Climate Change and Flooding

What is Global Warming and What is Climate Change?

Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released as people burn fossil fuels. The global average surface temperature rose 0.6 to 0.9 degrees Celsius (1.1 to 1.6° F) between 1906 and 2005, and the rate of temperature increase has nearly doubled in the last 50 years. Temperatures are certain to go up further – NASA Earth Observatory.

Climate Change refers to a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth's atmosphere. These phenomena include the increased temperature trends described by global warming, but also encompass changes such as, **sea level rise; ice mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events -** NASA Earth Observatory.

Causes of Global Warming

- ✓ Greenhouse gas (GHG) concentrations (including CO_2, methane and nitrous oxide)
- ✓ Global anthropogenic CO_2 emissions mostly from the burning of fossil fuels, cement, and flaring.

Evidence for Climate Change Around the World

- ✓ Over the past century, a sharp increase has been observed for the **global average of combined land and ocean surface temperature**
- ✓ **Intense weather events** - **Heatwaves** are stronger. **Storm surges** rise higher. **Blizzards** bring more snowfall.
- ✓ Hotter air increases ocean evaporation, causing **more floods.**
- ✓ As temperatures rise, the air holds more moisture. **Rainfall becomes less frequent, creating droughts.**
- ✓ The **Arctic is warming** faster than the temperate zones. That changes the air pressure and turns the jet stream.
- ✓ Along the shoreline, **rising sea levels** are making floods worse.
- ✓ **Coral reefs are dying**
- ✓ **Forests are crumbling**
- ✓ **Arctic animals**, such as polar bears, are losing the sea ice they call home.
- ✓ Climate change threatens our **agriculture, health, water supply, infrastructure**, etc.

According to the IPCC Report, 2014, the global mean surface temperature change for the end of the twenty-first century (2081-2100) is projected to likely exceed 1.5°C to 2°C (34.7 to 35.6 degree Fahrenheit) , extreme precipitation events over the wet tropical regions will very likely become more intense and more frequent, the global ocean will continue to warm and the sea level will continue to rise at the rate of 8-16 mm/year.

The number of natural disasters has more than tripled since 1970 – 90 percent of which are weather related. These intensified episodes can cause greater destruction to property and loss of life. Many more people are displaced each year by disasters than by conflict **- Climate change intensifies this risk.** In 2017, 18.8 million people were internally displaced by natural disasters, with floods accounting for 8.6 million. By contrast, 11.8 million were displaced by conflict.

Many of the world's megacities are on the coast and approximately a hundred million people live within about a 3.08 ft. of current high tide level. Seventy percent of the coastlines worldwide are projected to experience significant increase in sea level rise. Without abatement, it is estimated that by 2100, some of these areas which are vulnerable to sea-level change, will flood, displacing about 100 million people (IPCC Report, 2014).

The large-scale displacement of people will add another dimension to the already existing problem of flooding and climate change. The legal status of the displaced people (especially the internally displaced people or IDP) will be precarious because they will not qualify as refugees under the UN Refugee Convention (As of now, the environmental migrants are not recognized as refugees and have none of the legal protections guaranteed by the UN's 1951 Refugee Convention and warrants our attention). This could give rise to hostility amongst the people for reasons of race, religion, nationality, and political differences.

Dhaka, Bangladesh

(https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html)

Bangladesh is a South-Central Asian country, located in the delta of the Padma, Ganges and Brahmaputra rivers in the northeastern part of the Indian subcontinent. It is the eighth most populous nation in the world with 167 million (UN estimate, 2019) people in an area smaller than the State of Illinois, and also one of the most **climate vulnerable** nations in the world.

https://www.sparefoot.com/moving/wp-content/uploads/2017/05/how-big-is-illinois-sparefoot-truck-rental.jpg

Approximately 80 percent of the landmass is made up of alluvial lowland, called the Bangladesh Plain. Four major rivers (Ganges, Brahmaputra, Meghna, and Padma) and a vast number of rivulets (about 700) drain the plains of the country. The elevation of most of the region is less than 33 feet above sea level; elevations decrease in the coastal south, where the terrain is generally at sea level. With such low

elevations and numerous rivers, flooding is a natural phenomenon in this part of the world. The river systems in Bangladesh carries more silt and sediment than any other river system on Earth. Some of this sediment accumulated to form floating islands (Chars in Bangla), particularly in the Brahmaputra River—which at certain points is over 18 miles wide. Despite its temporal existence (chars disintegrate every few years), chars are inhabited by poor farming families because they are extremely fertile.

