NTNU – Trondheim
Norwegian University of
Science and Technology

Environmental degradation and loss of traditional agriculture as two causes of conflicts in shrimp farming in southwest coastal Bangladesh: present status and probable solution

Ajit Kumar Paul

Natural Resources Management
Submission date: June 2012
Supervisor: Eivin Røskaft, IBI

Norwegian University of Science and Technology
Department of Biology

Environmental degradation and loss of traditional agriculture as two causes of conflicts in shrimp farming in southwest coastal Bangladesh: present status and probable solutions.

By Ajit Kumar Paul

Acknowledgements

It is a matter of dignity and pride for me to express my heartiest gratitude, sincere appreciation and profound respect to my honourable research supervisor Dr. Eivin Røskaft, Professor, Department of Biology, Norwegian University of Science and Technology, Trondheim, Norway for his scholastic guidance, constant inspiration, valuable advice, constructive criticism, clear instruction, and excellent co-operation throughout my study period

I also take this opportunity to express my cordial and earnest gratitude and profound indebtedness to Dr. Thor Harald Ringsby, Associate Professor and Co-ordinator of the M Sc in Natural Resource Management Programme for his delicate and analytical approaches to maintaining a high qualitative research work and writing this thesis.

My deepest gratitude is also due to co-supervisor Dr. Subhash Chandra Chakraborty, Professor, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh, Bangladesh, for his kind and valuable suggestions and encouragement in conducting this research and completing my study.

With profound appreciation I would like to recognise the co-operation of the Government of Bangladesh Government for allowing me to complete my higher education abroad.

With my best regards, I gratefully acknowledge the contributions of Dr. Moslehuddin, DD, Dr. Nitayananda Das, DD, Mr. Nityaranjan Biswas, PSO, Mr. Profulla Kumar Sarkar, DFO, Mr. Horendranath Sarkar, DFO, Mr. Mohd. Golam Mostafa, SUFO, and other colleagues of Department of Fisheries for their valuable suggestions, information and co-operation before and during the collection of data.

Last but not least I would like to express my heartfelt love for my wife Bandana Das, my mother Renu Bala Paul, and my other family members who sacrificed their time to care for my son and daughter throughout the study period and tolerate all of the undue and insistent demand of my sweet and naughty boy. Finally, I would like to express my affection and love for my son and daughter, who missed me a lot during my stay abroad.

Ajit Kumar Paul

Table of content

List of Figures

List of Tables

Abstract

A survey was conducted among some of the stakeholders in the shrimp value chain on the south-western coast of Bangladesh. Using a well-structured and pre-tested questionnaire, the attitudes of the respondents towards the problems of environmental degradation and the loss of traditional agriculture were evaluated, and potential suggestions for solutions were sought. Eight negative influences were treated as conflict-generating factors, and the attitudes of the respondents were tested in this regard. Following two hypotheses were tested: a. 'environmental degradation is the main cause of the conflict'; b. 'loss of traditional agriculture is another main cause of the conflict'. To test the hypothesis in relation to the loss of traditional agriculture, three conflict-generating factors were included in the analysis: 'existing farming reduced grazing land for live stock', 'existing farming reduced yearly rice production' and 'existing farming reduced yearly cereal crop production'. Furthermore, to test the hypothesis in relation to environmental degradation, five conflict-generating factors were included in the analysis: 'present farming reduced availability of fresh water' 'present farming increased salt water intrusion' 'present farming caused death of trees', 'present farming increased intensity of cyclone-related hazards,' and 'present farming dismantled embankments providing flood protection.' Attitudes towards seven of the eight, conflict generating factors varied significantly among the four sub-districts (Dacope, Batiaghata, Paikgacha and Shymnagar). Attitudes towards all eight factors varied significantly among four groups of respondents/stakeholders with different land use histories {'mangrove-rice-shrimp' (MRS), 'mangrove-rice' (MR), 'mangrove-rice-shrimp-rice' (MRSR), and 'others'} and four groups of respondents/stakeholders with different farming practices '(brackish water users,' 'fresh water users,' 'alternate water users,' and 'others'). This study revealed that differences between sub-districts and differences in land use histories were the significant contributors to the explanation of the variation in the attitudes towards the conflicts. In our study, we found a trend in attitudes conflict-generating factors were more prominent where brackish water intrusion and brackish water shrimp farming were dominant. The reduction of grazing land available for livestock was a prominent (81.2 %) contributor of conflict in the case of conflict-generating factors related to loss of traditional agriculture. Salt water intrusion (81.2 %) and constraint of fresh water (75.3 %) were the two most prominent contributors of conflict in case of conflict generating factors regarding environmental degradation. Landless people and marginal farmers were the two pioneer groups most intensively involved in these conflicts. The primary arguments of the activists against shrimp farming were related to unemployment, environmental degradation and the loss of traditional agriculture. Two of the most popular suggestions towards sustainable farming and conflicts resolution were to'maintain proper outlet and inlet systems' and to 'maintain alternate farming of shrimp and rice'.

1. *Introduction*

1.1 Theories of conflict

According to conflict theorists, individuals and groups have feelings of relative deprivation when they perceive a gap between the situation they believe they deserve and the situation that they have actually achieved (Ted Gurr, 1970). Numerous scholars have concluded that the struggle over access to and control over natural resources has been an important cause of tension and conflict (Brock, 1991; Brundtland *et al*., 1987; Chouri and North, 1975; Galtung, 1982; Gleick, 1993; Homer-Dixon, 1991, 1993, 1995; Lodgaard, 1992; Opschoor, 1989; Percival and Homer-Dixon, 1998; Renner *et al.,* 1991).

The word 'conflict' carries negative connotations and is frequently considered the opposite of co-operation and peace. Conflict is most commonly associated with violence, the risk of aggression or disruptive (peaceful) arguments. In non-violent settings, conflict can often be seen as a force for positive social change, and its incidence is a visible expression of a society's adaptation to a novel political, economic or physical environment (Craig *et al,* 1998).

Two schools of thought dominate the theoretical battle over addressing the environmental conflict issue (de Soysa, 2005; Gleditsch, 1998, 2003): the Neomalthusian and Cornucopian schools. The Neomalthusian writers have developed theoretical arguments explaining that environmental scarcity causes violent conflicts, and have conducted numerous case studies that seem to support the view that the scarcity of biological assets, such as land and other renewable resources, causes conflict (Binningsbø *et al.,* 2007). The fundamental nature of the developing conflict is that natural resources are potentially scarce, and conflicts occur over these scarce resources. The Neomalthusians believe that the increasing growth of the world's population will lead mankind to the total consumption of resources that cannot be sustained by production. Economic growth becomes negative because it leads to further increased consumption (Gleditsch, 2003). In short, resources, and the technology to exploit the resource are inequitably distributed across the globe. Increasing population growth and economic growth leads to increased resource consumption and resource depletion, with resource scarcity following thereafter. Scarcity will, in turn, lead to competition over the limited access to resources, and violent conflict is a probable result (Gleditsch, 2003).

Cornucopians, have a more optimistic view of the environmental situation and, perhaps, of human nature. While most Cornucopians acknowledge that environmental degradation poses periodic challenges to human well-being, they emphasise the role of new technology, human inventiveness, market pricing, and cooperation in overcoming scarcity (Lomborg, 2001; Simon, 1998). Some argue that it is precisely because of a lack of pressure that resource-abundant countries fail to adopt best practices in economic and political life (Boserup, 1965).

Binningsbø *et al.,* (2007) used the ecological footprint (EF) and ecological reserve as stock measures that capture the environmental capacity for sustaining current levels of consumption (human use) and concluded that a larger EF is negatively correlated with the onset of conflict, controlling for income effects and other factors. They also agreed with Neomalthusian expectations that a greater ecological reserve (biocapacity minus footprint) also predicts peace, although this result is much more fragile. The authors stated that there is little evidence in the theoretical and large-N empirical literature suggesting a direct link from resource scarcity to conflict, but there is more evidence to suggest that obtaining large rents from natural resources hampers the state's capacity and socio-economic progress, which are factors directly linked to conflict. To address scarcity, a society requires ingenuity, but the very scarcities demanding social ingenuity act as constraints on innovation. This factor is referred to as an 'ingenuity gap' (Homer-Dixon, 1999) which develops if society is unable to address environmental scarcity and ultimately leads to social disarray and conflict.

Social friction and the availability of capital prevent a society from supplying the amount of ingenuity that it needs to adapt to environmental scarcity. In this situation five types of social effects can be derived, such as constrained agricultural productivity, constrained economic production, migration, social segmentation, and disruption of legitimate institutions (Fig.1) (includes village, community based organisations, the labour market, class relations, and even the state itself). These five effects canexacerbate the conflict among groups either individually or in combination, (Homer-Dixon and Blitt, 1998).

Hauge and Ellingsen (1998) tested the consequences of deforestation, land degradation, and a scarce supply of freshwater, both alone and in combination with a high population density with respect to indigenous conflict in the period 1980-1992 and found that these factors increase the risk of indigenous conflict, especially low-level conflicts.

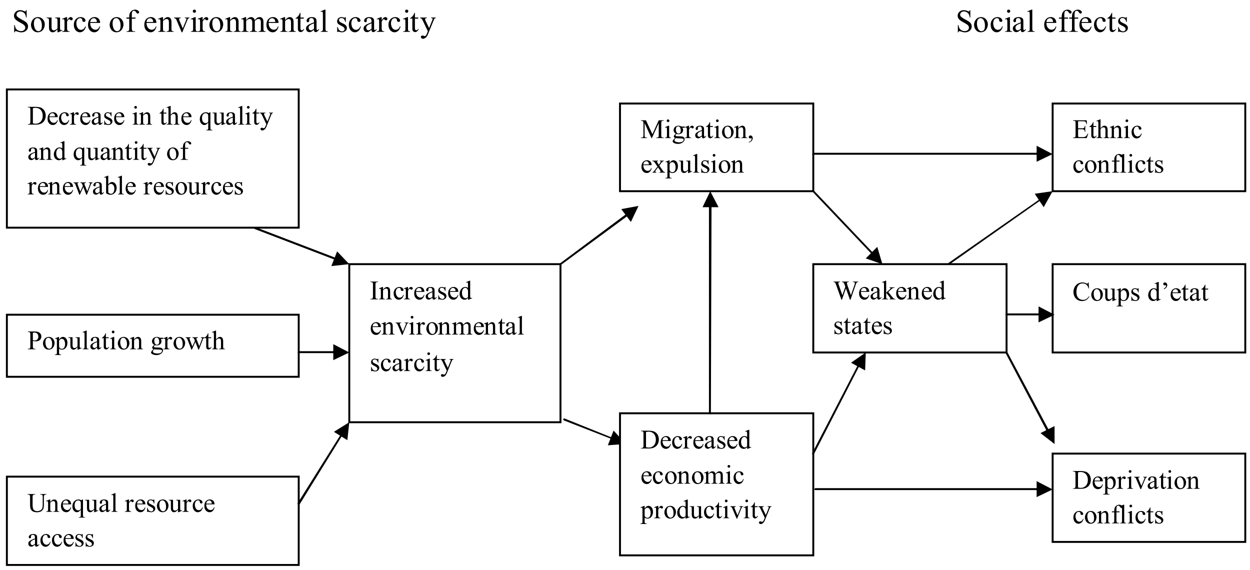

Fig. 1: *Some sources and consequences of environmental scarcity and how they interact and affect each other. Source: Homer-Dixon (1994:3).*

In their book *Ecoviolence: Links among environment, population and security* Homer-Dixon and Blitt (1998) investigated the links between environmental scarcity and the rise in violent conflict. They concluded that profit opportunities lead entrepreneurs to find new sources to replace scarce resources, and adequate flow of adaptive ingenuity permits the economy to respond to scarcity without a significant decrease in the population's standard of living. Here, scarcity is the main barrier against the production of ingenuity and adaptation to economic hardship. They introduced the term "market failures" which occur in two ways in case of renewable resources. First, many renewable resources to which people have "open access" or no property rights, such as the hydrological cycle or productive seas, cannot be controlled physically or divided into saleable units. This situation tends to produce overexploitation. Second, even when property rights exist, market prices often do not take into account the "negative externalities" of resource exploitation. Ultimately, these externalities are costs borne by people who do not participate in market transactions. For example, deforestation can cause siltation of rivers and damage to waterways and fisheries, which could affect the livelihoods of fishermen. Thus, fishermen may experience conflicts with other stakeholders who are responsible for deforestation. Therefore, environmental scarcities often contribute to major civil violence, and poor countries where large portion of the population depend on local renewable resources, such as croplands, forests, lakes and streams, and coastal fish stocks for their day-to-day livelihoods are more prone to exhibit this type of violence.

Increased environmental scarcity often provokes vigorous action by powerful groups and elite members to protect their interest (Homer-Dixon, 1995). These groups are referred to as "narrow distributional coalitions" because they are more interested in distributing the economic pie in their favour than increasing the overall size of the pie so that every body benefits (Olson, 1982). They tend to be small, with a disproportionate amount of political power relative to their size, and they are invariably motivated by narrowly defined self-interest that does not take society's needs as a whole into account. Therefore, they hinder efforts to reform existing institutions when these reforms do not coincide with their own interests. In so doing, this groups "interfere with an economy's capacity to adapt to change and to generate new innovations" (Olson, 1982). This "social friction" caused by environmental scarcities can therefore impede the generation and implementation of solutions to the very same scarcities.

1.2 International perspective regarding shrimp farming and conflict

1.2.1 International perspective on conflicts between shrimp farmers and other stakeholders

Recently, a strong demand for shrimp in the international market and technological advancement have fuelled a rapid expansion of traditional shrimp farming (Hoanh *et. al.,* 2006; Marta, 2009). These rampant and generally unplanned changes have aggravated conflicts (EJF, 2003) among-agriculture, shrimp farming, and fishing, the three dominant resource-dependent livelihoods. Conflicts continue when the people depending on agriculture are reluctant to compromise with the people who depend on aquaculture for their livelihood. Intensification of land use to achieve greater economic benefits also acts as a vector for such conflicts (Hoanch *et. al.*, 2006 and Primaver, 2006). People who seek to intensify their land use pattern for aquaculture and agriculture purposes initiate this conflict with other people (e. g. fisher folk, herders) whose livelihoods may be adversely affected by the negative impacts of a changing land use pattern (environmental impacts). Here, conflicts arise as the first group searches for short-term financial gains, while the second is desires long-term sustainable development (Hoanh *et. al.* 2006).

Worldwide, NGOs (nongovernment organisations) are contributing to introducing the words 'environmental' and 'ecology' among people who make their living from mangroves and to connecting this people into international networks, e.g., the "Mangrove Action Project" and the "International Shrimp Action Network" (ISANet) (Martinez-Alier, 2001). People, who depend on mangrove made a symbolic gesture when circumstances allowed them to do so. In 1998, a local grass-roots group of approximately 300 people in Muisne, Ecuador known as Fundecole, cooperated with other environmental groups to organise an action. The action consisted of the destruction of one crop of shrimp from an illegal pond by opening a hole in the pond and letting the water drain out of it, and followed by the transplantation of mangrove seedlings (Martinez-Alier, 2001). Protests against shrimp farming have led to human deaths in many parts of the world. In Honduras, a movement against the engulfment of mangroves for shrimp farming resulted in the death of individuals such as Israel Ortiz Avila and Marin Zeledonio Alvarado, who were killed on 4 October 1997 in an area called La Iguana (Stonich, 1991) and in Bangladesh, a woman named Karunamoi Sardar, died on 7 November 1990 defending her village of Horinkhola, in Khulna (Ahmed *et al.* 2002, p 15)

Protests against shrimp farming have also been observed in various regions in other Central American countries. In Mexico, a local group at San Blas, Nayarit fought against massive projects for shrimp farming and for tourism. Such projects involved the destruction of thousands of hectares of mangroves. In particular, they fought against a project of GranjasAquanova (Martinez-Alier, 2001). In 1998, the Costa Rican government initiated a plan to change the mangroves protection legislation, thereby allowing shrimp aquaculture and permitting the construction of channels through mangroves to ease the supply of sea water to shrimp ponds with convenient discharge points for pond effluent. Greenpeace and other members of ISANet urged Costa Rican legislators to oppose this change (Martinez-Alier, 2001).

