

Climate Change and Migration in the Coastal Zone of Bangladesh

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Geographische Rundschau

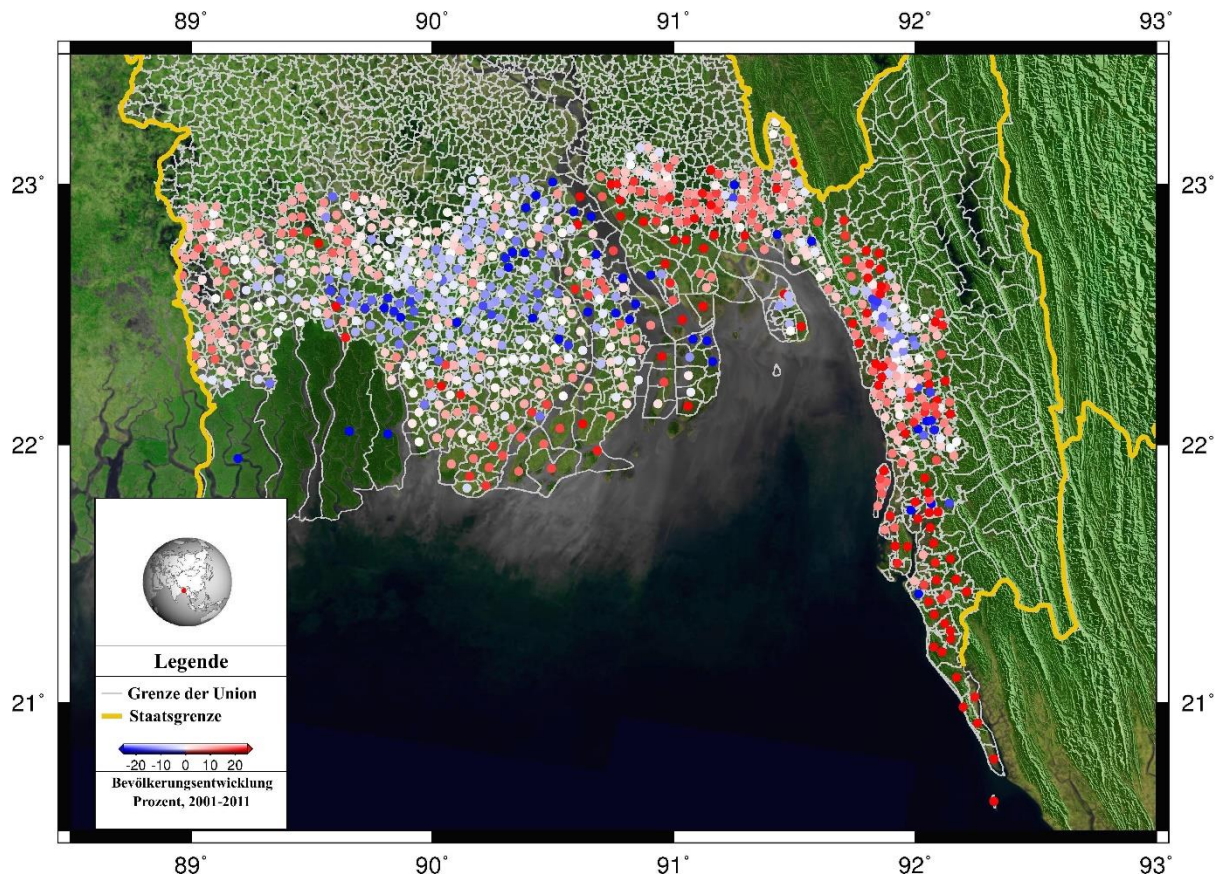
The coastal area of Bangladesh is determined by the delta of the Ganges, Brahmaputra and Meghna Rivers. Due to the high population density, there is considerable pressure on available land resources. At the same time, sea-level rise, tropical cyclones, shifts in precipitation regimes, heat waves, and massive erosion processes are increasing threats to humans. Temporary or permanent migration is a possible response to these changes in living conditions. Often the migrants are hastily called climate or environmental refugees. But the relationships that lead to migration or prevent it, but are much more complex. The idea that global climate change is contributing to migration in climate vulnerable regions such as coastal Bangladesh has generated considerable discussion but only limited systematic evidence (*e.g.*, Gray and Mueller 2012; Penning Rowsell *et. al.* 2013). In general, the evidence shows that climate change is generating more intense and destructive storms, greater rainfall extremes (both droughts and flooding) and temperature extremes (Karim and Mamura 2008; Mirza *et al.* 2003). All of these are creating greater environmental vulnerability for at risk populations such as the residents of coastal Bangladesh. But is this creating greater migration?