About 3,861 square miles of the total area of Bangladesh is covered with water, and larger areas are routinely flooded during the monsoon season. However, **climate change** has exacerbated the problem by causing heavier and more erratic rainfall in the Ganges-Brahmaputra-Meghna Basin in terms of depth, extent of inundation, and duration. Rapid unplanned urbanization, and the gradual filling-up of the low-lying plains, river canals, and other water bodies, traditionally used to drain or retain water during rainfall have further compounded the already existing problem.

https://www.dhakatribune.com/opinion/2017/08/26/why-so-flooded

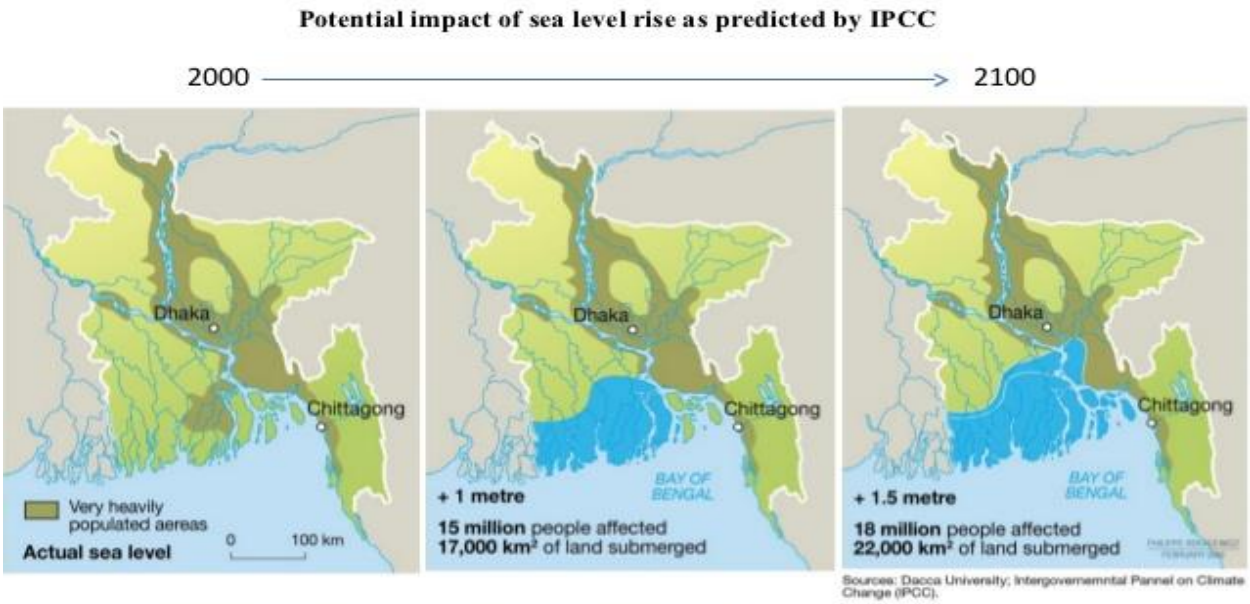
Photo: SYED ZAKIR HOSSAIN

https://www.dhakatribune.com/opinion/editorial/2019/07/14/a-city-under-water

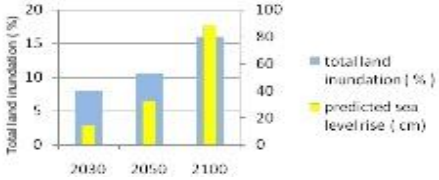
In the recent years, Bangladesh has become the poster child for climate change for various reasons.

- Bangladesh sits in an extensive delta formed by the Ganges, the Meghana, and the Brahmaputra Rivers.
- It is an extremely low-lying country and most of the land lies only a few meters above sea level. Much of the country is less than 16 feet above sea level.
- Bangladesh also lies squarely in the pathway of massive cyclones that form in the Bay of Bengal and hit make landfall almost every year. However, in recent years, **climate change** has compounded the rate and intensity of cyclones and large storms have increased. For instance, in Cox's Bazar, meteorologists confirmed that usually there is only one cyclone per year in the Bay of Bengal, but in 2016, there were four cyclones – Roanu, Kyant, Nada, and Vardah. Nazmul Huque, an assistant meteorologist stated that, "Two or three depressions occur normally," but in 2017, there were, "Seven or eight depressions."
- Bangladesh also experiences a predictable pattern of monsoon rains. However, in recent years, monsoons have been erratic and sometimes arriving weeks earlier than expected, making it difficult for farmers to know when to plant and harvest crops.
- Sea-level rise is pushing saltwater into coastal agricultural areas and promising to permanently submerge large swaths.

- Climate change is boosting silt-heavy runoff from glaciers in the Himalaya Mountains upstream, leading to an increase in flooding and riverbank erosion. **Every year, an area larger than Manhattan washes away.**



Year	IPCC (TAR) 2001	SMRC 2004	NAPA 2005	WARPO 2006
2030	14cm	18 cm	14 cm	14 cm
2050	32cm	30 cm	32 cm	32 cm
2100	88cm	60 cm	88 cm	88 cm



https://www.slideshare.net/SaimumKabir/presentation-climate-change-adaptation

Scientists say that the **Bay of Bengal is rising twice as fast as the global average**. At the present rate of sea level rise, it could take just 25 years for encroaching saltwater to waterlog the farmland and poison fresh drinking water for as many as 10-million people. The forecasted rise of one meter before the end of the century could permanently displace more than 30-million people. Entire islands are already disappearing into the sea from a combination of sea levels rise and river erosion. Every year, an area larger than Manhattan washes away.