1.2.2 Shrimp farming versus mangrove conservation conflicts

The shrimp-versus-mangroves conflict involves slightly different aspects in different parts of the world according to cultural differences, but it has common structural roots

(Martinez-Alier, 2001). Although shrimp farming is by no means the only factor that challenges mangrove conservation (Lewis *et al.,* 2003), it is an ‘ecological-distribution conflict’ (Martinez-Alier and O'Connor, 1996), that is, a conflict concerning environmental entitlements, the loss of access to natural resources and environmental services, the burden of pollution, and the sharing of uncertain environmental risks (Martinez-Alier, 2001).

Table 1: *Leading aquaculture shrimp producing (in tons) countries.*

SL	Country	2000	2001	2002	2003	2004	2005
01	China	217994	304 182	384141	789373	935 944	1 024 949
02	Thailand	309 862	280 007	264 924	330 725	360 292	375 320
03	Vietnam	89 989	149 979	180 662	231 717	275 569	327 200
04	Indonesia	138 023	149 168	159 597	191 148	238 567	279 539
05	India	96 715	102 930	114 970	113 240	117 589	130 805
06	Mexico	33 480	48 014	45 853	45 857	62 361	72 279
07	Brazil	25 388	40 000	60 000	90 190	75 904	63 134
08	Bangladesh	59 143	55 499	56 020	56 503	58 044	63 052
09	Ecuador	50 110	45 269	46 735	55 500	56 300	56 300
10	Myanmar	4 964	5 473	6 550	19 181	30 000	48 640
11	Philippines	41 812	42 390	37 479	37 033	37 947	39 909
12	Malaysia	15 894	27 014	25 582	26 180	30 838	33 364
13	Colombia	11 390	12 000	14 000	16 503	18 040	18 040
14	Venezuela (Bolivarian Republic)	8 500	10 512	12 000	14 259	16 500	16 500
15	Saudi Arabia	1 961	4150	4650	9 160	8 705	11 259
16	Belize	3 630	4 460	4 400	10 160	11 042	10 433

Source: FAO, 2007.

Shrimp farming leads to uprooting mangroves, which ultimately causes a loss of the livelihood loss of people who directly depend on the mangroves. Alongwith this livelihood loss, mangrove uprooting contributes to the destruction of coastal defences against sea-level rises, breeding grounds for different fishes, carbon sinks, and repositories of biodiversity (such as genetic resources resistant to salinity), together with aesthetic values. Shrimp farming extracts natural shrimp fry, which ultimately shrinks natural shrimp stocks (Martinez-Alier, 2001).

Conversion of mangroves is a severe consequence of shrimp farming. The global extent of mangroves has been estimated at 181,077 km^2 (Spalding *et al.,* 1997). Aproximately 35 % of the world mangrove forests are found in Southeast Asia (18 million ha). These mangroves have suffered the highest losses (70-80 %) over the last 30 years in the Philippines and Vietnam due to shrimp farming. The mangrove loss in the Philippines was estimated to be approximately 50 % between 1951 and 1988. Furthermore, approximately one third of global mangroves were destroyed between 1980 and 2000, among which 35 % were for farming (Valiela *et al.,* 2001). Martinez-Alier (2001) reported that although mangroves on the Pacific coast of Colombia had been preserved thus far, the pressure from the shrimp industry was increasing. In Tumaco, Colombia (very near the border with Ecuador), women lost a communal source of food and cash income due to the conversion of mangroves to shrimp farms (Martinez-Alier, 2001).

Vietnam is the third largest country with respect to aquaculture shrimp production (Table 1). With government patronisation, Vietnamese shrimp farmers have shifted from improved extensive to semi-intensive and intensive shrimp farming. This trend was acute in central Vietnam during late 1990s. At that time, a lot of agricultural land was converted to shrimp aquaculture, encouraged by government subsidies. This development and intensification of shrimp farming destroyed mangrove and wetland areas which ultimately exposed coastal areas to erosion and flooding, altered natural drainage patterns, increased salt intrusion and caused loss of critical habitats for many aquatic species, with serious implications for both biodiversity conservation and food security. Other environmental problems associated with shrimp aquaculture in Vietnam include the dispersion of chemicals and nutrients into the environment, pollution and salinisation of soil and water supplies, and biological pollution of wild fish and shrimp populations (EJF, 2003).

In 2000, Honduras designated Berberia (a wetland area of the Gulf of Fonseca nominated as a Ramsar Site) as a protected area after mass mobilisation by fishermen and forced negotiations with the shrimp farming sector. This ecosystem hosts a wide resident and migratory biodiversity which is linked with the fishing communities, giving them access to firewood, game, fish, and recreation. However, over a few months the Spanish company El Faro converted over 100 hectares of wetlands in the Protected Area of La Berbería into shrimp holding ponds.

In 2004, the Central American Water Tribunal condemned the Government of Honduras, shrimp farmers, and the World Bank for the pollution and destruction of the wetlands. Despite this condemnation, expansion of shrimp farms over the wet land continued. After the completion of a field assessment on 5 March 2010, it was observed that over two hundred hectares of wetlands had been added to thousands of others converted into fish farms in the Gulf of Fonseca. Almost all of the wildlife habitat in this region had been lost, and the fisher-folk had either lost or were fighting for their right to access the mangroves, representing the source of their food and livelihood. The fisher-folk were putting direct pressure on companies to provide social compensation measures. The police and even the state army were protecting the shrimp farming operations, equipment and facilities. The organisation of farming companies stated that "We need more security because while the peasants in BajoAguan try to recover their lands in the South, (Gulf of Fonseca), they have "taken over" a shrimp farm: work cannot be done in this way because they frightens off investment..." (World Rainforest Movement, 2012)

In Malaysia, there were artisanal fishermen's movements in some parts of the country aimed at stopping industrial fishing and the destruction of mangroves. They managed to replant mangrove seedlings outside a large Penshrimp farm in the mid-1990s. In the Philippines, aquaculture activities have been primarily responsible for the clearing of more than 338, 000 ha of mangrove forests since 1968, and have seriously affected the coastal fisheries catches (Gopinath and Gabriel, 1997, page 201).

In India and Bangladesh, there is strong opposition against the shrimp industry. In Bangladesh, there are organisations of fishermen who complain of the loss of fisheries: "They are creating alternatives. They want to fill all the ponds with soil and plant mangroves" (Ahmed *et al.,* 2002). Most of the shrimp farms in Indonesia are located on the north coast of Java. Along this coast, mangrove forests were destroyed between the mid-1970s and mid- 1990s. In 2001, most of these farms were abandoned due to low productivity and environmental degradation. After an abrupt decline in shrimp production due to viral disease, in the year 2000, Indonesia initiated a plan referred to as Protekan 2003 to increase shrimp production at the expense of mangroves over the next three years aimed at occupying to occupy an additional 320,000 ha (Martinez-Alier, 2001).

The Rufiji Delta in Tanzania is one of the most physically stunning areas in Africa. Over an area of approximately 1,500 square kilometres a web of rivers and channels intersect seemingly endless mangrove stands, occationally being interrupted by rice fields (Gibbon, 1997, page 5). An African fishing company proposed a project for prawn farming covering almost 10,000 ha in the Rufiji Delta, which drew great deal of opposition. Protests from environmentalists, local communities that would be displaced (Gibbon, 1997, page 52) and from outside organisations such as Prepare from India, and the Natural Resources Defense Council from the USA, were brought to bear on the government of Tanzania (Martinez-Alier, 2001). Another project previously proposed by NORAD, a private Norwegian company, was abandoned due to complaints of corruption (Gibbon, 1997, page 81).

Shrimp farming has clearly contributed to the overall loss of mangroves, as documented in some countries, but it is by no means the only factor in these losses. Lewis *et al.* (2003) examined the relationship between the decline in mangroves and the expansion of shrimp farming and showed that in Thailand half of the mangrove area present in 1960 had been lost before the shrimp boom in the 1980s.

1.2.3 Other worldwide environmental impacts of shrimp farming activities and conflicts

The ownership of resources in coastal zones is ambiguous along with the interactions among people, resources, and ecosystem. Many authors have presented shrimp farming as a crucial cause of environmental degradation (EJF, 2003; Primaver, 2006). Primaver (2006) described the withdrawal of saline underground water for shrimp farming as resulting in environmental degradation in Taiwan and Southeast Asia. The withdrawal and subsequent use of saline water for shrimp farming leads to lowering of the underground water level, emptying of aquifers, land subsistence and salinisation of adjacent land and waterways. Other negative impacts of shrimp farming are privatisation of public lands and waterways; conversion of residential, agricultural (rice, pastures) and common lands; salinisation of domestic and agricultural water supplies; fisheries decline and food insecurity; rural unemployment and urban migration; and in some cases human rights abuses, social disruption, conflicts and violence (EJF, 2003).

Brazil is the 8th largest country (Table 1) in terms of aquaculture shrimp production (FAO 2007). In 2005, the aquaculture shrimp production of Brazil was reduced by 15.8 % in comparison to 2004, but the number of shrimp farms increased from 905 to 997, covering a flooded area of 16,598 ha. Conflicts as a consequence of environmental degradation due to shrimp farming were observed in Brazil. The observed environmental degradations included destruction of marshes for shrimp pond construction; production of effluents and pollutants; saline intrusion; and introduction of exotic species. NGOs in Brazil organized mobilisation against the rampant growth of shrimp farms and the associated environmental damage. In 2006, in the Caravelas municipality of Bahia state, approximately 1500 ha area of extensive mangrove and 'restinga' areas was acquired for establishing a shrimp farm. There were approximately 1,300 people who were directly dependent for their livelihoods on fishing, crab harvesting, and family agriculture in that area. Furthermore, a wide adjacent area was supporting coral reefs, banks of seaweed, mangroves, beaches and 'restingas'. Due to the protest from NGOs, the Public Prosecutor's Office suspended the licensing process in spite of the favourable opinion of the state environmental agency (Jablonski and Filet, 2008). In Brazil the CONAMA (O CONSELHO NACIONAL DO MEIO AMBIENTE-CONAMA) 312 Resolution provides an exemption regarding environmental impact studies for small-scale enterprises. However, due to the mobilisation and consequent appeals from NGOs, the verdict the Public Prosecutor's Office was that this resolution was unconstitutional.

In Venezuela, plan for large-scale shrimp farms emerged in the early 1980s. In 1987, 14 entrepreneurs submitted proposals for establishing shrimp farms, which were to be located at the western end of Piritu Lagoon in the State of Anzoategui, Venezuela. This area is part of the coastal system formed by the Unare River flood plain and the adjacent lagoons of the Unare and Piritu (Sebastiani *et al*., 1994). Sebastiani *et al.* (1994) studied 3 sites to determine the causes of conflicts between the fishermen's association and entrepreneurs as well as probable environmental degradation. The authors found that this wetland area was a reservoir for a number of bird species, including many with a migratory status. They also noted that the prospective farming activities would alter annual water dynamics which would ultimately prevent the developmental/maturation stages of some fish species and crustaceans from occuring (such as white shrimp- *Penaeus schmitti*) (Padrón and Torti, 1984; Cervigón and Gómez, 1986). Furthermore, some of the prospective proposals were hazardous to the livelihoods of groups of fishermen as well as to biodiversity. The fishermen's associations of the coastal system and the Audubon Conservation Society of Venezuela (NGOs, supported by the Environmental Act - Republica de Venezuela 1976) submitted complaints to the regional and central offices of MARNR (Venezuelan Department of Environment) demanding legal actions against one of the prospective shrimp farms. The National Press also supported the fishermen's association on this issue and two of the three projects were finally halted by the governmental agency based on an Environmental Impact Assessment (EIA) report and illegal ownership.

1.3 Research problems and research objectives

Bangladesh is a riverine Asian country, situated among the largest deltaic Asian rivers: the Ganga, the Brahmaputra and the Meghna. Bangladesh is a very densely populated country with a human population of more than 140 million. More than 12 million of these individuals are directly or indirectly involved in the fisheries sector. Bangladesh includes 4,560,900 ha of inland water bodies and 166,000 km^2 of marine water bodies. All of these water bodies are propitious for fisheries production. Southern Bangladesh is exposed to the Bay of Bengal. This southern coastal region is suitable for brackish water shrimp farming. The coastal aquaculture in this area is a very old and traditional type of aquaculture. The local people practiced traditional coastal aquaculture, locally referred to as *Bheri*-culture, for centuries. They would intake tidal water for their paddy fields from January/February to June/July for aquaculture, and during the monsoon season, they would cultivate transplanted *aman* (paddy usually cultivated during the monsoon) plantations. The applied aquaculture was totally traditional. There was no fry stocking, artificial feeding, liming, fertilisation or aeration. The crops harvested were shrimp and fin fishes as well as paddy (Ahmed *et al*., 2002).

In the early 1960s, the government constructed a large number of coastal embankments to protect agricultural land in coastal areas from tidal waves and saline water intrusion. Almost all canals and medium sized rivers were closed with cross dams and the entire coastal area was subjected to embankment and divided into polders with small and large drainage sluice gates. This process brought an end to traditional shrimp aquaculture in these areas. However, since the 1970s, a strong international market demand and high prices for sea food products have encouraged farmers to resume shrimp farming in polders within the embanked areas. Equally important was the fact that it was no longer financially viable to cultivate rice because the polders had become waterlogged due to poor drainage. The combination of these two factors provided a catalyst for the acceleration of shrimp farming activities (Karim, 1986). The government of Bangladesh recognised shrimp farming as an industry under the Second Five-Year Plan (1980–85) and adopted necessary measures for increasing shrimp production (Haque, 1994). In 1979–80, slightly more than 20,000 ha were under shrimp cultivation (Ahmed, 1988). According to an estimate of the Master Plan Organisation (MPO, 1986), the total area under shrimp culture was expected to have risen from 96,048 ha in 1990 to 135,000 ha in 2005. Patronised by the government, development agencies and International Financial Institutions shrimp farming has grown rampantly as a means of reducing poverty, creating employment and generating revenue. The fundamental reasons for rampant growth of export-based industrial aquaculture are that it is considered helpful for developing countries to achieve food security and enhance development. Supporters argue that this practice leads to substantial socio-economic benefits, such as increased nutritional levels, income, employment, and foreign-exchange and results in vastly un-utilised and under-utilised land and water resources being brought under culture (Marta, 2009).

The leading shrimp farming areas of Bangladesh are the Bagerhat, Khulna and Satkhira Districts (80% of the total area) in the south-western region, Cox's Bazaar District in the south-eastern region and, to some extent, the Pirojpur District in the south-central region. Experts and fishery resource planners predict that all of the leading shrimp areas are unlikely to experience similar expansions. The Satkhira District has the greatest potential for the expansion of shrimp farming in the southwestern region, while the potential for expansion in the Cox's Bazaar District of the southeast also appears to be quite high (MPO, 1987).

The shrimp farming practices in coastal areas have been influenced by technological, social, economic, and environmental changes. A variety of farming practices are currently applied in the southwest coastal area. In some regions, the cropping pattern involves brackish-water shrimp culture during the dry months (December–July), followed by the cultivation of transplanted *aman* rice in July through to December. In other areas, shrimp farming is characterised by monoculture. In the southeastern coastal areas (i.e., Cox's Bazaar region) shrimp are grown from May to November, and for the rest of the year, the land is used for salt production. In some parts of the southeastern tidal area, rice alternates with shrimp and fish production (ESCAP, 1988). However, three main types of shrimp aquaculture are practiced in the coastal areas: extensive, improved extensive, and semi-intensive. The main commercial species used incoastal shrimp farming is the black tiger shrimp, *Penaeus monodon*, although other species, such as *P. Indicus* and *Metapenaeus monoceros,* are also found on some farms, usually introduced from natural sources. The fresh water prawn, *Macrobrachium rosenbergii* is also being introduced in coastal shrimp farming. In the case of extensive shrimp farming,

Fig 2: *A sluice gate (indigenous technology) for taking in brackish water to a shrimp farm.*

minimum inputs are needed. Embankments are usually constructed, and the entrance of natural shrimp/fish fry is facilitated. The yearly production under extensive culture is approximately 250 kg/ha. This type of farming is rarely found at present. An improved extensive method of shrimp farming is common, representing a slight modification of the traditional extensive method, whereby farmers apply several components of shrimp farming technologies. Most of these farms are shallow, and indigenous technology is used to intake brackish water from an adjacent river or canal (Fig. 2) during high tide. In some areas where the aquifer is brackish in nature, it is pumped out via a mechanised power pump and used as a water source (personal observation). Some farmers plough their land and use organic (e.g., oil seed cake, poultry droppings, cow dung) and commercial chemical fertilisers before taking water into their ponds. Water exchange may be performed during high tide at new moon and full moon. Natural or hatchery fry are stocked; homemade or commercially formulated pelleted feed is used; and additional organic/chemical fertilisers are applied to promote phytoplankton and zooplankton production. In most cases, stocking of additional fry is carried out for each subsequent partial harvest. Partial harvesting is performed using tools such as cast nets, box traps, and scoop nets. Harvesting is more common during the new and full moon. This method is most likely specific to shrimp aquaculture in Bangladesh. An annual yield of 250–1,000 kg of shrimp can be obtained (Mazid, 1994; Ahmed, 1996) from improved extensive farming. The current trend in farming practice involves a new type of innovation. Massive die-offs of black tiger shrimp are a common phenomenon in coastal shrimp farming. *P. monodon* is susceptible to viral diseases (especially white spot disease) while *Macrobrachium rosenbergii* is not susceptible to infection with white spot virus. For this reason, farmers stock the fresh water prawn simultaneously with black tiger shrimp in low salinity (usually less than 5 ppt) ponds to minimise the risk of losses. This type of practice is more common in cases of integrated or alternating farming of shrimp with rice. Here, it should be emphasised that the optimum range of salinity for the black tiger shrimp is 20-25 ppt (Chiu, 1988). In contrast, fresh water prawns grow well in fresh water. Therefore, in a pond with this level of salinity, both species grow slowly, but at the end of the season, the farmer expects a significant harvest in terms of monetary income if there is no massive mortality due to disease. In the case of integrated farming, farmers dig a deeper canal alongside the embankments (Fig. 3) of the pond where shrimp/prawns are stocked during rice cultivation, and after harvesting the rice, they increase the height of water (taken in by using a sluice gate or mechanised power pump) so that shrimp/prawns can access the rest of the field.