In a recent review of studies in tropical developing countries, Black *et al.* (2013) conclude that, while there is evidence of increased vulnerability to extreme weather events, there is no simple one-to-one relationship with migration. Migration also requires resources, both financial and social networks that provide people with the ability to relocate their households and reestablish economic and social activities. Studies of Bangladesh flood victims show that it is typically the more resourceful villagers who migrate while the poorer tend to hunker down and try to eke out survival (Paul and Rountray 2010, 2011; Yasmin and Ahmed 2013). Migration in response to climate disasters is for many a “last resort” (Rowsell, *et al* 2013). Those who are most vulnerable are also typically the least resourced and often the least likely to move and do so only under great duress. Instead they are trapped in their vulnerable locations, which in the long-run tends to increase the vulnerability of the rural poor.

Population changes in the coastal zone and its causes

Figure 1 shows the percent change in population in rural settlements (union parishads) in the coastal region of Bangladesh between 2001 and 2011. Some villages lost 20 percent or more of their population while others grew by a comparable percent. On average, these villages grew by about 7.5 percent with the majority of the negative changes due to severe river erosion and resulting loss of croplands and residences. Local falling population can be partly due to land use change, in particular the spread of less labor-intensive aquaculture in the western half of the coastal region (see also the article by Bernzen *et. al.* in this issue).

But the erosion of the coastline and the resulting loss of arable land can be a locally significant trigger for migration. For example, Char Ishwar, a rural village on the northeast of the island of Hatia, has experienced major river erosion and lost slightly over half of its population between 2001 and 2011. Some villagers moved to the other side of the island to Tamaruddin while others moved to other rural areas or to large cities. A major source of population loss is flooding linked to rainfall extremes during the moonson period, which accelerate the erosion of riverbanks. An example is Char Alexander along the Meghna River,



which lost between 100 and 150 meters of riverbank depth annually (Photo 1). While sandbags have created temporary protection for a major road and a nearby hospital (the only hospital in the subdistrict (upazila) for about 50,000 people) in what had been “downtown” Char Alexander (Photo 2), this erosion will reappear in the near future.

In the long run, erosion of the river bank is therefore not possible to prevent. This is particularly true of temporary repairs of dykes, which the villagers themselves often perform with bamboo and other available wood (Photo 3). An estimated 60,000 individuals are forced out of the homes due to riverbank erosion and about 14,000 hectares of arable land are eroded annually, 5,000 of which are on small river islands (Hutton & Haque 2004; Mirza et al. 2003). Another source of flooding is storm surges which threaten the polder (embankment) system of the coastal area. Picture 4 shows an embankment that has been cut by storm surge from Cyclone Aila in 2009 that is 6 years later allowing unchecked tidal saltwater to flow into what were previously rice fields.

Regression analysis make it possible to systematically analyze the relationships between flood events and population changes. To this end, a flood index was calculated from satellite data. This index measures floods based on peak values above two standard deviations relative to the mean in terms of water coverage of land that occurred during the monsoon season between 2001 and 2011. Using regression analysis, about 9% of the variance in population losses in the rural settlements of the coastal region can be explained by flooding.

Migration, agriculture and climate change

Nationally representative inter-censal surveys regularly carried out by the Statistical Office of Bangladesh permit the calculation of annual migration or emigration rates (Sample Vital Registration System, SVRS; see BBS 2011). In the SVRS, migration measures include all individuals who leave their homes permanently or temporarily for at least six months. As Table 1 shows, the number of such migrants per 1,000 population has increased in Bangladesh in recent years. In particular, cities are the preferred migrant destinations. This

Table 1. Migrants Per 1000 Population, Bangladesh, 2002-2010

Year	Rural- Rural	Urban- Rural	Total Rural	Urban- Urban	Rural- Urban	Total Urban
2002	10.3	2.7	13.0	39.8	11.0	50.8
2003	10.3	2.8	13.1	34.3	17.4	51.7
2004	13.8	3.1	16.9	38.1	16.0	54.1
2005	12.7	3.4	16.1	43.5	20.3	63.8
2006	13.9	3.6	17.5	38.2	21.9	60.1
2007	16.0	5.1	21.1	41.1	23.7	64.8
2008	12.5	4.1	16.6	34.4	17.3	51.7
2009	14.5	5.0	19.5	28.3	21.9	50.2
2010	16.2	6.0	22.2	48.9	24.5	73.4
% Growth	58%	121%	71%	23%	123%	45%

Source: Report on Sample Vital Registration System, 2002-2010.
Bangladesh Bureau of Statistics.

can be explained by the fact that the dynamic economic development in cities creates better job opportunities in the industry and services. The relative increase in the migration rate between 2002 and 2010, however, is proportionally higher in rural than in urban areas (71% vs. 45%), although the share of agriculture in the economy has steadily declined and productivity and profitability in the agricultural sector have been stagnant. This indicates that the migration of the last decade cannot be solely attributed to the strong economic conditions in urban areas.