Saltwater intrusion into the south-west of the country is poisoning ground water supplies for entire towns and villages. The loss of land due to permanent flooding means that less land would be available for people to grow food—a calamity of much higher proportion for this already overcrowded country. Due to saltwater intrusion, many farmers in Bangladesh are converting their rice paddies into shrimp farms, which are more tolerant of salt. Conversely, the northwestern region will likely be affected by drought creating food security and agricultural production; both fishery and forestry will likewise be immensely affected.

The entire **Sundarbans** - the largest mangrove forest in the world, located on the delta of the Ganges, Brahmaputra, and Meghna rivers on the Bay of Bengal - is sinking because dams and barrages in the Ganga and its tributaries, upstream hold back the silt that forms the soil that forms the delta.

In 2017, the peak water level crossed the highest recorded water levels in Brahmaputra, Teesta, Dharala, and Jamuneswari rivers. The officials of the Bangladesh Water Development Board said that the water levels of the Brahmaputra in 2018 were flowing 2.75 inches above its danger level, at the Fulchharighat point of the district. In total 3,583 acres in Sundarganj, 865 acres in Phulchhari, and 74 acres in Shaghata, of standing crops, were damaged, they said. District Relief and Rehabilitation Office sources said, hundreds of people, families, in: Islampur, Dewanganj, Bakshiganj, and Sarishabari upazila, have been affected by the flood. The Department of Agriculture Extension Office said, more cropland was inundated— raising the toll to thousands of acres lost across several areas of the district. According to sources concerned, two rivers—the Kapotakkha and Kholpetua—flow through seven unions in the Shyamnagar and Assasuni sub-districts of the Khulna district of Bangladesh. Moreover, the embankment on the Ichamati river, flowing through parts of the Debhata sub-district (Satkhira District), have also become dilapidated due to a lack of overhaul. The embankment bars in these areas are in such ruinous condition that they could collapse anytime; resulting a huge amount of land being submerged. According to the Water Development Board, **around 155 miles of the 497 miles-long embankments in the district have been labeled extremely risky.**

The trees show where the coastline used to be. Photograph: Noor Alam/Majority World for The Guardian
https://www.theguardian.com/global-development/2017/jan/20/climate-change-frontline-disappearing-fishing-villages-bangladesh

Dhaka

Dhaka, the capital of Bangladesh, is one of the most rapidly growing megacities in the world and an urban **hotspot for climate change**. Naturally speaking, because of its location in the lower reaches of the Ganges-Brahmaputra Delta, Dhaka naturally experiences recurring flooding and waterlogging, following intense rainfall, nearly every year. However, **sea level rise due to climate change has accentuated** the already existing concern. Apart from climate change, **human interventions** in the natural river systems, and the changes in the land-use pattern of their catchment areas, is creating steep slopes, causing rivers to carry large amounts of sediments leading to frequent and destructive floods.

It has been estimated by the UN IPCC's reports and analysis that a one-meter sea level rise in the south of the country will entail a 17-20% loss of territory to the sea, meaning that Bangladesh will lose up to 20% of its current landmass, which is going to create a very large climate refugee population. The internal capacity of the state, given its size and resources, to absorb such a large displacement of the human population and large number of climate refugees, certainly does not exist in the country. This may lead to internal destabilization (Muniruzzaman).

It is estimated that around 6 million people were either seriously affected or displaced by the climate-induced disasters in Bangladesh in recent years (UNU-EHS, 2015). The displaced population from the disaster hit areas or the climate refugees were forced to leave their homes, migrate to urban areas and end up living in slums that are highly exposed to other hazards like flooding and water pollution (Martin et al., 2012).

Migration: Linking migration directly to climate change is difficult, say academics, because people move for various reasons – political, economic, religious, social, etc. But Bangladesh officially expects 25-30 million people to move within the next 50 years, or nearly one in six of its present population. Overall, the number of Bangladeshis displaced by the varied impacts of climate change could reach 13.3 million by 2050, making it the country's number-one driver of internal migration, according to a March 2018, World Bank Report.

How Is the Human Displacement Affecting Big Cities Like Dhaka?

Many Bangladeshis affected by climate disruption migrate to **Dhaka (the capital) and other bigger cities**. These cities, already burdened, are beyond their capacity to accommodate additional people. The influx of large number of people is causing **unplanned urbanization, degrading the natural vegetation and water bodies.**

Bangladesh is listed as one of the **largest lesser developed countries (LDC) in the world**. The Gross National Income (GNI) per capita of Bangladesh is only US$ 286,521 as compared to US$20,738,399 for U.S.A (World Bank, 2018).