The semi-intensive method requires the incorporation of a nursery phase in the shrimp farming process. Shrimp fry obtained either from wild catch or commercial hatcheries are stocked in nursery ponds at high densities before being transferred to the shrimp farm (*ghers*).

The annual yield is 500–5,000 kg/ha (head on) averaging of 2,000 kg/ha (Rosenberry, 1995). In 1995, only 1% of the shrimp farms in the country used this method (Begum and Banik, 1995; Rosenberry, 1995).

Fig. 3: *An integrated (shrimp cum rice) farm.*

In 2011 the fisheries sector achieved third place, after the garments and jute sector, interms of export earnings. In the 2010-2011 fiscal year, the total export earnings from the fisheries sector was US$ 550 million. A lion's share of these export earnings come from shrimp-based products, a major portion of which involve *penaeid* shrimp cultivated in brackish or saline waters in coastal areas of Bangladesh. Over 203,071 ha of water bodies are currently suitable for shrimp farming.

Many stakeholders in the southwestern coastal area of Bangladesh have been organising with the aim of emancipation from the hazardous effects of shrimp farming. They are now adamantly supporting only rice farming in the low lands (which are normally used for shrimp culture by taking in saline water during high tide) by inhibiting saline water in take for shrimp culture. Owners of shrimp farms intended to intake saline water (which is not suitable for paddy culture) for shrimp farming. This conflict among farmers decreases shrimp production and export earnings along with increasing social unrest. The USFDA (United States Food and Drug

Administration) and EU authority asked the Bangladesh government to solve this problem before exporting shrimp to their countries. Exporters have been demanding the expansion of sustainable shrimp culture vertically together with horizontal expansion. They are emphasising earning foreign currency along side with income generation for women, who are involved in processing activities.

Loss of traditional agriculture and environmental degradation are being treated as the main causes of the prevailing conflict. Islam *et al.* (1999) argued that some adverse effects of shrimp farming on soil properties occur due to increasing soil salinity levels (up to 500 %) in non-saline areas, which hampers crop cultivation. Rahman *et al.* (1995) reported that unplanned shrimp cultivation resulted in decreased rice production, destruction of trees and vegetation due to salinity, declines of house hold income from non-farm sources, especially from ecological reserves, reduced production of poultry and livestock, and various forms of social conflicts. Manju (2000) investigated perceptions regarding environmental destruction due to extensive shrimp farming in southern coastal areas and identified declines in plants and trees as the most important problems. Many authors (e.g., Begum and Alam 2000; Bhattacharya *et al.,* 1999; Deb 1997; EJF 2003; Islam 1999) have reported that shrimp farming in the southern coastal region of Bangladesh increased soil salinity, reduced grazing land, with consequent reductions of livestock numbers, and had adverse effects on the overall cropping pattern in shrimp growing areas. Deb (1997) noted salt water intrusion as a vector for fresh water crises in shrimp farming areas. Shrimp farmers illegally dismantled flood protection embankments and constructed wooden structures (Fig. 3) for taking in saline water to their farms from adjacent rivers, which could allow water surges in embankment areas during cyclones. Thus, embankment areas became vulnerable to cyclonic hazards (Ahmed, 2002). According to a report of the EJF (2003), shrimp farming has caused decreased rice production in coastal areas. For instance, the rice production in the Satkhira District declined from 40,000 tons in 1976 to just 360 tons ten years later due to salt water intrusion from shrimp farm canals crossing ricefields. The report also noted that many landless people in Bangladesh who grazed livestock on *khas* (government-owned) land lost their livelihoods due to illegal encroachment on these *khas* lands by the influential shrimp farmers.

Highly profitable earnings in comparison to rice farming tend to attract outside investors rather than local workers. Seventy-five percent of shrimp farm investors in the coastal Khulna and Satkhira districts were from outside these areas, and 120,000 people were driven from their farmland in the Satkhira region (EJF, 2003). Majid and Gupta (1997) reported that small rice farmers are compelled to lease their lands to large shrimp farmers, and thus shrimp cultivation has led to social conflicts over land tenure and use rights. Due to the conversion of agricultural land into shrimp farms, sharecroppers and landless wage labourers lost their livelihoods and began movements to resist the introduction of shrimp farms in the areas where they live (Islam, 2006).

It is unlikely that stopping shrimp culture is the only way to resolve this crisis. A significant number of stakeholders, such as the depot owner, *faria* (intermediary group), ice factory owner, feed mill owner, hatchery owner, owner of the fish processing plant, employee engaged in shrimp farming and processing plants, and vendors or fry sellers, are attached to this value chain. A solution for this crisis should be prioritised.

Hossain and Lin (2002) proposed a probable solution to reduce social conflicts and promote the sustainable use of land, suggesting that land should be zoned on the basis of suitability into most suitable, moderately suitable and less suitable zones. They hoped that this would be helpful in minimising the unplanned horizontal expansion of any land use type especially shrimp farming, and maximise productivity from smaller areas through vertical integration, thereby improving socio-economic conditions along with maintaining environmental balance.

The Bangladesh government is soon going to finalise a Shrimp Policy. It is believed that such a policy will set the size of each shrimp cultivation pond considering the socio-economic activities of the area and the noted negative effects on both socio-economic value as well as the environment of the area concerned, followed by remedial measures. In an attempt to establish sustainable and environmentally friendly shrimp culture, management of this conflict is the prime issue. Therefore, there is an urgent need to analyse the situation delicately and determinea road map for resolving the conflict to achieve sustainable shrimp production to improve export earnings, along with domestic food security.

The objectives of this research project are to understand the cause of the increasing conflict and the present status of the conflict among stakeholders as well as to propose suggestions for resolving the conflict.

Hypotheses: The following two hypotheses were tested:

a. Environmental degradation is the main cause of the conflict;
b. Loss of traditional agriculture is another main cause of the conflict.

2. Methodology

2.1 Type of data

The data collected for the study were both quantitative and qualitative.

2.2 Study design:

Face-to-face interviews with some of the stakeholders in the shrimp value chain were performed using a well-structured and pretested questionnaire to determine the present status of the conflict related to environmental degradation and loss of traditional agriculture, and probable solutions related to this conflict in the southwest coastal part of Bangladesh. Some key informants and key indicators were also interviewed without a questionnaire but asking their opinion on specific issues. Four sub-districts from two districts were selected as the study area.

2.3 Study area and choice of respondents

2.3.1 History of the landscapes

To analyse the status of the conflict related to shrimp farming, it is important to examine the historical changes associated with the land use patterns, agricultural activities, and physical and geographical properties of the areas.

Wang Ta-ytian (1349-50), a Chinese merchant and traveller in the Bengal, and another Chinese visitor, FeiHsin (1436), made significant observations regarding ancient Bengal. According to them, Bengali people were honest, quiet, laborious, and efficient in tilling and planting. The soil was fertile, and they managed to produce two crops every year. Thus, they achieved all of their prosperity through devotion to agriculture in lands originally covered with jungle. Both men witnessed the transformation of the land from jungle to rice paddy at a time between 1204 and 1575 (Eaton, 1990).

According to Eaton (1990), in the mid-fifteenth century, there were a number of prominent *pirs* (Muslim holy men) who dominated the development of agriculture along with the articulation of the Islamic religion. *Pir* Khan Jahan and Mubarra Ghazi were the pioneers in the Khulna and Satkhira regions. During the Mughal reign (1612-1757), numerous intermediary groups arose between the Mughal authority and the land users in this region. They included *ta'alluq-dars, sarkars*, and *zamindars*, among others. In this tenure chain, the *zamindar* was at the upper end, and the actual cultivator was at the lower end, with numerous *ta'alluq-dar* and *sub-ta"alluq-dars* between them. “Reclamation of forest was no easy task. It took three or four years to clear the land for regular cultivation during which cultivators and labourers had to be maintained in a country where communications were difficult, rivers dangerous and markets few” (Eaton, 1990).

Richards *et al*. (1990) noted that two initiatives implemented by the colonial administration after a coup at Plassey helped the original cultivators to achieve land ownership in this area. First, the new East India Company administration granted tenure for reclaiming wasteland to Bengali applicants as early as 1770. The reclamation program rewarded cultivator settlements with land ownership. These settlers/cultivators were mostly migrants from other districts. Second, after 1830, the official policy gradually shifted from bestowing huge land grants on speculative entrepreneurs to favouring smaller grants to less wealthy applicants who would actually manage or even cultivate the lands themselves. These initiatives were most likely the two most influential causes of the settlement of numerous marginal farmers in this area. It is also remarkable that this area was the amalgamation of people from different trivial cultures.

Under the Permanent Settlement system, in 1793, the East India Company stipulated the taxes to be paid in perpetuity on landed property by a small group of large landholders (known as *zamindars*). As long as these *zamindars* paid their taxes promptly, they held complete ownership rights regarding alienation, mortgage, lease and inheritance over their land. If they did not pay their land taxes, their lands would be sold by the state to another purchaser (Rischards *et al.,* 1990). Thus, during Permanent Settlement, the property rights of a large number of original cultivators might have been ignored.

However, the usual course of reclamation was deforestation of the land, construction embankments, and then plantation of rice in alluvial soils when monsoon rains reduced their salinity. Rischards *et al.* (1990) also described the land use pattern of the settlers/farmers. Along with the dominant crop of *aman* rice, settlers grew limited quantities of vegetables for personal use and planted fruits such as coconut, mango, and jackfruit on raised plots or the bunds protecting their homesteads. Aman rice was usually sown in May or June, transplanted between mid-July and mid-September, and harvested in December or January. Settlers developed techniques for highly productive aquaculture as well. Several species of fish and several types of prawns could be grown in flooded rice fields. Other bunded areas that were still brackish could be used for annual trapping and harvesting of numerous species of river fish. These agricultural/aquacultural activities indicate the farmer's innovativeness toward the maximum utilisation of their land resources.

The landscapes taken as study areas historically belonged to communal peace, but conflicts existed regarding the forest and with uncultivated land (Eaton, 1990).

2.3.2 Study area and respondents

The study area was the southwest coastal region of Bangladesh, which included the Khulna and Satkhira Districts. I selected three sub-districts from the Khulna District and one sub-district from the Satkhira District. There are 8 *Upazila* (Sub-districts) in the Khulna District, among which 4 *Upazila* (Dacope, Batiaghata, Kaira and Paikgacha) are dominant in terms of shrimp culture. In the Satkhira District, there are 7 *Upazila*, among which 5 *Upazilas* are dominant (Tala, Ashasuni, Debhata, Kaligong and Shaymnagar). We selected 3 sub-districts, Dacope, Batiaghata, and Paikgacha in the Khulna District and the Shamnagar Sub-district from The Satkhira District. The sampling areas were as follows: Polder (Embankment area for flood protection) No. 31 in the Dacope *Upazila;* Polder No. 30 in the Batiaghata *Upazila;* Polder No. 16 and 23 in the Paikgacha *Upazila*; and Polder No. 5 in the Shaymnagar *Upazila* (Fig. 4).

The study areas were selected considering two main points: first, whether the area was dominated by shrimp farms, and second, whether the area is conflict prone. These two factors were examined through a literature review, personal observations, and consultation with the responsible personnel (Sub-district Fisheries Officers and District Fisheries Officers) in the study areas.

Approximately 50 respondents were interviewed from each sub-district. The database available in the Sub-district Fisheries Office regarding shrimp farming was initially considered for selecting polders and unions. The list of complaints regarding shrimp farming (if available) was considered so that conflict-prone areas were not excluded from the interviews. The number of respondents for each polder and union was selected based on the number of farms in operation in the respective polder and union. Stakeholders such as marginal shrimp farmers, poor shrimp farmers, rich farmers, depot owners (secondary stakeholders), leasees, and leasers were interviewed. Household heads (mostly males) were usually interviewed; however, in their absence, any member of the household with an age above 18 years who was willing to participate was interviewed. Households and farms were chosen randomly. Responsible officers and staff members, as key informants, were also consulted to obtain information regarding farming trends, the nature of conflicts, and communication system and the location of the area. After obtaining information from respondents, three key indicators were interviewed to collect data. Two data enumerators were appointed and trained for collection of data. The study period was approximately two months during summer (June- July, 2012). A local guide was also hired from the respective sub-district who was familiar with the study area and people.

2.4 Preparation of the questionnaire

The questionnaire was prepared based on the hypotheses presented above (see Introduction). The questionnaire was well structured, including both closed-ended and open-ended questions and both qualitative and quantitative questions. A common questionnaire was prepared with all of the required questions to cover all stakeholders. Open-ended questions were mostly asked at the end of the interview. In the case of closed-ended questions, the 'others' and 'specify' options were used to avoid missing data. General questions about the respondents, such as their name, age, occupation, yearly income, and the total land/pond areas under their control, were included. The collected farm-related information included the cropping pattern (Brackish water shrimp farming/Fresh water shrimp farming/rice farming/other) and sequence of land use history (Mangrove-rice/Mangrove-rice-shrimp/Mangrove-rice-shrimp-rice/other). Examples of conflict-related questions include "is there any negative influence of the present farming practices?" Yes/No; if yes, "does it create salt water intrusion in a fresh water area?" Yes/No; and "have trees died?" Yes/No. An example of an open-ended question is "what are your suggestions for sustainable farming?" Sufficient space was provided for open-ended questions. We used a coding option for some questions, such as regarding occupations, sex, the sequence of land use history, and the cropping pattern. First, the questionnaire was prepared in English and approved by the supervisor. I translated the questionnaire into the Bengali language, and the sentences were relevant and simple; after a pretest, several changes were made and reported to the supervisor for approval.

2.5 Procedure for data collection, and determining the relevance and quality of data

The study was financed by the Quota Scheme Programme and Department of Biology, NTNU, Norway. Prior to beginning data collection, I visited all of the sampling areas (sub-districts) and met all of the Officers relevant to targeted stakeholders, informed them about my research objectives, and asked for their suggestions regarding smooth implementation of the survey. Along with two data enumerators, I collected data in interviews through face-to-face communication using the questionnaire. The Data Enumerators were thoroughly briefed regarding the objectives of the project, the prevailing situation of farming practices, and the probable relationship of the farming practices to environmental degradation and the loss of traditional agriculture. Additionally, the Data Enumerators were trained in such a way that they were able to explain the goal of the study and probable answer/answers for each variable and question in the questionnaire. According to the sampling plan, we travelled to the respective area, met people ('gate keepers') to obtain initial information about farmers, targeted the proper respondent, and requested his consent for a face-to-face interview by explaining the research objectives briefly. We usually spent approximately 15-25 minutes with each respondent. In the case of key informants and key indicators, a prior appointment was made by explaining the objectives of the interview. In the case of some open-ended questions, the respondents were given hints about probable answers. When the respondents were confused regarding an answer (such as their yearly income), the interview was continued, skipping the question, and we asked the question again at the end of the interview if he/she agreed. Each questionnaire was reviewed at the end of the day by the respective data enumerator. I also cross-checked some of the completed questionnaires randomly to verify that if the data enumerators were doing their job properly. Maps of the sampling area were collected from the respective office (Water and Power Development Board, WAPDA) through official communications. We always noted our gratitude to the respondents after finishing each interview. Secondary data, collected from the key informants and key indicators, were verified with authenticated data available in the respective offices.

