Delta Growth despite a rise in Sea Level - Has Bangladesh got the all-clear?

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Worldwide, Bangladesh is one of the countries particularly threatened by the effects of global climate change. In fact, its sediment body could actually benefit from the rise in sea level due to climate change and even grow further. Nevertheless, the land use change in terms of extensive aquacultures increases the vulnerability of this amphibious country to a significant extent. Only small remaining parts of the coastal mangrove swamps have been preserved.

The Ganges-Brahmaputra delta forms an economic and residential area for more than 100 million people. The population is confronted with a high natural risk, due to regular tropical cyclones and floods. In past centuries various adaptation strategies have been developed for this partially amphibious space during the monsoon rains.

In connection with the increase in sea level globally, doomsday scenarios are often proposed for the region. According to an article in the German magazine SPIEGEL, “Bangladesh (lies) – In the Death Zone of Climate Change“ (SPIEGEL online, 4/23/2007). Furthermore, the current IPCC report regards the country to be threatened by an imminent increase in sea level (cf. Cruz et al. 2007). A more exact analysis, though, shows that it is not only a rise in sea level which is responsible for the situation in Bangladesh, and the subsequent increase in sedimentation, but rather, we are facing a far more complex systematic effect, caused by human interference in developing extensive aquacultures.

Delta growth in spite of sea level rise

All deltas of the earth are the result of post-glacial sedimentation processes. The Ganges-Brahmaputra Delta as it is today has evolved over the last 10,000 years. This is even more remarkable as the sea level has risen about 120 meters since the last ice age (cf. Goodbred and Kuehl in 1999) whereas the land has subsided about 1 to 2 mm per year due to isostatic movements (cf. Alam in

1996). The rivers carry a considerable sediment load, currently about 10 Billion tons of alluvial mud per year (cf. Kuehl et al. in 2005). The rising sea level not only hinders the outward flow of the rivers through backwater effects, but also leads to regular flooding that affects the hinterland and therefore accelerates silting. This again causes significant growth of the sedimentary body (cf. Staerker et al. in 2008) and a seaward shift of the delta front. The coastal mangrove swamps, in particular, have a key function concerning the sediment concentration. The Ganges-Brahmaputra Delta currently encompasses a total of 140,000 km² of which 110,000 km² is permanently above the average high tide level.

The increased vulnerability of the region as a result of land use change

„Traditionally, for the people living on subsistence agriculture the tidal forests served as a source of food and luxury goods (fish, shellfish, fruit, eggs, vegetables, honey, sugar, alcohol, vinegar, spices), timber and firewood, wattle, forage/animal feed, fertilizer and medicines. In the meantime, many of these have given way to the production of marketable goods. (…) The selective and partly excessive use leads to the degradation of these supplies. (…). This has considerably limited the function of the mangrove swamps not only as coastal protection but also as spawning and breeding areas.“ (Uthoff in 1998)

fig. 1: Traditional forms of fish and shrimp breeding in small lakes determined the land use until the 1970s.

Mangrove swamps form an ecologically unique habitat. For the sediment concentration, and therefore also for long-term coastal protection, the mangrove belt is of crucial importance as its prop and intertwined roots serve as baffle stones and thus stabilize the ground (cf. Ravikumar in 2008). The value of the mangrove swamps has been recognized, not least with the awarding of a "world natural heritage" ranking to the Sundarbans by UNESCO in 1987. Nevertheless, beyond the protected areas, virtually all the forest - about two thirds of the original extension - have been destroyed. In the past four decades the ecological situation in the southern third of the Ganges-Brahmaputra Delta has completely altered due to the change in land use. In place of the thick mangrove swamps, aquacultures have now spread extensively. Economic interests, population pressure and the degradation of the natural forest ecosystems considerably increase the vulnerability of the coastal area. Presently, the almost total destruction of the mangrove swamps reinforces various mutually

dependent hydrodynamic, meteorological and geomorphologic effects. These are evident in higher wind speed, in more rapidly rising water tables during flood events, as well as in increased erosion. The effects of climate change act as exacerbating factors.

Development of industrial shrimp breeding

Until the 1970s the coastal regions were dominated by traditional forms of cultivation, in which humans worked more or less in harmony with nature. Apart from rice-growing, which was influenced by the monsoon season, it was primarily extensive stock farming that played an important role. Moreover, fish and shrimp farming were practiced in the many of the smaller stagnant water areas. Agriculture and fishing was practiced only for subsistence or the local markets (fig. 1). In the early 1970s, local pioneers started to cultivate shrimps in rice fields, in Bangladesh, as elsewhere in Asia. Therefore, hydro-engineering techniques in terms of artificial embankments and water supply systems became necessary. With the rising demand worldwide, the commercial and increasingly export oriented form of shrimp production in bigger artificial breeding basins quickly caught on. Presently, these aquacultures in Bangladesh extend over an area of about 50,000 ha. With about 125,000 companies shrimp production, after the textile industry, forms one of the country's most important economic sectors with an annual export value of 386 million Euros.

fig. 2: Intensive use of pesticides guarantees stable production figures. The picture shows a shrimp farmer in his rice and shrimp field applying artificial pesticides.