In terms of the **Global Livability Index** (which is scored over 30 parameters under five categories: healthcare, infrastructure, culture and environment, stability, and education), Bangladesh was founding to be considerably behind. Of the one hundred and forty cities surveyed across the world by The Economists Intelligence Unit (EIU) for its Global Livability Index, 2018, **Dhaka was ranked as the world's second least livable cities in the world** - overall rating of 38 out of 100, where 100 represents ideal living conditions - preceded only by the war-torn city of Damascus, Syria.

According to a report published by Ahmed and Dewan, 2017; Alam and Mullick, 2014; Ahmed, 2015; Ahmed *et al.*, 2013, **rapid urbanization** in Dhaka and other bigger cities in Bangladesh are contributing to the problem of flooding in the following ways:

- ✓ by waterlogging
- ✓ flash flooding
- ✓ generating more runoff
- ✓ encroachment of the wetlands, floodplain areas and embankments
- ✓ confining flood water inside the river channel, which resultantly raises the flood peak, and excess sediments is raising the bed level and further exacerbating the flood conditions

- ✓ development of informal settlements
- ✓ urban heat islands
- ✓ urban landslides
- ✓ traffic jams
- ✓ air and water pollution
- ✓ scarcity of drinking water

Forty percent of the Dhaka's population live in slum areas. "The city has very little in the way of affordable housing. People are looking for any place they can stay, but it's all happening in a helter-skelter way that creates a lot of problems. Security, health, utilities, basic living conditions — all of these things are really negatively affected when you have so many people coming in, in such an unplanned way." (Tim McDonnell, writer, National Geographic). High rates of population growth in Bangladesh exacerbate all of its problems. More people are exposed to environmental catastrophes, which leads to increased levels of displacement. "The internal capacity of the state, given its size and resources, to absorb such a large displacement of the human population and large number of climate refugees, certainly does not exist in the country. Therefore, we are not only going to see internal destabilization due to large-scale displacement of people, but there will be transboundary migration of climate refugees into the neighboring countries," says Muniruzzaman, chair of the Global Military Advisory Council on Climate Change and a former military adviser to the president of Bangladesh.

The Environmental Justice Foundation (EJF) report stated that the number of people living in slums has increased by more than 60% in the past 17 years in Bangladesh. "Many of the new arrivals are 'climate refugees' – people forced to leave their homes due to extreme weather events related to climate change," it adds. No one knows exactly how many Bangladeshis are forced to move each year by temporary flooding caused by extreme storms, or by permanent flooding caused by a rise in sea level. But it could be up to 250,000 people a year, says the EJF.

Personal Stories

Renu Bibi (left) and Ruma Begum (Right), both lost their homes to river erosion

https://www.theguardian.com/global-development/2018/jan/04/bangladesh-climate-refugees-john-vidal-photo-essay

Ruma Begum, from Mehendiganj, was forced to move to Dhaka with her family and now lives in Mirpur. "We lost everything to river erosion. We escaped with just our lives," says Renu Bibi, an 80-year-old woman now living in a slum in the Mirpur district of Dhaka. "Today, boats pass over the place

where our land was. Sometimes three or four entire villages will be destroyed." "There were between 100 and 150 families along the riverbank. All their homes were washed away. We lost everything," she says.

https://www.theguardian.com/global-development/2018/jan/04/bangladesh-climate-refugees-john-vidal-photo-essay

"I jumped into the water to try to save the cattle, but I could not," says Komola Begum, recalling the floods that forced her family to flee their home

https://www.theguardian.com/global-development/2018/jan/04/bangladesh-climate-refugees-john-vidal-photo-essay

Mossammat Akhter from Charilmabad, southern Bangladesh, and his family. 'All the land is under water … we had to move very quickly. We were left with nothing. I feel like a refugee."

“One night the water came in … It was so high it almost reached the ceiling. Our house and all our land was washed away,” said Shoripa Bibi from Kalikabari, southern Bangladesh

Standing atop an 18-foot embankment in Baliara (edge of the Sundarbans), Badruddin Sarkar pointed to his previous home, engulfed by a rising sea (top). That was in 2009. In December 2017, Abdul Hanan showed the saline wasteland left behind (bottom) as that embankment was breached, and all other attempts to build sea walls were overwhelmed by the Bay of Bengal [images by: Joydeep Gupta]

http://southasiajournal.net/rising-sea-swamps-island-along-bengal-coast/

https://www.thethirdpole.net/en/2018/12/24/best-of-2018-rising-sea-consumes-bengali-coast/

https://www.thethirdpole.net/en/2018/12/24/best-of-2018-rising-sea-consumes-bengali-coast/

Jasimuddin Sarkar in front of his farm in the Island of Mousini that now grows nothing, and his house that gets flooded with dirty saline water every third or fourth day [image by: Joydeep Gupta]

http://southasiajournal.net/rising-sea-swamps-island-along-bengal-coast/

So how do the Bangladeshis survive? Jasimuddin's answer is the same as that of everybody in Baliara. "My son works in Kerala as a mason. He sends money home. That's how we survive." Others talk of their sons, brothers or husbands working as security guards, farm laborr, masons, mall cleaners, and so on. The diaspora that has moved from Kerala to West Asia to work has led to another, internal, diaspora from the Sundarbans to go and work in Kerala.