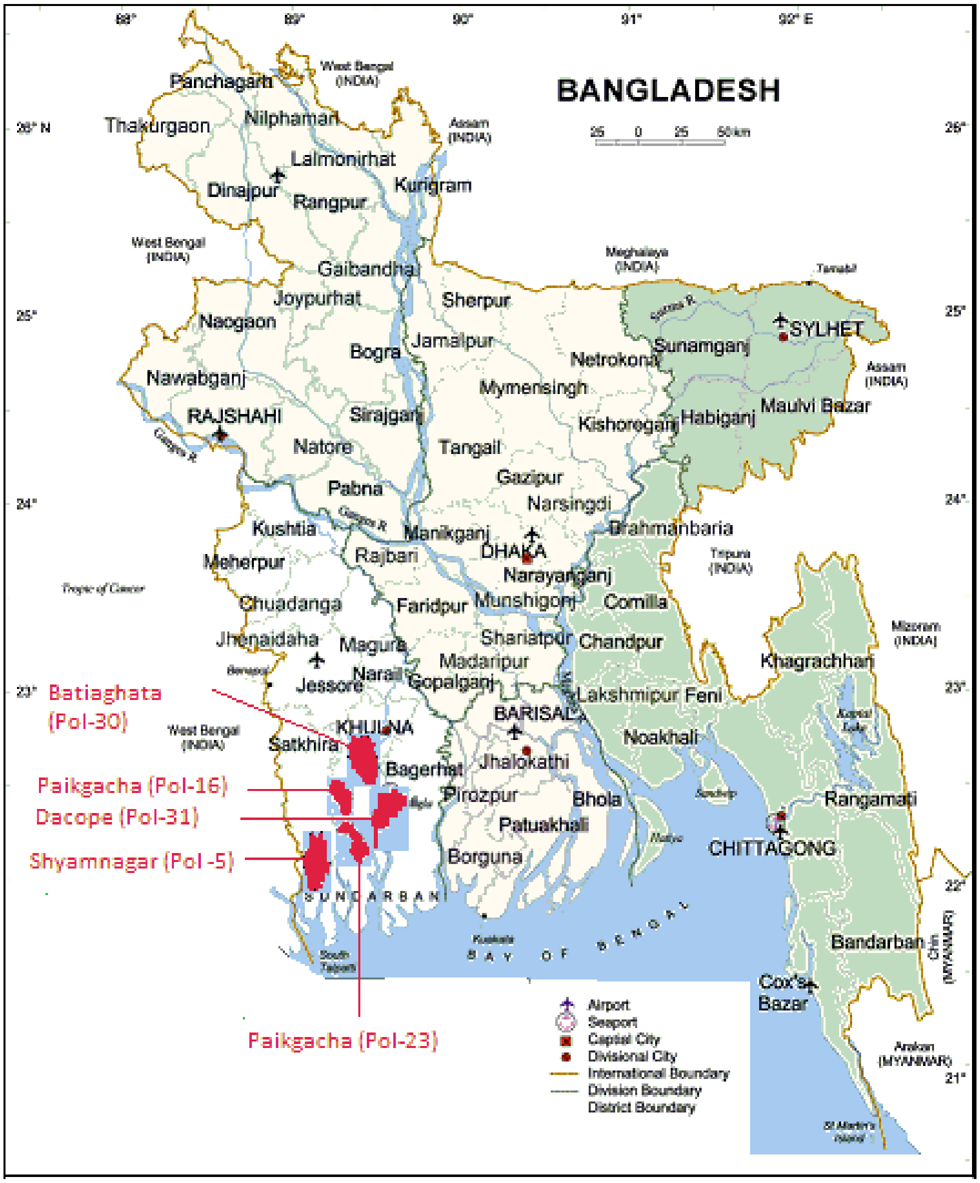

Fig.4: *Map of Bangladesh including the study area (indicated in red) in the southwestern part of Bangladesh (Source: WAPDA).*

2.6 Data analysis

We prepared data for analysis according to our research objectives. I used SPSS 17 software for analysing the data. All variables (according to the questionnaire) were inserted in variable view in SPSS, and data from each questionnaire were then inserted in data view. During collection of the data, my data enumerators and I inserted data in SPSS format, and after returning to Norway, I finished the data entry. To make the analysis more convenient, we (my supervisor and I) planned to categorise some data. We calculated the mean age of the respondents and then divided these data into two groups, designated ‘young’ and ‘elderly’. We designated below the mean age (up to 41) as ‘young’ and above 41 as ‘elderly’. Regarding the education of the respondents, we segregated the level of education into three groups:‘cannot sign or count’, for illiterate individuals; ‘up to high school’, for individuals who can write and count and had up to 10 years of school; and ‘SSC and above’, for people who had passed the Secondary School Certificate Exam and completed additional education. We divided the occupations of the respondents into three groups: ‘agriculture’, for individuals whose main livelihood is from agriculture (shrimp farming and other agricultural activities); ‘business’, for individuals whose main source of income is from business, though most of them have shrimp farms; and ‘others’, which included service/day-labourers/students/house wives/local doctors/rickshaw pullers/motorcycle drivers. The economic status of the respondents was categorised into three different groups: ‘poor’, ‘intermediate’ and ‘wealthy’, according to their yearly income. A yearly income below 140,000 TK (Bangladeshi currency; 1US$~70TK) is categorised as ‘poor’; a yearly income between 140,001 and 220,000TK is categorised as ‘intermediate; and a yearly income above 220, 001 TK is categorised as ‘wealthy’. The cropping patterns and culture practices of the farms were divided in to four categories. ‘Only brackish water users’ included only brackish water shrimp farming or shrimp farming together with brackish water white fish farming. ‘alternate water users’ indicated brackish water shrimp/white fish farming in the winter (dry) season, when the salinity of the water is higher, alternating with rice cultivation during the monsoon season, when the water on the farm becomes fresh. ‘fresh water users’ describes farms using only fresh water during farming practices, such as fresh water prawn farming throughout the year or integrated farming of fresh water prawns with rice and fresh water white fish. ‘Other cultural practices’ represented those farms/respondents who apply combined farming practices on the same or different farms. The ‘sequences of the land use history’ of the farm were divided into four categories: mangrove-rice-shrimp (MRS), when the farm land was initially mangrove, followed by conversion to a rice farm, and then to a shrimp farm; mangrove-rice (MR), when the farm land was initially mangrove, followed by conversion to a rice farm; mangrove-rice-shrimp-rice (MRSR), when the farm land was initially mangrove, followed by conversion to a rice farm, and then to a shrimp farm, and finally reconversion to a rice farm; and ‘other’, which included patterns such as mangrove-shrimp, river basin-shrimp, river basin-rice, and so on. The status of the farmers was divided into to four categories depending on their total ownership of their land: ‘landless,’ representing individuals whose total land ownership is not greater than 33 decimal; ‘marginal farmers’, corresponding 34 to 100 decimal land ownership; ‘intermediate farmers’, corresponding to 101 to 630 decimal, i.e., a mean value; and ‘big farmers’, corresponding to land ownership of greater than 634 decimal. Furthermore, depending on the ownership of ponds under cultivation, the farmers were divided in to four categories: ‘small fish/shrimp farmers’, with a total pond area of not more than 33 decimal; marginal shrimp/fish farmers, who have a total pond area of between 34 to 100 decimal; ‘intermediate shrimp/fish farmers’, who have a total pond area between 101 to 489 decimal, i.e. a mean value; and ‘big shrimp/fish farmers’, who have a total pond area of greater than 490 decimal

To determine the general scenario of the four sub-districts, we produced tables for general information about the respondents using descriptive statistics. We used columns for the four different sub-districts and rows for different variables (e.g., age, sex, occupation, economic status). Data were presented in the tables as percentages. We used chi square tests with a 95 % confidence level to test for significance. Following our hypotheses, we analysed what percentage of respondents indicated a negative attitude towards the present farming practices due to environmental degradation and loss of traditional agriculture, and if their attitudes varied significantly across the study areas. We also analysed the attitudes of the respondents employing the ‘cropping pattern’ as an independent variable. In this analysis, we used the descriptive statistics crosstab in SPSS. We also employed Excel for graphing the data. We tested all of the hypotheses in this manner. To predict which independent variables have more influence over the conflict-generating factors, we used binary logistic regression models in SPSS.

In the case of qualitative data (such as suggestions for resolving the conflict), we justified the respondent’s suggestions according to knowledge-based scientific observations.

3 Results

3.1 Demographic information

In this study, 214 respondents were interviewed from four sub-districts (Table 2). There were no statistically significant differences among the four sub-districts regarding the age, literacy rate, economic status and occupation status of the respondents (Table 2). However, a significant difference was found in the case of marital status. The highest percentage (18 %) of single respondents was found in the Shyamnagar Sub-district, while the highest percentage (96 %) of married respondents was found in two sub-districts (Dacope and Paikgacha) (Table 2).

Table 2: *Demographic information of the respondents' age, literacy rate, economic status, occupation, and marital status in four sub-districts.*

Variable		Dacope	Batiaghata	Paikgacha	Shymnagar	Total instudy area	χ^2	df	P
Total numberof respondents		56	50	51	57	214	-	-	-
Age (%)	Young	59	60	45	56	55	2.9	3	0.407
	Elderly	41	40	55	44	45			
Literacy (%)		87.5	96.0	94.1	82.5	89.7	11.0	6	0.087
Economic status (%)	Poor	57	50	59	37	50	7.4	6	0.289
	Intermediate	21	30	25	37	29			
	Rich	22	20	16	26	21			
Occupation (%)	Agriculture	52	52	57	53	54	11.2	6	0.083
	Business	20	30	37	31	29			
	Others	28	18	6	16	17			
Marital status (%)	Single	4	10	4	18	9	8.8	3	0.031
	Married	96	90	96	82	91			

3.2 Farmers and farming practices

The farming practices based on the type of water used varied significantly among the four sub-districts (Table 3). The Paikgacha Sub-district was dominated by the use of only brackish water in operating the farm. In contrast, most of the farms employed both brackish and fresh water in the Shymnagar Sub-district (Table 3). The Batiaghata Sub-district was first in the category of using only fresh water in farming practices, followed by the Dacope Sub-district. Approximately 41 % of the farms in the Dacope Sub-district fell under the 'other' category (Table 2). There were also significant differences in the numbers of farms among the land use history pattern categories between the four sub-districts (Table 2). Farms with only a two-tier conversion history, i.e., mangrove to rice farm and then rice farm to shrimp farm, were most frequently found in the Paikgacha and Shymnagar Sub-districts. Approximately 36% of the farms with a history of one additional conversion (e.g., mangrove to rice to shrimp and then rice again) were found in the Dacope Sub-district, with the Batiaghata Sub-district exhibiting the second most farms in this category (Table 2).

The status of the respondents as farmers (depending on the total land area under his/her control) varied considerably between the four sub-districts. Intermediate level farmers were dominant in all of the study areas, with Batiaghata being first in this category. In each sub-district, the status of the respondents as farmers followed the descending order of intermediate farmers> big farmers> marginal farmers> landless farmers. No landless farmers were interviewed in the Paikgacha Sub-district. The status of respondents as fish/shrimp farmers (depending on the pond area under his/her farming activities) also varied significantly among the four different sub-districts (Table 3). Intermediate fish/shrimp farmers dominated in all of the sub-districts, except for Dacope. The maximum percentage of intermediate fish/shrimp farmers was found in the Paikgacha Sub-district (Table 3).

3.3 Attitudes of respondents towards conflict-generating factors by sub-district

Eight negative influences were treated as conflict-generating factors, and the attitudes of the respondents were tested in this regard. Each respondent expressed his attitude regarding the negative influences of the existing farming practices. This attitude varied significantly (χ^2 =59.8, df = 3, P< 0.001) among the four sub-districts (Fig. 5). Almost all of the respondents from the Shyamnagar and Paikgacha Sub-districts admitted that the present farming practices had negative influences. The lowest percentage was found in the Batiaghata Sub-district, and the second lowest was found in the Dacope Sub-district. The percentage of negative attitudes among all sub-districts as found to be 81.3 % (N = 214) (Fig. 5).

Table 3: *Information about the status of the respondents depending on the type of water used in farming, land use history, ownership of land, and total pond area ownership in the four sub-districts.*

Variable	Dacope (N =56	Batiaghata (N =50)	Paikgacha (N =51)	Shymnagar (N =57)	Total (N =210)	χ^2	df	P
Status of respondents depending on the water used in farming (%).								
Onlybrackish water users.	11	10	65	24	27	129.5	9	0.0001
Alternating brackish and fresh wate- based farming	13	22	12	66	29			
Only fresh water-based farming	35	51	2	6	23			
Others	41	17	21	4	21			
Status of respondents depending on land use history (%)								
Mangrove, rice ,shrimp	57.1	44	94	87.7	71	68.3	9	0.0001
Mangrove, rice, shrimp, rice	35.7	26	2	0	15.9			
Mangrove and rice	3.6	28	4	7	10.3			
Others	3.6	2	0	5.3	2.8			
Status of respondents as farmer (%)								
Landless farmers	11	6	0	7	6	17.0	9	0.048
Marginal farmer	18	8	10	7	11			
Intermediate farmers	50	70	65	49	58			
Big farmers	21	16	25	37	25			
Status of respondents as fish/shrimp farmers (%)								
Small fish/shrimp farmers	(N=52) 26.92	(N =49) 18.37	(N =51) 1.96	(N =54) 9.26	(N =206) 14.08	28.43	9	0.001
Marginal fish/shrimp farmers	25.00	30.61	21.57	14.81	22.82			
Intermediatefish/shrimpfarmers	21.15	38.78	52.94	40.74	38.35			
Big fish/shrimpfarmers	26.93	12.24	23.53	35.19	24.75			

Approximately 90% (N =174) of the respondents claimed that the existing farming practices were the cause of reduced grazing land for livestock. Respondents from the

Dacope Sub-district were most frequently in favour of this claim, followed by Paikgacha, Batiaghata, and Shyamnagar. However, this opinion did not vary significantly between the sub-districts (Fig. 5). Overall, 42.5 % of the respondents agreed that the present farming practices reduced yearly cereal crop production, and this response varied significantly ($P < 0.001$) among the four sub-districts (Fig. 5). More than 80 % of the respondents from the Paikgacha Sub-district agreed with this opinion, with the next highest percentage found in the Shymnagar Sub-district. Approximately 10 % of the respondents from the Dacope and Batiaghata Sub-districts held this opinion (Fig. 5). Approximately two-thirds of the respondents reported that the present farming practices reduced yearly rice production, but the response varied significantly ($\chi^2 = 64.4$, $df = 3$, $P < 0.001$) among the four sub-districts. More than half of the respondents from Shymnagar and approximately half of the respondents of the Dacope and Batiaghata Sub-districts agreed with this opinion, while most of the respondents (94 %) in the Paikgacha Sub-district held this perspective. The availability of fresh water for daily use varied significantly ($\chi^2 = 39.5$, $df = 3$, $P < 0.001$) among the four sub-districts. The fresh water constraint was most acute in the Paikgacha Sub-district, followed by Shyamnagar, Dacope and Batiaghata (Fig. 5). The use of brackish water to replace fresh water usually occurred when *penaeid* shrimp (salt water shrimp) farming was introduced. The replacement of fresh water farming with brackish water farming practices varied significantly ($\chi^2 = 34.2$, $df = 3$, $P < 0.001$) among the four sub-districts. According to the respondents, the highest degree of replacement was found in Paikgacha Sub-district, followed by the Shymnagar, Dacope and Batiaghata Sub-districts.

One opinion reported by the participants was that death of trees was common when brackish water was introduced into fresh water areas. This opinion was most frequent in Paikgacha, followed by Dacope, Shymnagar and Batiaghata. The notion that trees died due to existing farming practices varied significantly ($\chi^2 = 37.3$, $df = 3$, $P < 0.001$) between the four sub-districts. The coastal area of Bangladesh is cyclone prone. The hazards due to cyclones can be prominent in the areas where the densities of forests or trees are low and flood protection embankments are dismantled. Approximately 50 % of the respondents claimed that cyclonic hazards increased due to shrimp farming. This response varied significantly ($\chi^2 = 39.1$, $df = 3$, $P < 0.001$) among the four sub-districts. The highest percentage of respondents claiming that cyclone-related hazards increased because of shrimp farming was observed in the Paikgacha Sub-district (80 %), followed by the Dacope, Shyamnagar, and Batiaghata Sub-districts (Fig. 5).

