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Climate Change, Food and Water Security in Bangladesh

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Key Points

- Bangladesh's geographical location, poverty levels and high population density contribute to its ranking as the most vulnerable country to the effects of climate change.
- Climate change-induced sea level rise could inundate 17 per cent of Bangladesh's land area by 2050, reducing cultivatable land and displacing 35 million people.
- Education and training programmes are required to increase the employability of migrants displaced from land or affected by climate change.
- All stakeholders – particularly community members – need to participate in effectively implementing climate change adaptation plans.

Summary

Bangladesh faces significant challenges in adapting to the impacts of climate change. Its topography and geographical location make it particularly susceptible to extreme weather events including cyclones, floods and storm surges. Bangladesh's population of over 152 million resides within a space of 144,000 square kilometres, making it one of the most densely populated regions of the world. The large population places significant pressure on land and water resources, leading to pollution, the rapid depletion of groundwater resources and detrimental impacts on food production. These challenges are expected to be exacerbated by the effects of climate change, which is set to impact Bangladesh to a greater degree than any other country by 2025. A per-capita gross national income of AUD$590, a lack of jobs and high levels of poverty create additional challenges for Bangladesh in developing and implementing adaptation strategies for its vulnerable population.

Analysis

Bangladesh Geography and Climate

Climate, Topography and Geographical Location

Bangladesh is situated on a low-lying, flat plain between the Himalayas in the north and the Indian Ocean in the south. It is at the confluence of three major rivers - the Ganges (Padma), Brahmaputra (Jamuna) and Barak (Meghna). The numerous rivers and streams throughout the country make it vulnerable to flood and drought. Neighbouring countries include India to the north and west and Myanmar to the south-east.

Bangladesh has a tropical monsoonal climate with three distinct seasons. The hot summer season between March and June, where little rainfall often leads to drought; the rainy season between June and September, where heavy rainfall frequently leads to flooding for up to two-thirds of the country; and the cool winter season between October to February. The average annual precipitation varies between 1,270mm and 1,520mm, with most of it (80 per cent) occurring in the wet season. The country frequently experiences violent storms including cyclones, thunderstorms and tornadoes. The average temperature ranges between 13 and 26 degrees Celsius during the cool season and 25 to 31 degrees Celsius during the summer/rainy season.

Water Resources

Surface water

The surface water resources of Bangladesh are fed by rainfall within the country and inflows from the rivers that cross into Bangladesh from outside it. The average annual rain falling onto Bangladesh, as a whole, is estimated as averaging 284km^3 between 1985 and 2010. Most of this rain occurs in the wet season when rainfall is approximately three times the evaporation rate. Most of the excess water becomes runoff and ends up in the sea, with the rest able to recharge aquifers. There is considerable potential for rainwater harvesting during the wet season, which could assist with agricultural irrigation during the dry season.

Rivers

The main rivers entering Bangladesh are fed by monsoons. They have high flow during the wet season and low flow during the dry season. The annual average inflow of the combined main rivers is 981 km^3. The trend of annual discharge has not changed significantly in both the Brahmaputra and Barak rivers. The Ganges River, however, has seen a significant reduction in flow, which has been attributed to the development of the Farraka Barrage in India.

The combined inflows of all transboundary rivers is about 1,260km^3, dropping to as low as 186km^3 in the dry season. The rivers receive further inflows of about 113km^3 from the combined regional runoff. The flow of Bangladeshi rivers is highly variable depending on seasonal conditions and they cannot be relied upon to provide uninterrupted access to water.

Groundwater

Bangladesh lies on a large and deep aquifer system with both deep and shallow groundwater resources. The deep and shallow sources are separated by an impermeable clay aquitard, a water-saturated sediment or rock, the permeability of which is so low it cannot transmit any useful amount of water. The majority of the country's water comes from unconfined groundwater. Annual groundwater availability in Bangladesh is estimated at 65km^3. Net annual recharge is estimated to be 32km^3. Seventy-nine per cent of Bangladesh's cultivatable land is irrigated by groundwater, with the remainder irrigated by surface water.

Current extraction rates of groundwater are unsustainable, with many reports suggesting it is being extracted faster than it is being recharged. In 2010, groundwater was recorded as being extracted at the rate of 53 billion m^3 a year, while it was recharged by 50 billion m^3. A high level of natural arsenic contamination in groundwater is also a significant problem, with an estimated 25 per cent exceeding safety levels specified by Bangladesh. Heightened exposure to arsenic can cause health problems for those that consume water with a high concentration of the element.