It's not a situation that anybody likes. "Nobody wants to get their daughters married to a boy from Baliara," Jasimuddin says. "We could get my son married only after searching for months. Ask her," and he points to a woman in her early twenties standing nearby.

Salma Bibi – married to Jasimuddin's son a few months ago – is from a village about 20 km inland. "I completed school. I know I can get a job elsewhere," she says confidently. "I've been telling my husband and everyone else at home we should just go away from here. This is no life – getting everything at home drowned in dirty salt-water every third or fourth day. Two of the three saris my father bought for my marriage have been ruined. I'm going to tell my husband the next time he comes home for a holiday, and we're going to go away."

Where will they go? Salma is not clear, while Jasimuddin says he knows nothing except paddy and freshwater fish farming, so what will he do elsewhere for a living? Over 150 families in Baliara have already left permanently. They could not sell their land, because nobody was interested in wasteland. They just left.

Has the government been of any help? Local panchayat member Himangshu Aich said those who could prove their farm ownership got a compensation of Rs 10,000 per family after Cyclone Aila. And since then, the efforts of the government engineers to hold back the waves are there for all to see. The situation is the same in other islands in the Sundarbans facing the world's largest bay. Now, Abdul Hanan, 61, retired headmaster of the school's primary section, pointed out the effects of the rising seas. There is no sign of the original embankment, girders from subsequent attempts to build a sea wall lie overwhelmed and abandoned, dead coconut and date palms dot a landscape of saline pools where nothing can grow.

At the confluence of the Muriganga – a distributary of the Ganga – with the Bay of Bengal, Mousuni is a bustling island of about 5,000 households. But over 2,000 of them are in Baliara, and they are under a sentence of displacement or death. "How do you expect us to live?" asks a visibly angry Jasimuddin Sarkar, pointing to his farm that is under about a foot of dirty brackish water, a small species of amphibious fish the only sign of life in it. "Do you see that embankment between my two farms, with the coconut tree on it? It is all dead." He has tried to protect his home from the rising sea with plastic fencing, but the water keeps getting in. Peek inside the large hut, and the first thing you see are piles of soggy old newspapers. That is what the family uses to mop up the water from their furniture, their floor, their walls. They do it every three or four days.

Due to saltwater intrusion, many farmers in Bangladesh are converting their rice paddies into shrimp farms, which are more tolerant of salt. Credit: Amir Jina/Flickr

https://www.pri.org/stories/2019-03-25/climate-migration-crisis-escalating-bangladesh

Sahia's Story

Sahia got married when she was 15 years old – and saw her husband for the first time on their wedding day. She had agreed to talk about the ways climate change and environmental stress are affecting the lives of Bangladeshis. She says that after their wedding, she moved in with her husband and father-in-law. Her new home was Singpur – a riverside village in central Bangladesh, only a couple of hundred kilometers from the capital, Dhaka. She had been living here for about a year when she witnessed her first home collapsing into the river. "One day we found cracks in the floor as the land had started to get pulled into the water. We realized that this was a bad sign. The cracks kept growing deeper and deeper for each day that passed," says Sahia.

Riverbank erosion usually happens slowly, but occasionally a larger chunk of land suddenly falls into the water. As soon as she noticed how deep the cracks were in the ground, she started carrying out their belongings to safety. A few hours later, the house was gone.

The only primary school in Singpur village is no longer safe to use due to riverbank erosion. Sonja Ayeb-Karlsson, Author provided

Sahia and her family moved in with her husband's uncle for a while. But it was not long before his house was swallowed by the river, too. They moved into an abandoned house after this, but they are still living too close to the river.

Sahia's husband was a fisherman so the family got by on what he managed to catch. "My husband used to catch fish, but when the fish got some disease he had to stop fishing … Nowadays, there is hardly any fish left in the river … There used to be tons of fish, but when the fish started dying from that disease people stopped eating them … All the big and good fish disappeared". Thereafter, the family felt forced to migrate seasonally to work in a brick factory in Aliganj, further up the river. Nowadays, they leave Singpur for six months every year during the rainy season, to avoid being there when the village is flooded.