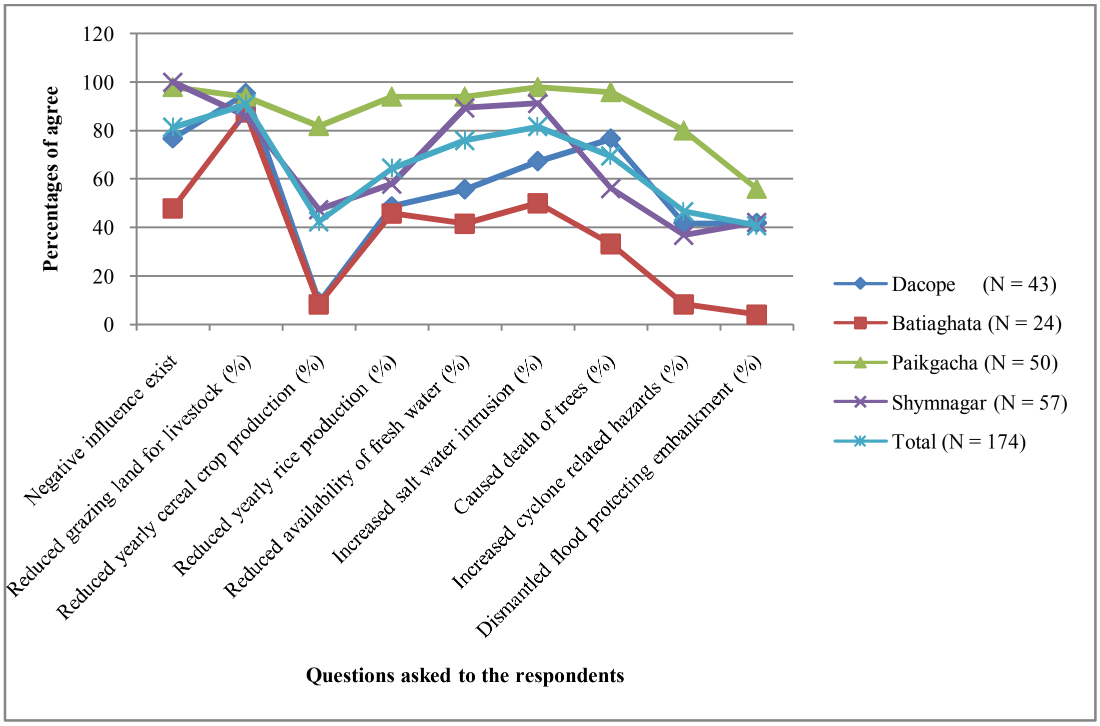

Fig. 5: *Attitudes towards conflict-generating factors in the four sub-districts.*

Approximately 40 % of the respondents reported that the dismantling of flood protection embankments was due to shrimp farming. This opinion also varied significantly (χ^2= 18.2, df = 3, P< 0.001) between the four sub-districts. More than 50 % of the respondents from the Paikgacha Sub-district reported that shrimp farming might be the cause of the dismantling of flood protection embankments, which was the highest percentage among the sub-districts, followed by Shyamnagar, Dacope and Batiaghata (Fig. 5).

3.4 Present farming practices versus conflict-generating factors

We divided the total farming practices in to four categories. Each farmer (N = 210) gave their opinion regarding the negative influence of their own farming practices (Fig.6). Most of the respondents employing brackish water and alternating farming practices thought that their current farming practices had negative influences. Approximately 50 % of the respondents, operating their farm using only fresh water thought that their farming had no negative influences. Approximately three-fourths of the respondents in the 'other' category thought that their farming activities had negative influences, and this opinion varied significantly among the four different categories. The lowest percentages of positive responses were found for all conflict-generating factors in the case of 'only fresh water users' (Fig. 6). The attitudes of the respondents varied significantly (P <0.05) among the different farming groups regarding all of the conflict-generating factors.

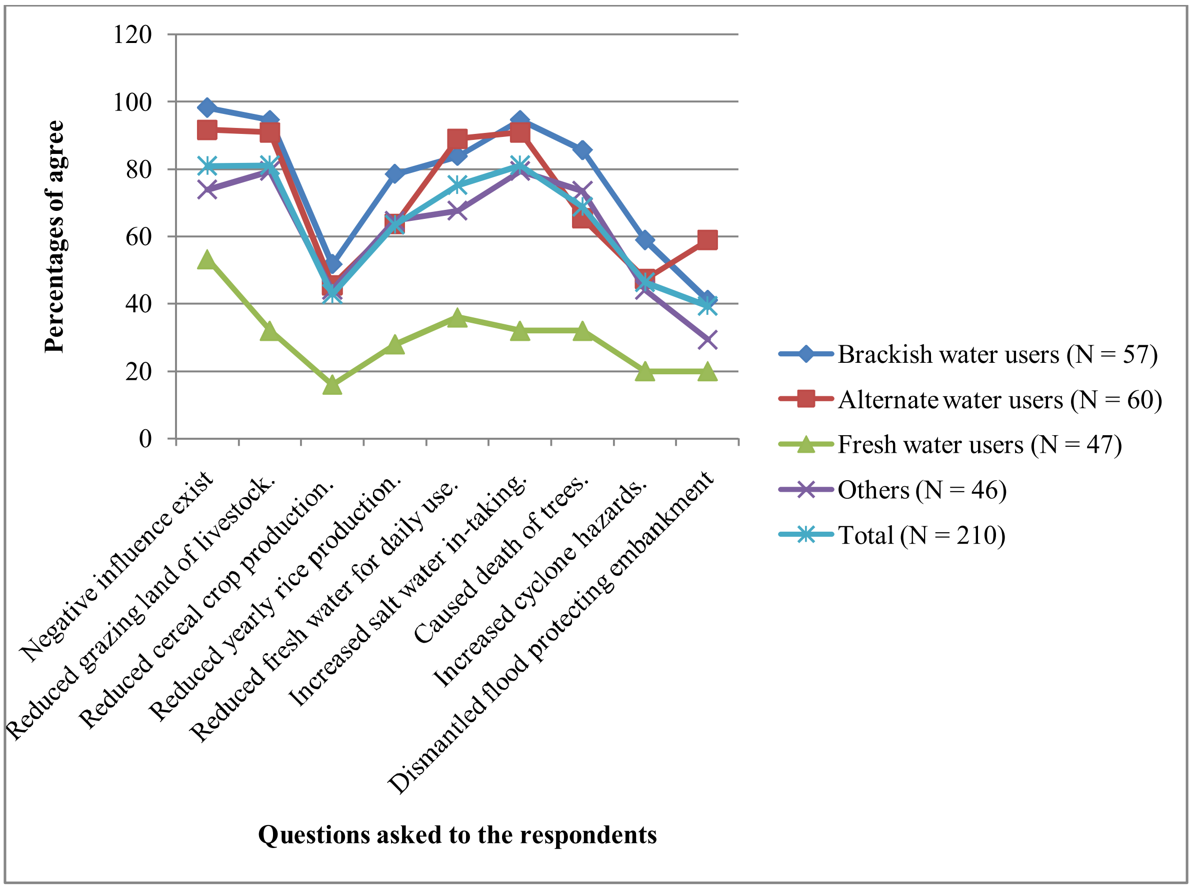

Fig. 6: *Attitudes of different types of water users towards conflict-generating factors.*

3.5 Land use history versus conflict-gerating factors

Most of the farmers reported a land use history with mangrove-rice-shrimp pattern (MRS) (N = 152), which was followed by the mangrove-rice-shrimp-rice (MRSR) (N = 34), mangrove-rice (MR) (N = 22) and other categories (N = 6). The farmers with a MRS land use history mostly (92.1 %) claimed that their existing farming practices had a negative influence, whereas only approximately half (47.1 %) of the respondents with a MRSR land use history thought that their existing farming activities had a negative influence. Overall, the attitude that 'present farming practices reduced grazing land for livestock' was the most frequent (90.8 %) among the respondents, and this opinion did not vary significantly among the farmers with different land use history patterns. The attitudes of the respondents varied significantly ($P < 0.05$) among the different farming groups regarding all other conflict-generating factors (Fig. 7).

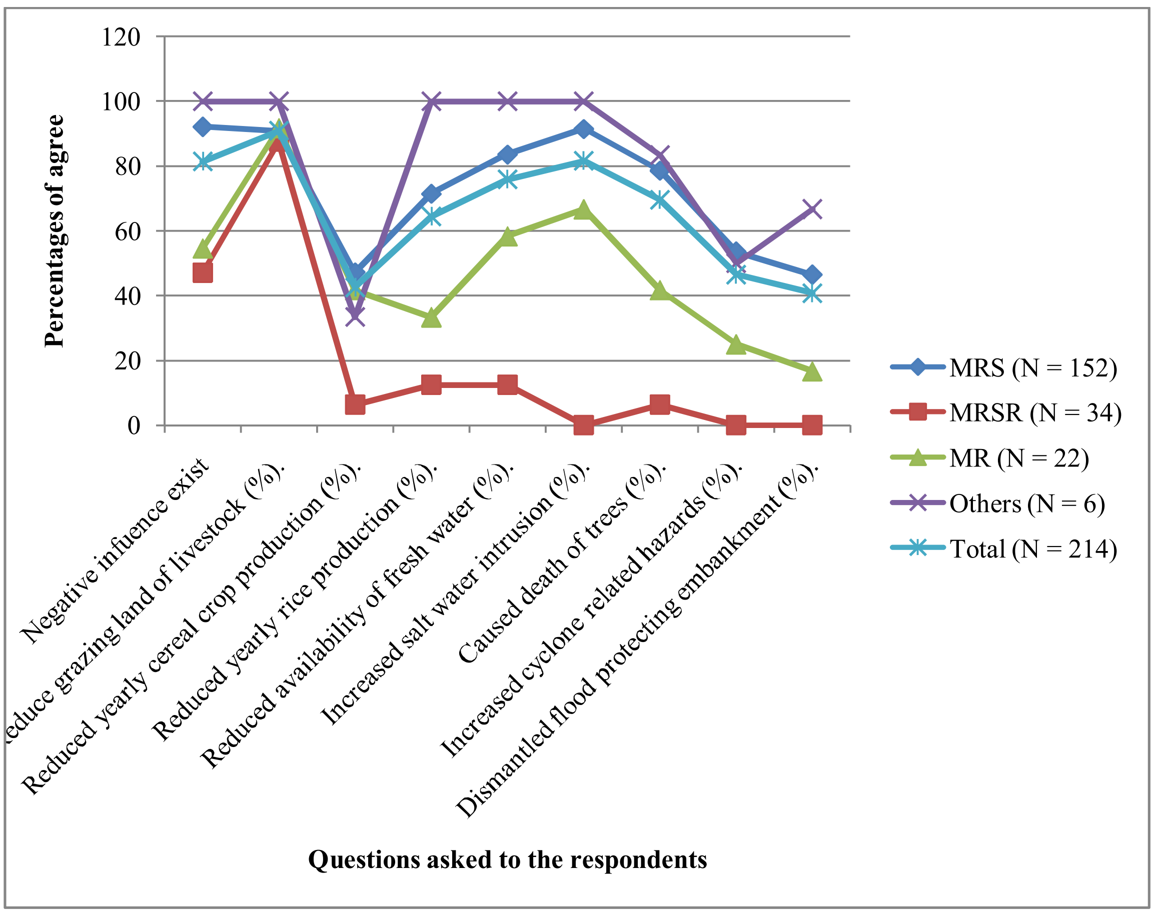

Fig. 7: *Attitudes of farmers with different land use histories towards conflict-generating factors.*

3.6 Binary logistic regression analyses

Binary logistic regression analyses were performed with conflict-generating factors as dependent variables and the sub-districts, education, yearly income, cropping pattern, and sequence of land use history, which have most significant contribution, as independent variables. The results of the logistic regression analysis were statistically significant (Table 4) for the perception of the respondents regarding whether there is any negative influence of present farming practices. However, only two independent variables, the 'sub-district' and 'land use history sequence', added a significant contribution to this variation. This means that these five independent variables explain 36 % of the variation of the respondents' perception regarding the negative influence due to present farming.

Table 4: *Results of binary logistic regression analyses with different perceptions as dependent variables in relation to five different independent variables.*

	Negative influence due to farming			**Reduced grazing land for livestock**			**Reduced cereal cropproduction**			**Reduce rice production**		
Independent variable	**Wald**	**df**	**P**	**Wald**	**df**	**P**	**Wald**	**df**	**P**	**Wald**	**df**	**P**
Sub-districts	15.4	3	.001	2.53	3	.47	32.64	3	.000	13.71	3	.003
Education	3.9	2	.139	1.33	2	.51	1.21	2	.55	3.74	2	.15
Yearlyincome	1.9	2	.380	7.19	2	.03	1.39	2	.50	1.80	2	.41
Croppingpattern	6.0	3	.113	2.62	3	.46	5.49	3	.14	1.26	3	.74
Sequence of land use history	8.1	3	.044	.33	3	.96	.59	3	.90	7.81	3	.05
χ^2	93.8			18.53			84.59			59.94		
Cox and Snell R^2	0.36			.10			.39			.30		
Nagelrke R^2	0.57			.22			.53			.41		
P	.000			.14			.000			.000		

The contribution to explaining the variation among the independent variables was significant with respect to the perception regarding each dependent variable,with the exception of “reduced grazing land for the livestock” (Tables 4, 5). In terms of the most conflict-generating factors, the sub-district was the most significant contributor to explaining the variation of the respondent’s perception. The land use history sequence was the second most important factor in explaining the variation in the respondents’ perception regarding conflict-generating factors. The greatest variation (42 %) in the respondent’s perception of the dependent variable was found for the conflict-generating factor “whether present farming was the cause of the death of trees”, which was explained by five significant independent variables.

Table 5: *Results of binary logistic regression analyses with different perceptions as dependent variables in relation to five different independent variables.*

	Present farming reduced the availability of fresh water.			**Present farming increased salt water.**			**Present farming caused the death of trees.**			**Intensity of cyclone related hazards increased.**			**Present farming dismantled flood protection embankments.**		
	Wald	**df**	**P**	**Wald**	**df**	**P**	**Wald**	**df**	**P**	**Wald**	**df**	**P**	**Wald**	**df**	**P**
Sub-districts	12.86	3	.005	6.25	3	.10	12.80	3	.005	20.38	3	.000	12.48	3	.006
Education	1.22	2	.54	1.44	2	.49	.24	2	.89	3.55	2	.17	3.68	2	.16
Yearly income of the respondent	1.69	2	.43	.49	2	.78	2.42	2	.30	7.48	2	.02	1.70	2	.43
Cropping practices in the pond	4.69	3	.20	3.21	3	.36	2.09	3	.55	3.65	3	.30	9.24	3	.03
Sequence of land using history	7.49	3	.06	.57	3	.90	1.74	3	.63	2.00	3	.57	.052	3	.99
χ^2	63.73			83.87			92.63			71.93			55.11		
Cox and Snell R^2	.31			.39			.42			.35			.28		
Nagelrke R^2	.46			.63			.59			.46			.38		
P	.000			.000			.000			.000			.000		

Table 6: *Attitudes of respondents regarding protests associated with shrimp farming in the four sub-districts.*

Variables	Dacope (N=56)	Batiaghata N=50)	Paikgacha (N=51)	Shymnagar (N=57)	Total in study area (N=214)	χ^2	P
Respondent thought stakeholders protest against shrimp farming (%).	64.3	38.0	86.3	63.2	63.1	25.3	<0.001
Who is against shrimp farming?							
Rice farmers (%)	(N=35) 8.57	(N=14) 7.14	(N=30) 6.67	(N=15) 26.67	(N=94) 10.64	4.9	0.18
Land owners(%)	28.57	42.86	26.67	40.00	31.91	1.8	0.61
Landlesspeople(%)	91.42	42.86	80.00	73.33	77.66	13.9	0.003
Marginal farmers (%)	57.14	42.86	86.67	73.33	67.02	10.8	0.013
NGOs (%)	42.86	28.57	23.33	26.67	31.91	3.2	0.36
Politicians(%)	34.29	28.57	16.67	13.33	24.47	3.9	0.26
Reasoning of the activists against shrimp farming							
Increasedunemployment (%)	82.86	64.29	83.33	80.00	79.79	2.5	0.47
Destruction of the environment (%)	91.43	100.00	1000.00	80.00	93.62	7.9	0.047
Unplanned farming (%)	14.29	14.29	13.33	33.33	17.02	3.4	0.33
Riskiness (%)	5.71	14.28	33.33	20.00	18.09	8.5	0.037
Reduce potable water (%)	40.00	14.28	70.00	13.33	41.49	19.2	0.003
Reduced cattle numbers (%)	40.00	21.43	50.00	13.33	36.17	7.4	0.06
Dismantling of embankments (%)	17.14	21.42	20.00	6.67	17.02	1.5	0.678
Increasedsalinity (%)	62.86	57.14	63.33	40.00	58.51	2.68	0.44

3.7 Protests against shrimp farming and the reasoning behind them

Overall, 63.1 % of the respondents reported that protests against shrimp farming existed in their respective areas, which varied significantly among the sub-districts. According to the respondents, the stakeholders involved in this movement were ranked in the following descending order: landless people, marginal farmers, land owners, NGOs, politicians, and rice farmers (Table 6). Similarly, the reasons of the activists for protesting shrimp farming according to the respondents can be categorised into the following descending order: destruction of the environment, creation of more unemployment, increasing salinity, reducing potable water, reducing cattle numbers, the riskiness of the farming practices, unplanned farming, and the dismantling of embankments(Table 6).