The extent to which environmental and climate-related changes have an impact on the migration rates can be estimated from regression analysis of weather data effects on outmigration. Precipitation and temperature have a significant impact on subsistence farmers relying on traditional farming methods in Bangladesh. Crop loss, according to the analysis by Gray and Mueller (2012), is the main trigger for migration from rural regions. Since both heat and cold can slow plant growth, so-called “growing degree days” are often used as a measure of plant growth – they measure the amount of time for which there has been favorable air temperature in the course of a year and are considered as a meaningful indicator for the growing condition of crops.

Figures 2 and 3 show the annual average of the total rainfall and the growing degree days in the coastal region of Bangladesh and the corresponding moving average over ten years. There are two main findings to note. First, looking at the long-run averages, there is a clear increase in surface temperature between 2000 and 2010, along with a more modest increase in total precipitation. Second, the variability in both precipitation and air temperature has also increased. Erratic rainfall and temperature variation have been estimated to reduce crop production in Bangladesh by 20% and 5%, respectively (UNDP, 2009). For households living

near subsistence, this type of climate variability poses a clear threat to their livelihoods and could easily drive individuals to migrate in search of better (more lucrative, less volatile) work opportunities.

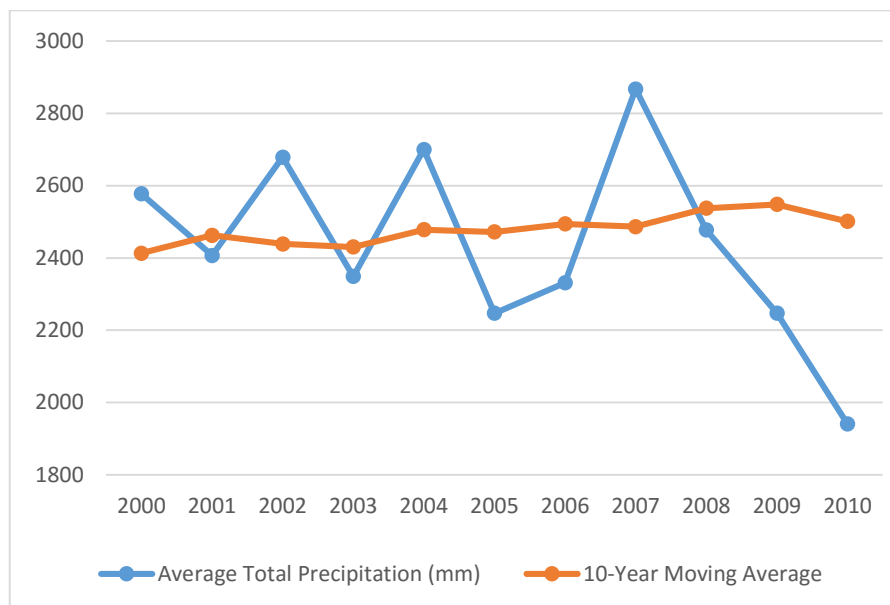


Figure 2. Precipitation in Coastal Bangladesh

In fact, the increase in climate variability coincides with an increase in rural migration (see Tab. 1 and Fig. 2 and 3). However, it must be noted that only a very short period of eight to ten years is considered, and many other factors of migration decisions can play a role. To isolate the role of climate, we can use regression analysis. This analysis shows that warmer temperatures and increased rainfall increase migration, but greater precipitation during the rainy season decreases migration. This seems to suggest that, while areas with better growing conditions throughout the year have greater out-migration, perhaps due to increased crop production in the off-seasons, peak season rainfall tends to deter migration, likely due to the increased need for harvest labor.

