelihoods in tropical coastal zones. CAB International

Monju, T. (1996). বাংলাদেশেচিংড়িচাষেররাজনৈতিকঅর্থনীতি. Poverty Research Report 13, Grameen Trust Network of Aquaculture Canters in Asia-Pacific (NACA, a) 2001-2010, Retrieved from www.enaca.org/content.php?page=aquaculture_certification

Network of Aquaculture Canters in Asia-Pacific(NACA, b) 2001- 2010, Retrieved from www.enaca.org/modules/shrimp projects/index.php?content_id=3

Owen, J 2004. Shrimp's success hurts Asian environment, Group Says. National Geographic News. Retrieved on June 2015, also available at http://news.nationalgeographic.com/news/2004/06/0621_040621_shrimpfarm.html

Pa'ez-osuna, F. (2001). The environmental impact of shrimp aquaculture: Causes, Effects and Mitigation Alternatives.Environmental Management Vol.28. No. 1. PP. 131-140

Perman. R, Ma, Y, Mcgilvray, J. and Common. M. (1999). Natural Resource and Environmental Economics. Pearson Education Limited, 2 Ed. England

Primavera,J.H. (1991). Intensive Prawn Farming in Philippines : Ecological, Social and Economic Implication. Ambir 20:28-33.

Primavera, J.M. (1997). Socio-economic impact of Shrimp culture. Aquaculture Research 28: 815-827

Rahman, M., M., Flitner M., andKrause, G.,(2009). Environmental assessment of shrimp farming in relation to livelihoods in the south-west coastal Bangladesh, *Bangladesh Fish. Res.*, 13(1), 2009: 47-54

Toufiq, Kazi Ali. (2000). Impact of Structural Adjustment Policies on the environment in Bangladesh. A drafts paper.

Umamaheswari, L.Hattab, K.O.Nasurudden, P. and Selvaraj, PXXX. Should Shrimp Farmers Pay Paddy Farmers? The Challenges of Examining Salinisation Externalities in South India. SANDEE Working Paper No. 41-09

Valiela, I., Bowen,J.L., and York, J.K., (2001). Mangrove Forests: One of the World's Threatened Major Tropical Environments. BioScience 51(10):807-815.
Wikipedia: www.wikipedia.org (The Free Encyclopedia)