Table 7: *Suggestions of respondents regarding sustainable farming in four sub-districts.*

	Dacope (N=56)	Batiaghata (N=50)	Paikgacha (N=51)	Shymnagar (N=57)	Total in study area (N=214)	χ^2	P
Respondents who made a suggestion (%)	98.21	98.00	100	78.95	93.46	27.0	0.0001
Reommended suggestion (%)							
Control of viruses	(N=55) 36.36	(N=49) 24.49	(N=51) 62.75	(N=45) 35.55	(N=200) 40.00	16.6	0.001
Zoning	16.36	24.49	3.92	37.77	20.00	18.2	0.0001
Modern farming	20	51.02	9.80	4.44	21.50	37.3	0.0001
Proper outlet-inlet system	74.55	75.51	92.16	71.11	78.50	7.9	0.049
Cultivation of salt tolerant rice	00	00	1.96	2.22	1.00	2.2	0.53
Environmentally friendly farming	14.55	30.61	27.45	4.44	19.50	13.3	0.004
Alternating farming	89.09	65.31	84.31	42.22	71.50	32.3	0.0001
Interest-free loans	1.82	6.12	1.96	2.22	3.00	2.2	0.53
Coordination	49.09	16.33	31.37	15.55	29.00	18.7	0.0001
Cease salt water intake	36.36	34.69	11.76	2.22	22.00	24.6	0.0001
Use of local knowledge	9.09	34.69	27.45	00	18.00	25.2	0.0001
Free access to shrimp farming	00	00	5.88	00	61.5	8.9	0.031

3.8 Suggestions for sustainable farming

Most of the respondents made suggestions regarding sustainable farming. Overall, the most popular (78.5 %, N = 200) suggestion related to sustainable farming was to maintain a proper outlet and inlet system for shrimp farming. The other suggestions fell in following order in terms of their frequency: 1) 'alternating farming of shrimp and rice', 2) 'free access to shrimp farming for every body', 3) 'control of diseases' (especially viral disease), 4) 'coordination among stakeholders', 5) 'cease salt water intake, and start fresh water farming', 6) 'introduction of modern shrimp farming', 7) 'zoning of land for specific farming', 8) 'environmentally friendly shrimp farming', 9) 'use of local knowledge', 10) 'interest-free loans for shrimp farmers', and 11) 'cultivation of salt-tolerant rice (Table 7).

Table 8: *Suggestions of the respondents for solving the conflicts in four sub-districts.*

Variables	Dacope (N=56)	Batiaghata (N=50)	Paikgacha (N=51)	Shymnagar (N=57)	Total in study area (N=214)	χ^2	P
Suggestion given by respondents (%)	58.93	28.00	58.82	29.82	43.93	19.46	0.0001
Suggestion for resolving the conflict (%)							
Alternating farming (%)	(N=33) 96.97	(N=14) 64.29	(N=30) 93.33	(N=17) 64.71	(N=94) 85.11	15.63	0.001
Coordination (%)	87.88	42.86	46.67	64.71	63.83	14.76	0.002
Proper drainage system (%)	90.91	78.57	96.67	64.71	86.17	10.64	0.014
Local farming policy (%)	60.61	50.00	40.00	47.06	50.00	2.74	0.433
Zoning (%)	39.39	28.57	23.33	41.18	32.98	2.51	0.47
Modern culture practices (%)	21.21	42.86	23.33	41.18	28.72	3.98	0.26

3.9 Suggested tools for resolving conflicts

Overall, 43% of the respondents (N = 214) made a suggestion for resolving the existing conflicts (Table 8). Most respondents chose 'to maintain a proper drainage system for farming areas' as an effective tool for resolving these conflicts. The second and third most popular suggested tools were 'alternating farming of rice and shrimp' and 'coordination among stakeholders', respectively. The frequency of all of these three tools being suggested varied significantly among the four sub-districts. The other three tools suggested by the respondents as a mechanism for resolving the conflicts were local farming policies, zoning and modern culture practices. However, these opinions did not vary significantly among the four sub-districts (Table 8).

4. Discussion

4.1 Factors contributing to conflicts

4.1.1 The loss of traditional agriculture

Rice is a staple food for the Bengali people. The production of rice and cereal crops, along with livestock herding, are considered a farmer's tradition. These traditional agricultures require minimal or no cash investment; to establish a shrimp farm, by contrast, a substantial investment is necessary, especially for building embankments. Small-scale farmers want to protect rice cultivation as their yearlong food source. When brackish water shrimp farming is introduced, it is almost impossible to cultivate rice in adjacent fields at the same time. The price of shrimp is very high, and if the production of shrimp goes smoothly, then shrimp farmers can easily affords to buy staple foods. Recently, the massive death of shrimp has become common in brackish water shrimp farming. For this reason, most farmers are not interested in cultivating shrimp on their farm. Nevertheless, some farmers are quite willing to take the risk because of the lucrative potential profit from shrimp farming (Gowing *et al.,* 2006). If this risk-taking does not succeed continuously, it becomes an influential contributor to conflict. In this study, the perception of the majority of the respondents was that the production of rice has been reduced due to the introduction of shrimp farming. Karim (2006) found that the yields of most of the field crops in the Rampal sub-district of Khulna District declined following the establishment of shrimp cultivation. Those who experienced a staple food shortage had to buy rice for their yearly food. Death of shrimp due to diseases or obstacles to cultivating rice due to brackish water shrimp farming ultimately create an ingenuity gap (Homer-Dixon and Blitt, 1998), a vector of conflict generation (see chapter 1.1).

Previous studies (Choudhury *et al.,* 1994; Crow and Sultana, 2002; Deb, 1998; Haque and Saifuzzaman, 2002) have concluded that the introduction of shrimp farming reduces the availability of grazing land for livestock. The people who depend on livestock herding for their livelihood and additional income thus lose some of their earnings, which lead them towards conflicts with other farmers. Benjaminsen and Boubacar (2010) identified three factors as the primary causes of land use conflicts by carrying out a detailed case study of one local land dispute in an inland delta in Mali. One of those factors was agricultural encroachment on productive resources that were keys for pastoralism. Karim (2006) reported a sharp decline in the production of livestock due to the decreasing availability of grazing land and of food and fodder in the Rampal sub-district of Khulna District; the rate of decrease from 1985 to 1999 was nearly twice that of 1975 to 1985. However, the author noted that it is very difficult to isolate the effects of shrimp farming in the decline of livestock. Our results revealed that cereal crop and rice production declined significantly in the Paikgacha Sub-district in comparison to other sub-districts. In our study, we also found that the intensification of land use was a crucial factor in the loss of the tradition of livestock herding. Almost all respondents, irrespective of sub-districts and land use history, claimed that existing farming reduced the area of grazing land for livestock. Notwithstanding, this attitude was less prevalent among the fresh water users in comparison to alternate water users and brackish water users. If fresh water is used for farming, then feed and fodder for livestock can grow, whereas in the case of brackish water farming, feed and fodder are not supposed to grow due to the high salinity. Salt water intrusion and constraints on the availability of fresh water also reduced the suitability of soil for cereal and rice production. Miah *et al.* (2010) reported that the salinity problem was severely aggravated by the long-term nature of brackish water shrimp farming in the southwest coast of Bangladesh, and the gradual increase in salinity has exceeded the tolerable limits for agricultural crops and other vegetation.

4.2 Environmental degradation

4.2.1 Salt water intrusion and fresh water limitation

In our study, we found a trend in attitudes where conflict-generating factors were more prominent in areas where brackish water intrusion and brackish water shrimp farming were dominant. Farmers using brackish water were dominant in the Paikgacha Sub-district; farmers alternately using brackish water and fresh water were dominant in the Shymnagar Sub-district; farmers using only fresh water were dominant in the Batiaghata Sub-district; and farmers belonging to the 'others' category dominated in the Dacope Sub-district. Consequently, almost all of the conflict-generating factors were more prominent in the Paikgacha and Shymnagar Sub-districts in comparison to the Dacope and Batiaghata Sub-districts.

The trend of environmental degradation explained the pattern of conflicts in the four sub-districts. Most of the respondents thought that conflicts among stakeholders were due to increased salinity and constraints on fresh water caused by shrimp farming and salt water intrusion. The requirement of brackish water for continuous shrimp farming over time allows saltwater to penetrate the water table (EJF, 2003); hence, easy access to fresh water from the underground water table through tube wells or surrounding freshwater reservoirs is reduced (Miah *et al.,* 2010; Paul and Vogl, 2011). We found that the areas dominated by brackish water shrimp farming were more prone to a fresh water crisis. The attitude that existing farming was the cause of the shortage of fresh water was most prominent in the Paikgacha Sub-district, followed by the Shymnagar, Dacope and Batiaghata Sub-districts; a similar trend was observed when the attitudes among different types of water users were analysed. In Sri Lanka, 74 % of fisher folk in shrimp farming areas no longer have ready access to drinking water (EJF, 2003). Paul and Vogl (2011) identified the salinisation of groundwater by shrimp ponds and consequent problems with potable water as the primary environmental and social impacts in Bangladesh.

Long-term trends in the salinity of major rivers in the Khulna and Satkhira regions showed that the upper limit of salinity (30–45 dS/m during the peak period) was beyond the tolerable limits for crops and vegetation (Miah *et al.,* 2010). The changes caused by salinity in the physical and chemical characteristics of soil are related to the soil's capacity to produce crops such as rice as well as shrimp. In a comprehensive study, Ali (2006) examined the change in soil salinity in shrimp farms during the period 1985–2003 compared to control soil from a rice farm. He found that over the same period, the salinity of the soil under the rice field increased slightly by 7 % owing to low-lift pump irrigation for HYV (high yielding variety) *boro* rice cultivation. In contrast, the salinity of the soil under 5-year shrimp farms increased by 33%. This finding supports the perception of the respondents that salt water intrusion could be harmful for the environment/soil. In Andhra Pradesh, India, the degree of severity of specific factors including the salinisation of the land and shortages of fodder were the primary problems identified in shrimp development areas (Patil and Krishnan, 1997).

Based on a logistic regression analysis, we found that the differences among the sub-districts were significant contributors to the explanation of the variance in the respondents' perceptions regarding all conflict-generating factors. This trend was magnified in the case of the attitudes of different types of water users. The attitudes of different types of water users indicated that almost all of the conflict-generating factors were prominent where brackish water was used for farming.

4.2.2 Cyclonic hazards and tree death

The death of trees could expose an area to cyclonic hazards by weakening its defences against strong winds and water surges. Shrimp farming might be responsible for the death of trees through mangrove destruction and salt water intrusion into freshwater areas. This study revealed that attitudes about existing farming being the cause of cyclonic hazards such as damage to houses, crops, and lives, the dismantling of flood protection embankments, etc. were most prominent in the Paikgacha Sub-district, moderately high in the Dacope and Shymnagar Sub-districts, and lowest in the Batiaghata Sub-district. Overall, this attitude was not prevalent in all sub-districts. The geographic positions of the sub-districts are important in this respect. The Shymnagar, Paikgacha and Dacope Sub-districts are situated nearer to the coast of the Bay of Bengal than the Batiaghata Sub-district, and most of the cyclones usually initiate in the Bay of Bengal and move towards the coast. As a result, the sub-districts nearer to the coast are more vulnerable to cyclonic hazards. Here, it would be difficult to relate cyclonic hazards to brackish water shrimp farming because in the Dacope Sub-district, brackish water shrimp farming was not dominant but the attitudes of respondents indicated the same magnitude of concern as in the Shymnagar Sub-district. Some studies have indicated that in some areas, shrimp farmers have illegally dismantled embankments that protect against floods to access salt/brackish water from adjacent rivers (Brammer, 1983). This has weakened the embankment, and during cyclones, water surges could more easily access polders through this area and ultimately cause damage. In the case of two conflict-generating factors, ‘death of trees’ and ‘cyclonic hazard’, a higher percentage of the respondents from the Dacope Sub-district showed concern than in the Shymnagar Sub-district. To explain these perceptions, we identified a relationship with a cyclone named ‘Aila’ that hit the coastal area on 27 May, 2009 and damaged infrastructures, crops, trees etc. A salt water surge during this cyclone inundated some freshwater areas where the deaths of trees subsequently occurred due to saltwater logging. This cyclonic hazard was more disastrous in the Dacope sub-district than the Shymnagar sub-district, which may have affected the perceptions of the respondents. Karim (2006) argued that the shrimp farms have gradually encroached on homestead areas in the Rampal sub-district of Khulna District. This encroachment has caused serious problems for the survival of trees in and around homesteads. By 1999, some species of trees (e.g*., Litchi chinensis*) had almost disappeared.

4.3 Present status of conflicts

The results of the study indicated that protests against shrimp farming were most severe in the Paikgacha Sub-district, followed by Dacope, Shyamnagar and Batiaghata. This study also indicated that salt water intrusions and/or shrimp farming were the causes of the organised protests. The perceptions towards the protests against the present shrimp farming practices were similar in the Shyamnagar and Dacope Sub-districts. The trend of the conflict in the Shymnagar Sub-district could be explained in another way. The aquifers of some unions in this sub-district were saline and river water also had higher salinity, so most of the farmers had no alternative other than shrimp farming (personal communication with key informants). Key informants indicated that movements against shrimp farming in the Batiaghata and Dacope sub-districts were more organised and violent than in the Shymnagar and Paikgacha Sub-districts; additionally, lawsuits gainst brackish water intrusion were enormous in these two sub-districts. These two factors simultaneously discouraged brackish water users to continue brackish water intrusion in the Dacope and Batiaghata Sub-districts; at the same time, it encouraged pro-activists to reconvert their farms from shrimp farms back to rice farms, which ultimately minimised the conflict in these two sub-districts. These phenomena indicated that the introduction of salt/brackish water and brackish water shrimp farming were two of the primary causes of conflict.

Information from key informants also indicated that the ensuing conflict was not only restricted to shrimp farmers. Government organisations, such as the Department of Fisheries (DOF), Department of Livestock (DLO), Department of Agricultural Extension (DAE), Water and Power Development Authority (WAPDA) and different non-government organisations (NGOs) were also indirectly involved in this conflict. Although they were not directly associated with the shrimp value chain, they had conflicts of interest. A complex situation that helped to promote conflicts among stakeholders was the transportation of brackish water from the adjacent river to the shrimp farms through sluice gates. WAPDA was involved in this mechanism. In some cases, rich shrimp farmers finagled permission from WAPDA to make a sluice gate in a flood protection embankment, through which they took in brackish water for their own farming and also sold water to other farmers. In most cases, marginal farmers who had land at a distance from the brackish water source would buy brackish water for shrimp farming from the rich farmer whose land had a direct connection with the natural water source. Those marginal farmers who had no access to the brackish water necessary for shrimp farming wanted to prevent salt water intaking and shrimp farming. The primary cause of this attitude was the unequal sharing of the brackish water supply from the natural sources. This lack of a free distribution of brackish water created conflict among farmers.