"The man who brought us there [to the brick factory] gave us some money, and with that money we managed to survive the six months in Singpur. What we earn we use to feed our family. They usually pay us on a weekly basis, around 2,000-4,000 taka ($23.7 – 47 USD). After feeding my family, consisting of six family members, we manage to save about 1,000 taka ($11.85 USD) or so per week. That amount is our family's whole savings per week.

The shift of livelihood has been hard on Sahia physically and socially. Before the factory work, she was a housewife like the rest of the women in Singpur village. Working outside of the house as a woman has brought social stigma on her. In this village, if you work outside you end up losing your honor…… After

observing us some people said: ‘The women out there are working! What do they know about work?’ We see those people, we hear them, but we do not fear their words anymore. We work to survive.”

“I can see that she is watching me. My hair, which is tied up in a bun, and the clothes I am wearing. We are two women not that different from one another in a lot of ways, but we are living two completely different lives in very different parts of the world.” She says: “I am actually not that old. It is the hard work that made me look like this. Did you not see my husband? Nobody thinks I am his wife after meeting him.”

https://youtu.be/u75qiLAKVX8

Chinirpatal Government Primary School in Gaibandha's Saghata was declared closed after flooding left it waterlogged **Dhaka Tribune, September 20, 2018.**

https://www.dhakatribune.com/bangladesh/nation/2018/09/21/flood-situation-continues-to-worsen

Locals try to temporarily repair the embankment that collapsed into the river in Pratapnagar union of Satkhira **Dhaka Tribune**

https://www.dhakatribune.com/bangladesh/nation/2019/04/29/satkhira-coastal-areas-at-flood-risk-from-aging-embankments

Biermann and Boas (2010) suggested five principles to address the climate refugee problems:

1. planned relocation and resettlement;
2. resettlement instead of temporary asylum;
3. collective rights for local populations;
4. international assistance for domestic measures; and
5. international burden sharing.
6. There is also an urge to recognize climate refugees in international law and develop a convention for them.

Adaptation

As one of the most flood-prone countries in the world, Bangladesh has learned to adapt to climate change faster than any other country in the world. Up to 70% of the country can end up submerged in

water. The fleeting nature of the chars makes it impossible for the government to build any permanent structures on them, like a school or a hospital. And officials are hesitant to build on other land in the area because the climate is changing, the seas are rising, and nothing feels permanent. In some parts of Bangladesh, due to the torrential downpours, thousands of schools across Bangladesh are flooded and closed for 3-4 months a year, causing an impediment to young children's education and adversely affecting the availability of resources like, libraries, health clinics, and community centers.

Floating Schools

In order to combat the situation and provide continuing education to young children even during the floods, an architect named Mohammed Rezwan, in 1998 invented the, "Floating Schools" - a genius invention. He founded the non-profit Shidhulai Swanirvar Sangstha to bring education and improve livelihoods to rural communities in northwestern Bangladesh. Shidhulai currently operates a fleet of 111 floating schools, libraries, health clinics and floating training centers. Each have wireless internet access, serving close to 500,000 people. Each morning the boat goes along the river picking up students.

The boat has one classroom that holds about 30 kids. The walls are made of reeds. The lone computer runs off solar panels (*Mahmud Hossain Opu for NPR)*

The charity has a fleet of 23 school boats. They pick up kids along the river, then pull over into the marshy riverbank to hold class (*Mahmud Hossain Opu for NPR)*

The floating library also has a playground with a slides on either side of the boat and a swing set on the top deck.

Mahmud Hossain Opu for NPR

Mohammed Rezwan is the executive director of Shidhulai Swanirvar Sangstha, which has a fleet of floating schools and medical clinics in the northwest of Bangladesh (*Mahmud Hossain Opu for NPR)*
https://www.darpanmagazine.com/people/spotlights/floating-schools-of-bangladesh/

Solar-Powered Floating Schools

The "Floating School" initiative has introduced **solar-powered floating schools** to tackle the problem, ensuring that children are offered uninterrupted learning sessions even during the height of monsoon season. has developed solar-powered floating schools for use during these periods, which drive right up to the mainland to pick-up students. each boat-cum-classroom accommodates 30 students and is equipped with an internet-linked laptop, library and electronic resources, providing basic education up to the grade IV level.

The computers and overall electricity of the vessels are powered by solar energy via panels which are installed on their roof top. The use of this sustainable source offers flexible school schedules – when the day is over, students can take home a recharged-low-cost solar lantern, offering them a light source in which to continue study, while women for example, may continue to stitch quilts after dusk to generate more income for their family, the solar powered lamps are given to families for free providing their children go to school regularly, and better off households pay a small monthly fee to receive one of the devices.