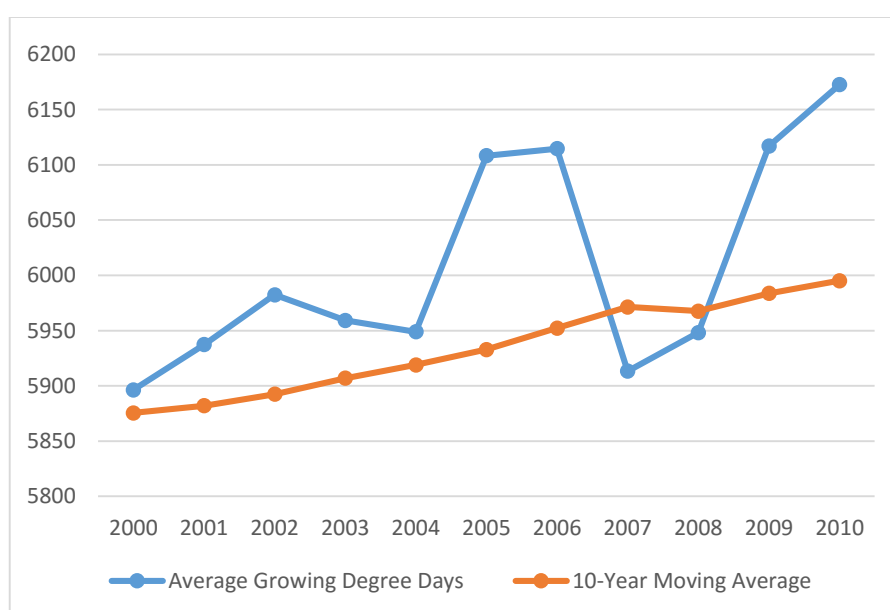


Figure 3. Growing Degree Days in Coastal Bangladesh

However, the magnitude of these effects is relatively modest. In 2010, there were 36.1 migrants per one thousand people in Bangladesh. A 5 percent increase in growing degree days would lead to 1.9 additional migrants per one thousand people. A 5 percent increase in total precipitation would lead to 1.3 additional migrants, and a 5 percent increase in rainy season precipitation would lead to 0.65 fewer migrants. But with nearly 38 million people living in coastal Bangladesh, total migration flows due to moderate climate change would be near 100,000 people per year. This number is significantly lower than the alleged 25 million and more Bangladeshi “climate refugees” cited by the mass media and non-governmental organizations. In addition, many of these migrants are not travelling long distances but short distances in neighboring municipalities or the next town. Nevertheless, even this may overwhelm existing support systems and infrastructure, both in the countryside and in cities.

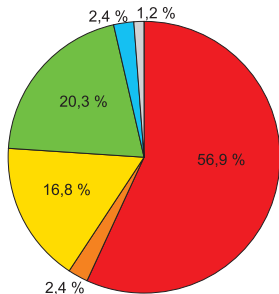
Migration motives and behavior

Circular migration between rural and urban areas has long been standard practice in many Bengali families. This applies both to internal migration and international migration. In terms of the amount of remittances from abroad, Bangladesh is among the top five countries in the world (US \$ 11 billion in 2010, World Bank data). According to the investigations of Parvin et al. (2008), many families on Hatia send remittances in response to events such as storm surges, eddy storms or riverbank erosion or send more family members (often temporarily) to work in the larger cities. Migration is, in addition to loans, savings, or the sale of real property, a typical adaptation strategy to short-term shocks such as cyclones and floods, but also in more subtle changes such as riverbank erosion and soil salinity.

At the end of 2014, an international team conducted survey of nearly 1,200 households in nine selected villages in the coastal zone provides deeper insights into the extent and causes of migration (to the study areas (see the map of Bernzen *et. al.* in this issue). The household survey covered a total of more than 6,100 people (53% men, 47% women; 27% were children under 15 years.). Among them are people who have moved temporarily or permanently since 1998 (total. 5% of all people). Including only the adults, the proportion of migrants is 6%. The actual migration rate will presumably be somewhat underestimated by these figures because families who have left the study areas completely are not detected by this method. Nevertheless, it must be noted that in the rural coastal regions of Bangladesh, although significant population losses are observed by emigration, there is no evidence of large-scale mass exodus from the areas most affected by climate change. Somewhat higher outmigration rates are, however, observed in villages that were affected by tropical cyclones Sidr (2007) and Aila (2009) and suffered considerable damage, where in recent years, the aquaculture have spread very fast and/or where soil salinization in agriculture is very difficult. Here the outmigration rates are 8 to 12%, well above the average. Again, the proportion of families in which one or more members were migrants is significantly higher. However, the expansion of "Cyclone Shelters" or cyclone early warning systems has helped more people stay in the affected regions because the chances of survival are higher.