The focal stakeholders involved in the shrimp value chain, the subject matter of this research, were landless farmers, marginal farmers, intermediate farmers, and big farmers. This study revealed that landless farmers and marginal farmers were intensively involved in movements against shrimp farming, and to some extent, land owners, NGOs, political leaders, and rice farmers were also involved. This study also exposed the environmental degradation and unemployment caused by shrimp farming as the major causes of protest against shrimp farming as well as a generator of conflict, as were, to some extent, increases in salinity, reductions in the number of cattle, unplanned farm construction, massive deaths of shrimp, and the dismantling of flood protection embankments. Choudhury *et al.* (1994) found that the introduction of shrimp farming to the Chakaria Sundarbans in Bangladesh did not improve the socio-economic status of poor people-rather, many stakeholders became jobless; a similar study conducted in the central Philippines revealed that the economic benefits of shrimp culture did not trickle down to the residents but remained with the farmers, entrepreneurs and traders (Amante *et al.,* 1989). Deb (1998) estimated the labour intensity of shrimp farming in comparison with other agricultural activities and found that shrimp farming was less labour-intensive than rice cultivation. He estimated a 75% reduction. Thus, shrimp farming gave rise to concern for the impact on poor people whose livelihoods depend on selling labour. Nonetheless, some studies showed (Gowing *et al.,* 2006; Karim, 2006) that the overall labour requirement of the shrimp industry was higher than that of rice production because of the level of employment in ancillary activities. They also stated that it was logical to assume that the shrimp industry should absorb the surplus rural labour force in coastal areas, but in reality, benefits to local people were lower because many shrimp producers preferred hiring non-local labour.

4.4 Conflict minimising measures

Freshwater farming practices could be the ultimate target of the activists, and the achievement of this target might be helpful for minimising the on-going conflicts. In the Batiaghata Sub-district, considerable numbers of farms had an MR land use history, which meant that brackish water was never introduced to these farms and consequently conflict was minimised in this sub-district. Some of the respondents believed that shrimp farming should be forbidden in some areas. One of the popular suggestions regarding minimising conflicts was the alternate farming of rice and shrimp. This option satisfied the desire of the respondents to go back to their old tradition. This system could provide understanding beneficial compromise because then those farmers who were interested in investing capital to earn a significant profit from shrimp farming (Gowing *et al.,* 2006), could intrude brackish water for shrimp farming in February/March, and after harvesting their shrimp in June, they could use their ponds for rice farming. Here it should be mentioned that from February to the pre-monsoon season (usually June), the salinity of the rivers increases and the salinity of farm lands depends on their distance to the river, carrying salt water from the sea. However, with the beginning of the monsoon season, runoff from upstream areas increases and salinity decreases. At this time, shrimp farmers want to stop the water exchange because the low-salinity or almost fresh water from the river might reduce the salinity of the pond water, which ultimately reduces the growth of their shrimp. Rice and shrimp cultivation are not conflicting if shrimp farmers are willing to finish their harvest within the time limit, i.e., June. During the last harvest, if they (shrimp farmers) drain all salt water from their farms to the river and allow fresh water into their farm, then it is possible to prepare the land for rice planting. However, if the farmers who take brackish water into their farm do not discharge it, adjacent lands might become contaminated with salt and the rice seedlings will grow poorly or die. Thus, coordination among farmers is also an important factor for minimising conflicts.

Again, a proper drainage system could contribute to minimising conflicts. When a pond and rice farm are adjacent, there is a chance of salt water from the pond contaminating adjacent lands via seepage (Gowing *et al.,* 2006), which ultimately causes damage to the rice or cereal crop, especially during the dry period (December-May). If a shrimp farm is planned properly with an outlet drain (a drain surrounding the pond) that contains seepage water from the pond and reduces direct contact between the pond's salt water and adjacent land, sometimes it might have a water discharge facility so that during low tides water can be discharged from this drain.

It is very difficult to manage a uniform system for all farming areas. Topography, the nature of aquifers, the salinity status of the river, water irrigation facilities, the economic status of farmers, infrastructural development, etc. can vary from area to area. Local farming policy should be formulated considering all of these factors. Some respondents, key informants, and key indicators suggested that zoning could be good solution for minimising conflicts.

Some respondents suggested another vertical expansion of shrimp farming as a tool for minimising conflict. That means the introduction of modern farming system such as semi-intensive farming. In a semi-intensive farming system, farms are designed with sufficient infrastructures to avoid the unnecessary contamination of adjacent land with salt water. Environmentally friendly farming systems were also suggested, meaning farming systems that do not destroy the existing environment. In freshwater areas, the integrated farming of freshwater prawns with rice and vegetables is becoming more popular. In the case of brackish water areas, if possible, the alternate farming of shrimp and rice could be considered as environmentally friendly farming.

Free access to shrimp farming was a crucial issue for minimising the conflict. To facilitate this, easy access to sources of capital, the provision of technical knowledge, the development of law and order etc. are important. To move towards these goals, the qualifications for taking out a loan from a commercial bank should be relaxed, a training program for the shrimp farmers should be conducted, and proper justice must be ensured. The control of pond sizes by law could be another mechanism allowing small scale farmers access to shrimp farming. Sometimes influential/rich farmers build an embankment surrounding a huge area and bring brackish water within the embankment. As a result, other farmers within this embankment become compelled to lease their land to that farmer (Honah, 2006). In Tumaco, Columbia, one local cooperative has been successful in setting up small-scale shrimp farming (with ponds of approximately 1 ha rather than 10 ha) (Martinez-Alier, 2001).

4.5 Management approach and suggestions for resolving the conflicts

A management approach should be based on intertwined conflict management and sustainability (Hoanh, 2006). Biodiversity conservation, including mangrove protection, the prevention of salt water intrusion into new areas, and the protection of trees that are vulnerable to salt water contamination, must be kept in mind. The negative impacts of shrimp farming have usually arisen from poor planning and management practices as well as the weak application of existing regulations (Paul and Vogl, 2011). In Bangladesh, shrimp policy is still being formulated. Good aquaculture practices (GAP) and better management practices (BMP) **(**Paul and Vogl, 2011**)** should be adopted in shrimp policy to minimise ecological losses and social disruption and produce high quality and safe food products.

A well-structured shrimp policy was the foremost demand from many key informants, key indicators, and respondents for sustainable shrimp farming systems. Many respondents also advocated for the creation of zones for different activities; these zones might be a good option as a management tool for reducing conflicts (Gowing *et al.,* 2006). Comprehensive surveys should be conducted throughout the coastal areas to measure physico-chemical, socio-economic and biological parameters, which might include topography, the status of aquifers, the salinity of rivers, soil pH and salinity, the diversity of flora and fauna, the values and perceptions of the stakeholders, etc. Depending on these factors, zones could then be established for planned management and a diverse land use (Islam, 2006) pattern. In areas where the elevation is low and nearer to the sea, salinity intrusion is a natural phenomenon (Phong *et al.,* 2003) and it is difficult to introduce rice farming; these areas might be declared shrimp farming zones. Similarly, areas propitious for alternate shrimp and rice farming might be declared alternate farming zones. Geographic information systems (GIS) could be useful in facilitating this zoning (Kam *et al*., 2006). Zoning helps to control environmental deterioration at the farm level, reduces adverse social and environmental interactions, and serves as a focus for estimates of environmental capacity and as a framework for providing or improving infrastructure to small-scale farmers (Gowing *et al.,* 2006). When management measures to minimise conflict are being formulated, two primary groups of stakeholders should be taken into account: those who want to increase the productivity of the land and those concerned with environmental protection (Honah, 2006). To maintain this management measures, Environmental Impact Assessment (EIA) studies, which have been used widely in coastal management, could become a standard planning tool for evaluating the potential consequences of development decisions (Gowing *et al.,* 2006). Depending on the findings of an EIA, planned vertical and horizontal expansions of farms should be approved by a legitimate authority. Although initiatives in favour of the rampant vertical and horizontal expansion of shrimp farming could be propitious for short term benefits, the continued natural productivity of the environment is also important. Sustainable development depends upon the co-existence of productivity and environmental quality rather than specialisation (Bailey and Pomeroy, 1996), and conducting coastal aquaculture in an environmentally (and socially) responsible manner requires the adoption of a principal of co-existence for mangroves and aquaculture (Lewis *et al.,*2003).

Coordination among all of the stakeholders included in the value chains of shrimp farming was suggested as an obvious tool to minimise on-going conflicts along with sustainable development. Management techniques derived from bottom-up, cross-sectoral participation and collective action at micro and meso levels, have been widely successful (Honah, 2006; Holmern, 2010). Community-based management has been hailed as asuitable alternative for the management of disputed resources (Arriaga *et al.,* 1999; Masalu, 2000; Rouf and Jensen, 2001). According to a key informant, a project named Integrated Planning for Sustainable Water Management (IPSWAM), with a community-based management approach, is now in action on the coast of Bangladesh under the supervision of WAPDA. There is a Water Management Association (WMA) for each catchment area. The WMA is supposed to make water management decisions for the catchment area in a democratic way. This initiative has helped to minimise conflicts among different types of stakeholders. A zone-wise management committee should be formulated with representatives from all stakeholders, including NGOs and governmental departments. Knowledge-based experts should also be involved in this committee.

Most of the survey respondents agreed that crop failure was a common phenomenon for shrimp farming in coastal areas. Unplanned farm infrastructures, the lack of sufficient depth for the shrimp pond, the lack of disinfected fries, the lack of water discharge capacity, etc. were all recognised as causes of crop failure. Due to indiscriminate farm construction, the illegal occupation of canals and rivers, and the lack of co-operation among the stakeholders, it is very difficult to maintain a proper drainage system in all farming areas. To minimise the conflicts, most respondents and key indicators emphasised the need to recover occupied water channels from illegal and so-called legal occupiers. To this end, political and professional commitments from politicians and government administrators were urged. There are many existing committees from the national to the sub-district level. To take on this giant job, all task force committees from national to grassroot levels must be activated as soon as possible.

Some respondents claimed that their homesteads are affected by salt water intrusion and that shrimp farmers did not acknowledge their distress due to the salt water intrusion. Some shrimp farmers were even affected by their own farm. To protect homesteads from the encroachment of shrimp ponds and the resulting salinity problems that affect the daily living environment of farmers, the creation of a buffer zone by regulation or policy around homesteads will be necessary (Gowing *et al.,* 2006).

The livelihoods of poor people depend upon the open access to resources. Frequently, development decisions that enhance production from aquaculture and/or agriculture also adversely impact the access to and productivity of open-access resources; planners and decision-makers should recognise this conflict and ensure the importance and value of open-access resources (Gowing *et al.,* 2006).

Primaver (2006) suggested that all stakeholders in a coastal community should be involved to avoid a sectoral focus on aquafarms. That author also proposed some key issues for fulfilling the promises of food security and poverty alleviation without causing negative environmental and socioeconomic effects. These issues are sustainable aquaculture, farm siting, farm and effluent management, mangrove-friendly aquaculture, disease control, low trophic level species, native species, the role of government, market mechanisms and self-regulation.

Economic incentives and disincentives in the form of taxes, penalties and credits could be more effective than regulatory approaches in inducing changes in behaviour towards the environment (Primaver, 2006).

5. Conclusion

Our study revealed that the loss of traditional agriculture was the main cause of conflict and that environmental degradation was another major cause. These conflicts were accelerated by forced salt water intrusion andthe encroachment of intensive land uses such as shrimp and agricultural farming on traditional seasonal grazing lands. The Paikgacha and Shymnagar sub-districts were more conflict-prone in comparison to the Batiaghata and Dacope sub-districts. We found that landless people and marginal farmers were intensively involved in these conflicts. The intensive land use trend in favour of agriculture and shrimp farming indirectly reduced the livelihoods of these groups of people. Cyclonic hazards and the deaths of trees were not acute causes of conflict but were significant.

At one time, the southwest coast of Bangladesh was made up of mangroves; after a lot of changes, this area became dominated by shrimp farms along with different types of stakeholders' settlements. To return the land to mangroves might be good for the environment and a few of the stakeholders, but it would not provide a sufficient livelihood to the variety of stakeholders residing within these areas. Therefore, we have to strive for a sustainable compromise between these two land uses. We should take measures to save the environment, maintain traditions and the livelihoods of stakeholders, and pursue development. To do that, we could consider returning to the traditional and environmental friendly farming systems as well as some planned vertical expansions of farming to minimise environmental degradation but promote development. Traditional forms of agriculture such as livestock herding, rice farming, cereal crop farming, and the alternate farming of rice and shrimp were established on locally based knowledge. After a long period of practice, shrimp farming has also become an occupation for large numbers of stakeholders. Again we should remember that this area is traditionally a brackish water area, so introduced fresh water alone and the prevention of brackish water intrusions would not be sustainable because the availability of fresh water throughout the year could not be ensured from natural sources (e.g., rivers and rainwater) or from aquifers (which is also an environmental issue). However, a return to traditions such as alternate farming might be the right way to resolve these conflicts. In traditional agriculture, the environmental manipulation is less intensive. A community based management approach was also proved as an efficient tool for managing conflicts among stakeholders. All stakeholders, directly or indirectly involved in this conflict, should be incorporated in this management approach. Along with these efforts, some innovations can be adopted as environmental friendly measures, such as the introduction of both brackish water and fresh water shrimp with rice during the monsoon and dry seasons. This will not harm the environment but would be good sources of livelihood for the stakeholders. This will also help to create employment for poor people. To ensure development without destroying the environment, zoning and the vertical expansion of farms could be a good solution. The proper design and construction of farms and the invention of control measures for viral diseases would ensure the natural growth of the environment. Social factors also fuel the ongoing conflict, which should be investigated. Furthermore, global climate change must be incorporated into planning efforts because climate change will lead to a rise in sea level and if it rises too much, all of these coastal areas will be inundated. We therefore need to think about how to acclimate to saltwater in this area. However, in these regard, comprehensive studies should be conducted to clarify the prospective effects of global climate change and the probable consequences for the local environment and the socio-economic status of the stakeholders.

References

Ahmed, S. A., Mallick, D. L., Ali, M. L. and Rahman A. A. (2002). Literature Review on Bangladesh Shrimp. Individual Partner Report for the Project: Policy Research for Sustainable Shrimp Farming in Asia (PORESSFA), a comparative analysis of Bangladesh, India, Thailand and Vietnam with particular reference to institutional and socio-economic aspects. *European Commission INCO-DEV Project PORESSFA No.IC4-2001-10042, CEMARE University of Portsmouth UK and BCAS, Dhaka, Bangladesh,* 31p.

Ahmed, M. (1988). *Bangladesh agriculture: towards self-sufficiency*. Dhaka, Winrock International.

Ahmed, ATA. (1996). Policy guidelines for management of coastal shrimp culture development. *The World Aquaculture '96 Conference, Bangkok, January 1996.*

Ali, AMS. (2006). Rice to shrimp: Land use/land cover changes and soil degradation in Southwestern Bangladesh. *Land Use Policy*, 23(4): 421- 435.

Amante, S.V., Castillo, F.A. and Segovia, L.Z. (1989). *The Aquaculture Industry in Panay*. Panay Self Reliance Institute. Manila. Philippines. 61 pp.

Arriaga, L., Montaño, M. and Vásconez, J. (1999). Integrated management perspectives of the Bahía de Caráquez zone and Chone River estuary, Ecuador.*Ocean and Coastal Management* 42: 229–241.

Bailey, C. and Pomeroy, C. (1996). Resource dependency and development options in coastal South-east Asia. *Society and Natural Resources* 9(1): 191–199.

Begum, A. and Alam, SMN. (2000). *Bangladesh: Case Study-1; Social Aspects of Coastal Shrimp Aqua-culture in Bangladesh.* Caritas- Bangladesh (Sponsored by World Bank, NACA and FAO), Dhaka, Bangladesh.

Benjaminsen, T.A. and Boubacar, B.A. (2010). Land Use Conflicts in the Inner Niger Delta of Mali: Does Climate Change Play a Role? *The Climate Change and Security conference,* Trondheim, Norway, 21–24 June 2010.

Bhattacharya, D., Rahman, M. and Khatun, F.A. (1999). *Environmental Impact of Trade*

Liberalization and Policies for the Sustainable Management of Natural Resources: A case Study on Bangladesh's Shrimp Farming Industry, Centre for Policy Dialogue (CPD), Dhaka, Bangladesh

Binningsbø, H. M., de Soysa, I. and Gleditsch, N. P. (2007). Green giant or straw man? Environmental pressure and civil conflict, 1961-99. *Population and Environment,* 28:337-353.