Installation of solar panels onto boats selected for educational use

The floating classrooms offer education to elementary school children even during monsoon season

The boats dock on the mainland, bringing students to and from their doorstep each day

https://www.designboom.com/technology/solar-powered-floating-schools-bangladesh/

https://youtu.be/u3j2K2XQz7I

Floating Hospitals

Shidhulai Swanirvar Sangstha also operates five floating medical clinics and just launched a playground-slash-library that plies the rivers. All their services are free. Rezwan says, “Shidhulai pieces together funds from national and international groups as well as individual donors to pay for its programs.”

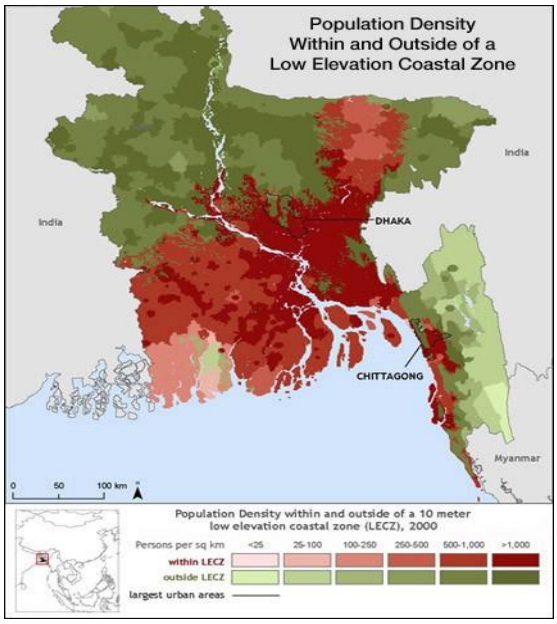
Villagers wait to see a doctor at a Shidhulai Swanirvar Sangstha floating clinic. On different days the boat docks at different points along the river (*Mahmud Hossain Opu for NPR)*

In 2005, Shidhulai won an Access to Learning Award for $1 million from the Bill and Melinda Gates Foundation (which is a funder of NPR and this blog). The group won a U.N. Prize for Inspiring Environmental Action in 2012. In 2006 UNDP honored Shidhulai with its Equator Prize and said the group is "transforming the region's waterways from obstacles to human development into pathways for education, information and technology."

Floating Farming

People in the low-elevation coastal zone of Bangladesh are disproportionately poorer than people outside of the low-elevation coastal zone. These people depend on agriculture to survive. During the rainy season, however, when rivers flood, their livelihoods are compromised. Due to sea level rise these floods are intensifying and lasting longer, inundating arable land. Agricultural productivity has dropped more than 61,776 acres due to saltwater intrusion in recent years.
Rising sea levels are increasing the salinity of water sources near the coastline of Bangladesh making it harder for farmers to grow their crops. Growing conditions are already challenging as the clay soil becomes hard during the dry season (November to March) while prolonged rain during the monsoon (June to October) causes flooding.

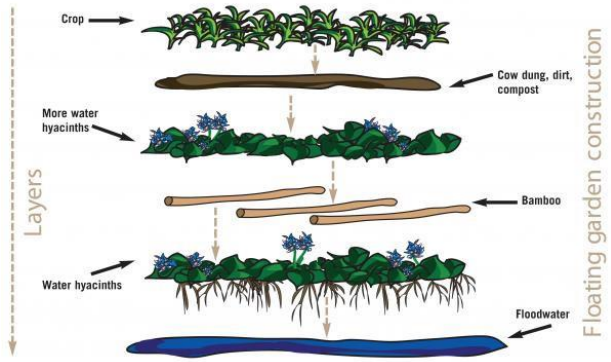
In the wetlands of southern Bangladesh (parts of Gopalganj, Pirojpur and Barisal districts of Banglasedh), local communities have had difficulties in securing farmlands to provide food and livelihoods during the monsoon season (from June to October). These vulnerable, marginalized communities are constrained by not having cropping space in terms of access to and/or ownership of land (Ministry of Agriculture People's Republic of Bangladesh).

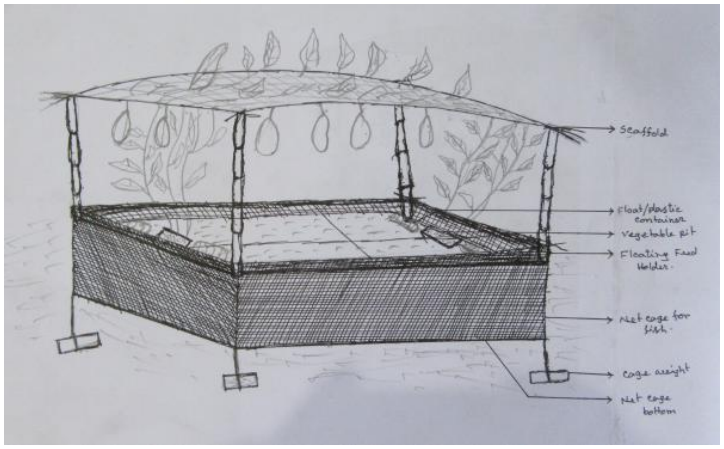


(The Center for International Earth Science Information Network, Columbia University)