Ecological problems

Industrial shrimp breeding has numerous negative ecological outcomes, including the progressive salinization of the region. During the dry season artificial water management is needed in the breeding basins to keep the harvest stable in the medium term. For this, brackish water as well as fresh water from the surrounding rivers but also ground water is pumped onto these areas. In the long term, this leads to a drastic lowering of the ground water level and therefore to a shortage of drinking water sources. After 10 to 15 years of intensive use the productiveness of a large basin declines severely so that it is not profitable any more. Salt-crusted fallow land without vegetation remains (fig. 3).

Shrimps grown in monoculture are prone to virus infections. Also, the increasing shortage of larvae limits the industry's growth. Before breeding, the larvae are caught in coastal waters with extremely fine-meshed nets which also causes the spawn of countless other types of fish to be caught as by-catch. This depletes fishing resources considerably and has serious effects on local fishermen, fishery and coastal ecosystems.

Well into the 1990s, large areas were transformed into aquacultures and the intensive shrimp production, without taking the ecological aftermath into account. In particular, the use of artificial fertilizers, pesticides and antibiotics in order to increase the harvest contaminated not only the sapropel in the compounds, but also the shrimps themselves.

fig. 3: Particularly during the dry season (December until April) the unused fallow land is clearly evident.

Increasing ecological consciousness

„As of 15th July 2010, imported shrimps from Bangladesh are controlled more strictly by the European Union. (…) The authorities in Brussels decided on this step after further serious defects had had been ascertained (…). Thus, since 2008, Bangladesh had failed to extend its laboratory capacity sufficiently for the analysis of prohibited substances in the shrimps. (…). As the EU is Bangladesh's most important shrimp market Maqsudur Rahman, vice president of the exporter's union for frozen food, spoke of a „serious setback". (…) In the second half of 2009, Bangladesh had interrupted the export of fresh water shrimps voluntarily, after the cancer causing antibiotic Nitrofuran had been discovered in more than 50 shipments for the EU." (www.fischmagazin.de, 8/2/2010)

The implementation of HACCP (Hazard analysis and Critical Control Points system) standards for the supervision of food hygiene by the EU, together with stricter controls caused a significant setback for the shrimp industry. Temporarily exceeding the maximum permissible limits even resulted in an entire EU import ban. In the meantime, stricter on-site controls and not least greater consumer awareness have improved the situation, although the problems have not yet been resolved. Recently, a positive trend has been demonstrated by the production of organic shrimps, where artificial feeds and other chemical additives have been abandoned.

Social ramifications of land use change

"Shrimp farms harm poor nations" was the striking but absolutely appropriate title of a BBC programme in 2004. Quite apart from the ecological effects described above, the traditional economic and social structures in the affected regions have also almost totally disintegrated. This can be attributed to the land-intensive farming, which has resulted in the dislocation of parts of the local population, particularly of smallholders. An indirect indicator for the developments in the rural area is the growth of towns at an explosive rate, in particular of informal settlements. Violent conflicts about land rights also reflect the social upheaval.

Only some of the smaller farmers succeed in finding work in the new industries. Currently one million people are directly or indirectly involved in shrimp breeding (Ahmed et. al. in 2008). The production process can roughly be divided into three phases. First, the young larvae are caught in rivers or are bred in artificial basins. The second phase comprises the breeding and harvesting of shrimps in aquacultures (Ghers) and linked activities, e.g. the building of artificial embankments, the spreading of fertilizers and feed in the basins or the collecting of snails as food for the shrimps. This phase employs predominantly women and children. The third phase comprises the further processing and commercialization of shrimps. Apart from the wages, currently between 30 and 35 Euros per month, the cultivation of vegetables on the embankments secures the survival of the wage earners.

No all-clear for Bangladesh

As far as the vulnerability of Bangladesh is concerned, there can be no all-clear. Even if the geomorphologic facts document a mildly positive sediment balance, the anthropogenic interference, caused by monetary interests and the demand for shrimps in the western world, increase the risks to the natural environment. As is so often the case, it is primarily the poorer population that is affected, either by the very present danger of storms and flooding or by the radical upheaval of traditional social structures which force thousands of former small farmers and their families into urban slums.

Figures

fig. 1: Traditional forms of fish and shrimp breeding in small lakes determined the land use until the 1970s. (source: Falk)

fig. 2: Intensive use of pesticides guarantees stable production figures. The picture shows a shrimp farmer in his rice and shrimp field applying artificial pesticides. (source: Falk)

fig. 3: Particularly during the dry season (December until April) the unused fallow land is clearly evident. (source: Falk)

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