Boserup, E. (1965). *The Conditions of Agricultural Growth; the Economics of Agrarian Change under Population Pressure.* London: Allan and Unwin.

Brammer, H. (1983). Agriculture and Food Production in Polder Areas. *Water International*, 8(2):74-81.

Brauch, H. G. (Ed.). (2003). *Security and the environment in the mediterranean: Conceptualising security and environmental conflicts*. Berlin: Springer.

Binningsbø, H. M., de Soysa, I. and Gleditsch, N. P. (2007). Green giant or straw man? Environmental pressure and civil conflict, 1961-99, *Population and Environment*, 28: 337-353.

Brock, L. (1991). Peace through Parks: The Environment on the Peace Research Agenda, *Journal of Peace Research,* 28(4) 407-423.

Brundtland, G. H. (1987). *Our Common Future. World Commission on Environment and Development.* Oxford: Oxford University Press.

Cassils, J. A. (2004). Overpopulation, sustainable development, and security: Developing an integrated strategy. *Population and Environment,* 25(3): 171–194

Cervigòn, F. and Gòmez, A. (1986). Las lagunascosteras de Margarita. Fundaciòn Cientifica Los Roques, Caracas, 88 pp.

Chiu, Y.N. (1988). *Considerations of planning prawn farm projects.* Technical Consideration for the Management and Operation of Intensive Prawn Farms. (Eds.) Chiu, Y.N., Santos, L.M. and Juliano, R.O. U.P. Aquaculture Society, Iloilo City, Philippines. Pp. 25-28.

Choucri, N. and North, R. (1975). *Nations in Conflict*. San Francisco, CA: Freeman

Choudhury, A. M., Quadir, D.A. & Islam, M.J. (1994). *Study of Chokoria Sundarbans using Remote sensing techniques.* ISME Mangrove Ecosystems Technical Report 4: 1-22.

Craig, G., Hall, H. and Mayo, M. (1998). *Editorial Introduction: Managing conflict through community development.*

Crow, B. and Sultana, F. (2002). Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta, *Society and Natural Resources: An International Journal*, 15(8): 709-724

Deb, A. K. (1997). *Fake Blue Revolution: Environmental and Socio-Economic Impact of Shrimp Culture in the Coastal Areas of Bangladesh,* Community Development Centre (CDC), Canada.

Deb, A. K. (1998). Fake Blue Revolution: Environmental and Socio-Economic Impact of Shrimp Culture in the Coastal Areas of Bangladesh, *Ocean & Coastal Management,* 41:63-88.

deSoysa, I. (2005). Filthy rich, not dirt poor! How nature nurtures civil violence. Peter D., (Ed.), *Handbook of Global Environmental Politics*. Cheltenham: Edward Elgar, 149–169.

Diamond, J. (2005). *Collapse: How societies choose to fail or survive.* London: Penguin.

Eaton, R.M. (1990). Human settlement and colonization in the Sundarbans, 1200-1750. *Agriculture and Human Values*, 7(2): 6-16.

EJF (2003). *Smash & Grab*: *Conflict, Corruption and Human Rights Abuses in the Shrimp Farming Industry.*Environmental Justice Foundation, London, UK.ISBN No. 1-904523-02-1.

ESCAP (Economic and Social Commission for Asia and the Pacific) (1988).*Coastal environmental management plan for Bangladesh*, Volume II. Final report. Bangkok, United Nations Economic and Social Commission for Asia and the Pacific.

European Commission (2002). Policy Research for Sustainable Shrimp Farming in Asia A comparative analysis of Bangladesh, India, Thailand, and Vietnam with particular reference to institutional and socio-economic aspects.

FAO (2007). *Capture production 1950–2005*. FISHSTAT Plus – Universal software for fishery statistical time series. Rome. (Available at www.fao.org/fi/statist/FISOFT/ FISHPLUS.asp; or CD-ROM).

Galtung, J. (1992). *Environment Development and Military Activity. Towards Alternative Security Doctrines.*Oslo: Norwegian University Press.

Gibbon, P. (1997). Prawns and piranhas: the political economy of a Tanzanian private sector marketing chain. *Journal of Peasant Studies* 24(4): 1 - 86

Gleditsch, N. P. (1998). Armed conflict and the environment: A critique of the literature. *Journal of Peace Research*, 35(3): 381-400.

Gleditsch, N. P. (2003). Environmental conflict: Neomalthusians vs. Cornucopians. Hans Günter Brauch et al., (Eds.), *Security and the Environment in the Mediterranean: Conceptualising Security and Environmental Conflicts*. Berlin: Springer , 477–485.

Gopinath, N. and Gabriel, P. (1997). Management of Living Resources in the Matang Reserve, Perak, Malaysia, in Curtis H. Freese, *Harvesting Wild Species. Implications for Biodiversity Conservation*, Johns Hopkins U.P., Baltimore, 167-216.

Gowing, J.W., Tuong, T. P. and Hoanh, C.T. (2006). Land and Water Management in Coastal Zones: Dealing with Agriculture-Aquaculture-Fishery Conflict. Hoanh, C. T., Tuong, T.P. and Hardy, B. (eds.) *Environment and Livelihoods in Tropical Coastal Zones Managing Agriculture-Fishery-Aquaculture Conflicts*. Wallingford, Oxfordshire, GBR: CABI Publishing, p7-21.

Haque, M.Z and Saifuzzaman, M. (2002). Social and Environmental Effects of Shrimp Cultivation in Bangladesh: Notes on Study Methods. Chapter 13, Rahman, M. (Ed.) *Globalization, Environmental Crisis and Social Change in Bangladesh.* Winnipeg Manitoba, CanadaR3T3A6.

Hauge, W. and Ellingsen, T. (1998). Beyond environmental scarcity: Causal pathways to conflict. *Journal of Peace Research*, 35(3): 299-317.

Hoanh, C. T., Tuong, T.P. and Hardy, B. (2006). *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts*. Wallingford, Oxfordshire, GBR: CABI Publishing, p 1.

Holmern, T. (2010). Bushmeat Hunting in Western Serengeti: Implication for Community – Based Conservation.Gereta, E. J. and Røskaft, E. (Eds.) *Conservation of NaturalResources: Some African and Asian Examples.* Tapir Academic Press, Trondheim, Norway, 2011-2012.

Homer-Dixion, T. F. (1991). On the Thresh holds. Environmental changes and Causes of Acute conflict, *International Security* 19(1): 76-116.

Homer-Dixion, T. F., Jeffrey, H.B. and George, W. R. (1993). Environmental Change and Violent Conflict, *Scientific American,* 268(2): 38-45.

Homer-Dixion, T, F. (1994). Environmental Scarcity and Violent Conflict: Evidence from Cases. *International Security* 19 (1): 5-40

Homer-Dixon, T.F. (1995). The Ingenuity Gap: Can Poor Countries Adapt to Resource Scarcity? *Population and Development Review*, 21(3): 587-612

Homer-Dixon, T. F. and Blitt, J. (1998). *Ecoviolence: Links among environment, population and security*: Rowman& Littlefield Pub Inc.

Homer-Dixon, T., F. (1999). *Environment, Scarcity, and Violence*. Princeton, NJ: Princeton University Press.

Homer-Dixon, T. F. (2000). The Ingenuity Gap. New York: Knopf.

Hossain, M.S. and Lin, C.K. (2002). Land suitability analysis for integrated coastal zone management in Cox's Bazar, Bangladesh: a remote sensing and GIS approach. *Proceedings of the Coastal Zone AsiaPacific Conference*, May 2002, Bangkok, Thailand.

http://www.wrm.org.uy/bulletin/153/Honduras.html dated: 27.02.12.

Islam, A. (1999). *Effects of Shrimp Farming on the Physico-Chemical and Biological Qualities of Water*. Bangladesh Agriculture University, Mymensingh, Bangladesh

Islam, M.R. (2006). Managing Diverse Land Uses in Coastal Bangladesh: Institutional Approaches. Hoanh, C.T. Tuong, T.P. Gowing, J.W. and Hardy, B. (Eds.), *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts*. Wallingford, Oxfordshire, GBR: CABI Publishing, 2006. p 1.

Jablonski, S. and Filet, M. (2008). Coastal management in Brazil – A political riddle.*Ocean & Coastal Management* 51: 536–543.

Kam, S.P., Nhan, N.V., Tuong, T.P., Hoanh, C.T., Be Nam, V.T. and Maunahan, A. (2006). Applying the Resource Management Domain (RMD) Concept to Land and Water Use and Management in the Coastal Zone: Case Study of Bac Lieu Province, Vietnam. Hoanh, C. T., Tuong, T.P. and Hardy, B. (Eds.) *Environment and Livelihoods in Tropical Coastal Zones : Managing Agriculture-Fishery-Aquaculture Conflicts*. Wallingford, Oxfordshire, GBR: CABI Publishing, 193-205.

Kamal, A., Kathe, R., Jensen, C. and Lin, K. (2009). Coastal Aquaculture Development in Bangladesh: Unsustainable and Sustainable Experiences. *Environmental Management* 44:800-809.

Karim, M. (1986). *Brackish water shrimp culture demonstration in Bangladesh*. Madras, Bay of Bengal Programme for Fisheries Development, FAO (Food and Agriculture Organization of the United Nations).

Karim, M.R. (2006). Brackish-water Shrimp Cultivation Threatens Permanent Damage to Coastal Agriculture in Bangladesh. Hoanh, C. T., Tuong, T.P. and Hardy, B. (Eds.) *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts*. Wallingford, Oxfordshire, GBR: CABI Publishing.

Lewis, R.R., Phillips, M.J., Clough, B. and Macintosh, D.J. (2003). *Thematic Review on Coastal Wetland Habitats and Shrimp Aquaculture.*Report prepared under the World Bank, NACA, WWF and FAOConsortium Program on Shrimp Farming and the Environment: 81.

Lodgaard, S. (1992). Environmental Security, World Order and Environmental Conflict Resolution. Gleditsch, N. P. (Ed.), *Conversion and Environment proceedings of a Seminar in Perm, Russia,* 24-27 Nov. 1991. PRIO Report 2(92): 115-136.

Lomborg, B. (2001). Resource Constraints or Abundance? Diehl, P.F and Nils P. Gleditsch (Eds.). *Environmental Conflict*. Boulder, CO: Westview: 125-152.

Mazid, M.A. (1994). Environmental issues and aquaculture development in Bangladesh. *Final Workshop, FAO (Food and Agriculture Organization of the United Nations)1994.*

Majid, M.A. and Gupta, M.V. (1997). Research and information needs for fisheries and development and management. *Proceedings of National Workshop on Fisheries Resources Development and Managementin Bangladesh,* 29 October–1 November 1995.

Marta, G. and Rivera-Ferre. (2009). Can Export-oriented Aquaculture in Developing Countries Shrimp Case. *Journal of Agricultural and Environmental Ethics,* 22: 301-321.

Martinez-Alier, J. (2001). Ecological conflicts and valuation: mangroves versus shrimps in the late 1990s. *Environment and Planning C: Government and Policy*, 19, 713-728.

Martinez-Alier J, O'Connor M. (1996). Ecological and economic distribution conflicts, *Getting Down to Earth: Practical Applications of Ecological Economics* (Eds.) R Costanza, O Segura, J Martinez-Alier (Island Press, Washington, DC), 153-183.

Masalu, DCP. (2000). Coastal and marine resource use conflicts and sustainable development in Tanzania. *Ocean and Coastal Management* 43: 475–494.

Miah, M.G., Bari, M.N. and Rahman M.A. (2003). Agricultural activities and their impacts on the ecology and biodiversity of the Sundarbans area of Bangladesh. *Journal of Natural Science Foundation Sri Lanka*, 31(1and 2):175-199.

Miah., M.G., Bari, M.N., Rahman, M.A. (2010). Resource degradation and livelihood in the coastal region of Bangladesh. *Frontiers of Earth Science in China,* 4(4): 427–437.

Monju TH. (2000). *Commercial Shrimp Culture: Environment, Gender and Socio-economic Changes,* OXFAM (GB), Bangladesh

MPO (Master Plan Organisation). (1987). *Coastal shrimp aquaculture resources, Technical Report No. 18*. Dhaka, Master Plan Organisation.

MPO (Master Plant Organisation). (1986). *Final report (Volumes I–III).* Dhaka, Master Plan Organisation.

Olson, M. (1970). *The rise and decline of nation: Economic Growth stagflation, and Social Rigidities,* New Haven: Yale University Press.

Opschoor, J. (1989). North South Trade, Resource Degradation and Economic Security, *Bulletin of Peace proposals* 20(2): 135-142.

Padròn, M., and Torti, M. R. (1984). Desarrollopesquero integral del Complejo Lagunar Unare -Piritu: Plan paraincrementar la producciòn de camarones. Universidad de Oriente, Guatamare, Estado Nueva Esparta, Venezuela, (mimeograph). Sebatiani, M., Gonzalez, S.E., Castillo, M.M., Alvizu, P., Oliveira, M.A., Pérez, J., Quilici, A., Rada, M. and Yaberl, M.C. 1994. Large-Scale Shrimp Farming in Coastal Wetlands of Venezuela, South America: Causes and Consequences of Land-Use Conflicts. *Environmental Management,* 18(5): 647-661.

Patil, P.G. and Krishnan, M. (1997). The Kandaleru shrimp farming industry and its impact on the rural economy. *Agricultural Economics Research Review,* 10(2): 293– 308.

Paul, B.G. and Vogl, C. R. (2011). Impacts of shrimp farming in Bangladesh: Challenges and alternatives. *Ocean & Coastal Management,* 54(3): 201-211.

Percival, V. and Homer-Dixon, T.F. (1998). Environmental Scarcity and Violent Conflict: Case Of South Africa, *Journal of Peace Research* 35(3): 279-298.

Phong, N.D., My, V., Nang, N.D., Tuong, T.P., Phuoc, T.N. and Trung, N.H. (2003). Salinity dynamics and its implication on cropping patterns and rice performance in shrimp-rice system in My Xuyen and GiaRai. Preston, N. and Clayton, H. (Eds.) *Rice-shrimp Farming in the Mekong Delta: Biological and Socioeconomic Issues.* ACIAR Technical Reports No. 52e, Canberra, Australia, 70–88.

Primaver, J.H. (2006). Overcoming the impacts of aquaculture on the coastal zone. *Ocean & Coastal Management,* 49:531–545.

Rahman, A., Islam, M.A., Roy, I., Azad, L. and Islam, K.S. (1995). *Shrimp culture and the environment in the coastal region*. Dhaka, Bangladesh Institute of Development Studies.

Renner, M., Pianra, M. and Franchi, C. (1991). International Conflict and Environmental Degradation. Vayrynen, R. (Ed.) *New Directions in Conflict Theory, Conflict Resolution and Conflict Transformation.* London: SAGE, in association with International Social Science Council, 108-128.

Renner, M. (1996). *Fighting for survival: Environmental decline, social conflict, and the new age of insecurity*. London: Norton.

Richards, J.F. and Flint, E.P. (1990). Long-term transformations in the Sundarbans wetlands Forestsof Bengal. *Agriculture and Human Values,* 7(2):17-33.

Rosenberry, B. (Ed.). (1995). World shrimp farming 1995: annual report. San Diego, *Shrimp News International.*

Rouf, M.A. and Jensen, K.R. (2001). Coastal fisheries management and community livelihood: possible strategy for the Sunderbans, Bangladesh. *ITCZM Monograph Series*, No. 4. Asian Institute of Technology, PathumThani, Thailand.

Sebatiani, M., Gonzalez, S.E., Castillo, M.M., Alvizu, P., Oliveira, M.A., Pérez, J., Quilici, A., Rada, M. and Yaberl, M.C. (1994). Large-Scale Shrimp Farming in Coastal Wetlands of Venezuela, South America: Causes and Consequences of Land-Use Conflicts. *Environmental Management,* 18(5): 647-661.

Simon, J. L. (1998). *The Ultimate Resource II*. Princeton, NJ: Princeton University Press.

Stonich, S. (1991). The promotion of non-traditional exports in Honduras: issues of equity, environment, and natural resource management. *Development and Change,* 22:725-755.

Spalding, M.D., Blasco, F. and. Field, C. D (Eds.). (1997). *World Mangrove Atlas*. The InternationalSociety for Mangrove Ecosystems, Okinawa, Japan. 178pp.

Ted Gurr. (1970). *Why Men Rebel,* Princeton: Priceton University Press, 1970.

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.

World Rainforest Movement http://www.wrm.org.uy/bulletin/153/Honduras.html dated: 27.02.12.