Water Security

The current population of over 152 million is projected to grow to about 214 million by 2050 and the economy is currently growing at a rate of about six per cent per year. Increasing wealth and affluence will lead to a greater per capita demand for water and food. Depending on preferred diet and the productivity of crops, this may also lead to an increase in the need for irrigation water. By 2050, annual domestic water demand is expected to increase by 200 per cent compared to current levels, while industrial demand is expected to increase by 440 per cent.

Total demand for irrigation water is about 33km^3 per annum. Future water use will be tied to the production of the dry season *boro* rice crop. Currently, the *boro* crop uses 95 per cent of the total irrigation supply, with other dry season crops using significantly less water. Crops grown during the wet season, such *aus* and *aman* rice, are able to use rainfall. Concerns about the overuse of groundwater focus on irrigation water use and particularly that of *boro* rice.

Limiting or reducing water use while continuing to meet the future food security needs of the country will require increasing yields and shifting production to other crops and other regions. The agriculture sector is by far the largest consumer of water in Bangladesh and will need to be managed to ensure it is used sustainably.

Impact of Climate Change on Water Resources

Climate change is expected to cause significant changes in river salinity, particularly in the south-west coastal area of Bangladesh during the dry season. This will lead to shortages of drinking water in the coastal urban areas.

There is uncertainty surrounding the effect climate change will have on rainfall and temperature. The observed temperature and rainfall over Bangladesh has increased in the last 50 years. Extreme temperatures and precipitation are expected to increase, but there is disagreement on whether this change lies within historical variation or deviates from it. Some climate scenarios suggest that temperatures are projected to increase beyond the range of historical variation, while precipitation remains within historical variability for any month or season. Other projections suggest that the mean change in rainfall will be significantly larger than the standard deviation in historic annual rainfall totals. More accurate projections will be required to create policies that will effectively mitigate the effects of climate change on the region.

Climate change may affect the flow of rivers by impacting on the storage of water in Himalayan glaciers due to temperature and precipitation changes. Several studies suggest there will be a greater overall discharge rate and greater peak discharge during the wet season, with diminished low flows in the dry season. This may significantly reduce the amount of water available for irrigation during the dry season.

Most wells (56 per cent) show declining water levels, with the remainder showing stable levels. Between 2000 and 2010, declining water level trends were exacerbated due to reduced rainfall during the wet season. During the dry season many wells fall below a critical threshold of about 8m, at this point wells become inoperable, leading to a lack of access to water for drinking and irrigation. It is expected that recharge may decline further due to reduced rainfall as a result of climate change. Groundwater will also be impacted by the increased intensity and frequency of storms during the wet season, due to greater runoff and shorter periods of recharge.

Food Security in Bangladesh

Rice is the most important crop in Bangladesh. The harvested area covers 11.5 million hectares or 80 per cent of the cultivated area. Agriculture accounts for 19.6 per cent of gross domestic product and employs 63 per cent of the population.

The cultivation of rice in Bangladesh varies according to seasonal changes in the water supply. The largest harvest, *aman*, which accounts for more than half of annual production, occurs in November and December. Rice for the *aus* harvest occurs during the summer. The *boro* growing season occurs during the dry season and requires irrigation.

It is common for fields throughout Bangladesh to produce rice for two harvests annually. Between rice-growing seasons, farmers grow vegetables, peanuts, pulses or oilseeds.

Considerable progress has been made in improving food security by increasing annual rice production from 151 kg per capita in 1995, to 217 kg per capita in 2010. For the last few decades, the increase in production outweighed the growth in population. This has been due to the development of shallow tubewells for irrigation and policies that promoted rapid expansion of irrigated *boro* rice farming in the dry season and the expansion of the rain-fed, low-yielding *aus* rice area. This led to accelerated growth in rice productivity and a reduction in the unit cost of production, which increased availability and made it more affordable. This

arrangement, however, is unsustainable in the long-term. Groundwater is rapidly declining; it is expected to be under increased pressure due a rapidly increasing population and increased pollution. Surface water sources will also come under pressure due to rising salinity in rivers.

Despite the increase in productivity, Bangladesh still remains food-insecure. In 2012, it was estimated that 60 million people consumed less than the daily recommended calorie intake. A lack of access to nutritional foods has also heavily impacted health. About 43 per cent of children under-five in Bangladesh are currently stunted due to malnourishment. Rice accounts for an estimated 75 per cent of calories consumed by the population. Bangladesh will need to create strategies for the local diversification of crops to increase nutrition levels. Trade-based food security can also be achieved by exporting the surplus rice it produces to import more nutritional alternatives.