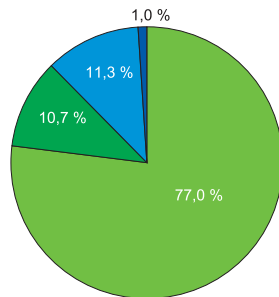
When asked about the main motives for migration, environmental or climate-related factors are almost never named (Fig . 4A). The dominant migration motive is clearly economic. This is especially true for better employment and training opportunities in the larger cities of the coastal area (Khulna , Barisal , Chittagong) and in the capital Dhaka . Marriage, especially for women, and other family reasons are important motives for migration. About three quarters of all moves are temporarily created and on domestic objectives directed (Fig. 4B).

A. Hauptgründe für die Migration



- Bessere Beschäftigungsmöglichkeiten in der Stadt
 - Bessere Beschäftigungsmöglichkeiten in der Landwirtschaft
 - Schule, Studium, Ausbildung
 - Heirat und Familienzusammenführung
 - Politische Konflikte und Unruhen
 - Sonstige Gründe
- (n= 167)

B. Art und Ziel der Migration



- Temporäre Migration innerhalb von Bangladesch
 - Dauerhafte Migration innerhalb von Bangladesch
 - Temporäre Migration ins Ausland
 - Dauerhafte Migration ins Ausland
- (n= 291)

The permanent internal migration (11%) or even international migration are significantly lower.

This clearly shows that the migration from the coastal areas of Bangladesh should not be rashly called climate or environmental flight. The migrants are not the poor, disadvantaged and particularly vulnerable people, but rather the more affluent and better educated (see also Paul and Routray 2011). This makes a comparison of the outmigration rates by educational attainment precise: If the proportion of temporarily or permanently migrated from the villages in persons who never attended school or did not complete the grade school education below 2%, it reaches at those who have completed primary school, already almost 4%. Even higher migration values be achieved in people who have completed secondary school (10%) or at people who have completed college (17%) or university education (35%). However, making the last three groups of only 9%, 8% and 1% of all persons captured on the survey.

Overall, the figures lay suggest that the exodus or "flight" of particularly poor and vulnerable against uncontrollable environmental change is less, but rather is supported by quite rationally grounded hopes for better earning opportunities and more favorable living conditions in cities.

Conclusion

Environmental and climatic changes are empirically hardly reliably separate from other migration reasons. But this also means that the existing estimates for "climate" or "environmental flight" are scientifically little trustworthy. Simple deterministic approaches into account neither the multi-causality of migration and non-migration, yet the adaptability of people to changes in environmental conditions (Findlay / Geddes 2011 Foresight Report 2011). This does not mean that there is no link between environmental change and migration. As these relationships are much more complex than just suggest deterministic cause-effect theories.

The future number of migrants will depend in Bangladesh, among other things also on the speed of possible climate and environmental changes. But these changes are even perceived by the people as a rule as a deterioration in the local economic conditions and assessed (reducing arable land, loss of employment opportunities, etc.), so that ultimately especially economic motives for the actual migration decision will continue to prevail. Moreover, by no means is a clear or even linear relationship between social vulnerability and migration. Especially particularly vulnerable because poor and poorly educated population generally have little opportunity to migrate, because they lack the material means but may also provide the social conditions necessary for this purpose. In recent years, this relationship is under the heading "trapped population" discussed (Foresight Report 2011). This people are meant suffering the deterioration of the local physical conditions, but do not have the resources to leave their homes can. This may in the longer term further increase the vulnerability of the rural population. Above all, these people lack a potentially beneficial option for individual adaptation. Migration does not necessarily have to be something "bad", but in many cases is an efficient and meaningful also way of social adaptation to changing conditions. This applies to the coastal areas of Bangladesh, like others, of climate and

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Summary

Climate Change and Migration in Coastal Bangladesh

The idea that global climate change is contributing to migration in vulnerable regions such as coastal Bangladesh has generated considerable academic debate but only limited systematic evidence. In general, the existing evidence shows that climate change is generating rising sea-levels, more intense and destructive storms, greater rainfall extremes (both droughts and flooding) and higher temperatures. All of these are creating greater vulnerability for at risk populations. But is this creating greater migration? This paper presents empirical evidence based on data from national statistics and targeted household surveys in rural areas of coastal Bangladesh. Our analyses suggest that migration is a rather complex process which is not adequately described by deterministic models and simplistic concepts such as climate or environmental migration. Our results point toward a new understanding of climate- and

disaster-induced mobility that recognises the significant barriers to migration for vulnerable households as well as their substantial adaptive capacity.

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