The increasing population and the loss of arable agricultural land due to urbanisation, as well as climate change-induced sea level rise, will pose significant challenges to agricultural productivity into the future. Current projections, however, suggest that Bangladesh is well equipped to meet this demand with the use of high-performing crops. The main challenge involves increasing rice production without using groundwater unsustainably.

Impact of Climate Change on Food Security

Agricultural production is expected to be significantly impacted by the spread of soil salinity caused by climate change-induced sea level rise, tidal flooding and heightened storm surges. Two-thirds of Bangladesh is less than five metres above sea level, making it one of the most vulnerable countries in the world to rising sea levels. Scientists predict that sea levels could rise 50 to 130cm by 2100. In best case scenarios, such as the implementation of the 2015 Paris Agreement, sea levels are still projected to increase by 20 to 60 centimetres by 2100. By as early as 2050, 17 per cent of land in Bangladesh is predicted to be inundated, potentially displacing 35 million people.

As 30 per cent of cultivatable land is found in coastal areas, this will have a significant impact on food security. A study by the World Bank has shown that increased soil salinity will lead to a 15.6 per cent decline in the yield of high-yield rice. It is also likely to lead to a scarcity of irrigation water for agriculture during the dry-season, and reduced incomes for farmers.

Agriculture in Bangladesh is heavily dependent on the weather. One severe cyclone, for instance, can destroy a large amount of the seasonal harvest. Increased frequency of extreme weather events due to climate change will therefore pose a significant risk to future food security.

More frequent droughts, due to lower rainfall during the dry season, will have devastating implications for the livelihoods of small-holder farmers. The drought of 1994-5, for instance, resulted in a decline in rice and wheat production of about 3.5 million tonnes and led to the importation of a large amount of grain. Research and investment into drought-resistant crops will help to ensure that these impacts can be effectively mitigated into the future.

Climate Change and Migration

Many Bengalis have been pushed to migrate out of their communities due to climate change-induced pressures such as more frequent extreme weather events, rising sea levels, soil salinity and flooding. Members of many coastal communities, whose livelihoods depend on farming or fisheries, choose to move to urban cities due to loss or damage to land. Farms have been inundated with salt water, damaging crops and reducing yield. River erosion from flooding claims 20,000 acres of land and leaves up to 200,000 people homeless each year.

Increased rural to urban migration has placed significant pressures on urban food and water resources. Urban groundwater is being extracted faster than it is being recharged. In Dhaka, 87 per cent of water used each year is extracted from groundwater resources, and although many homes have access to this resource, it is unsustainable in the long-term. In 2010, troops were called to guard pumps during an acute water shortage in Dhaka. The shortage was caused by a lack of rainwater and was exacerbated by regular power outages. This highlighted the heavy dependence on groundwater resources and the urgent need for investment in water infrastructure to meet future demand. More sustainable water management is required to facilitate migration from rural to urban areas.

While research over the years has focused on migration as a challenge to be addressed, more recent research has focused on migration as a form of adaptation. Large greenhouse emitting countries generally accept that they hold some responsibility in resettling people displaced due to climate change, particularly in vulnerable countries such as Bangladesh that account for a very low percentage of global emissions. There is a lack of international policies, however, that help facilitate and manage climate-induced international migration, making the large-scale resettlement of “climate refugees” unlikely.

Internal migration within Bangladesh also requires more attention, with many migrants facing challenges due to the lack of services, resources and employment opportunities. Those moving from a rural to urban setting require a different set of skills to find employment, while more capital is required for urban living costs.

Strategies that assist migrants, including education programmes, training and affordable accommodation will be required for an effective adaptation plan. It will allow vulnerable rural people, who face risks living in areas prone to climate shocks and food insecurity, to relocate to safer areas. Skills development should be undertaken as a priority throughout vulnerable communities to increase employment prospects. Adaptation strategies would require the involvement of all stakeholders – particularly vulnerable communities likely to migrate – to assess what requirements need to be met to ensure effective adaptation when relocating.

Conclusion

As a densely populated, low-income country, Bangladesh faces significant challenges in adapting to the impacts of climate change, particularly in the areas of water and food security. Sea-level rise and other climate-induced events, such as flooding and storm surges, will leave millions displaced in the coming century. Migration needs to be used as an

adaptation strategy that ensures food and water security in urban areas. This will mean more sustainable management of urban water resources and increasing the capacity of migrants to relocate safely away from areas affected by climate change.

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