Recently, Bangladeshi farmers have adopted a technique to float their farms on the river floodwater – Floating Garden

1. First, farmers collect water hyacinths, aquatic weeds that grow abundantly in Bangladesh, and replant them to establish a foundation for the riverine raft.
2. Once the water hyacinths are rooted, rows of bamboo reeds make a platform.
3. Farmers plant an additional layer of water hyacinth on top, which interlaces with the weeds below, for added stability.
4. Once the structure is established, the farmers spread a combination of cow dung, organic fertilizer, and dirt to provide soil for the crop.
5. Often, farmers first sow seeds in a ball of compost, to promote early seed germination, and then transfer them to the raft. Leafy vegetables, okra, gourds, eggplant, pumpkin, and onions can typically be found growing on the rivers in





New York Times

According to the Ministry of Agriculture People's Republic of Bangladesh, the advantages of floating garden agricultural heritage system are manifold.

- ✓ Bangladesh's Floating Garden Agricultural Production System has largely contributed to local food security, as well as local livelihood security under severe environment. By floating their crops, farmers can feed their families during the monsoon season and fill previously barren marketplaces with extra yields to generate income. Without this system, thousands of farmers would lose their farms and jobs every time they were affected by flooding.

Furthermore, this cultivation practice helps to supplement people's income, which contributes towards the alleviation of poverty, and provides greater food security by increasing the landholding capacity of poor as well as landless people by allowing them to grow vegetables and crops with lower input costs, due to the minimal infrastructure required.

- ✓ The floating beds are made of free, locally abundant materials, especially water hyacinth. Water hyacinth is considered to be one of the most dangerous invasive species due to its high reproduction speed but in this particular farming system this dangerous invasive species are converted to most useful resources.
- ✓ Water hyacinth is utilized not only for the foundation of production system as floating beds during the monsoon season but also for compost especially during the winter cultivation on the ground.
- ✓ Because crops could absorb prime nutrients such as nitrogen, potassium and phosphorus from the floating beds and below water, there is almost no need for fertilizer input.
- ✓ This technique brings many ecological benefits, such as the good use of an invasive species like water hyacinth – a very effective way to control this notorious weed; platform residues can be used as organic fertilizer (this practice cuts pollution from chemical fertilizers).
- ✓ Crops require shorter time to mature when cultivated on floating platforms; Prime nutrient elements, namely nitrogen, phosphorus and potassium are available in water hyacinth comparable with cow-dung; When water recedes from haor (a wetland ecosystem in the north eastern part of Bangladesh), dismantled floating platforms are used as organic fertilizer. In this way it enhances eco-friendly agriculture practice in winter seasons to cultivate winter crops
- ✓ The floating-bed technique also has some positive social impacts. It involves both men and women, thereby improving the gender balance, as well as people's perception of particular areas as suitable places to live.
- ✓ This technology can provide a growing area for poor communities who lack access to land, as many wetlands are submerged under water for 7-8 months of the year.
- ✓ Local communities have discovered that this system is resilient to increasing impact of climate change and is spreading over a wide area in Bangladesh.

Suborna and Mithun Sarkar's story

https://practicalaction.org/aqua-geoponics

Suborna and Mithun Sarkar live in the Jessore district of south west of Bangladesh. They have five sons (3 of whom are still studying) and a married daughter. They make a living by catching and selling fish from the nearby rivers and canals, earning around BDT 5,000 (£46) a month. They also work as day laborers in other people's paddy fields. Most people in their village earn their living in similar ways.

Although they own some land (a bit less than 1 acre) this has been under water for the last 2 years, making it impossible to grow crops. The water height rises during the monsoon making fishing riskier because of the depth of the water.

Their house was damaged by floodwater this year and their fishing nets are often torn by the force of the water and the plants and debris in it. As most of the paddy fields in the area are also under water, they cannot supplement their income through daily labor.

Suborna has built and stocked one cage with Practical Action's support. Her fish are growing well and she expects to earn at least BDT 5,000 (£45.6) from the harvest. The vegetables she grows will provide a healthy addition to the family diet. Next year she hopes to build more cages and increase her income further.

https://youtu.be/jBv8GeKzDuw

Futuristic Model of a Floating Farm

Bangladesh is also looking into a futuristic architecture model of a floating farm designed by an innovative Barcelona architecture firm. The designers envision a two-million-square-foot, triple-decker barge with fish farms on the bottom level, a hydroponic greenhouse above, and solar panels on the roof to power the operation. The roof also incorporates skylight openings to provide ample sunlight for the plants as well as gutters to harvest rainwater for irrigation. The farm would function autonomously by collecting sensor data and administering the adequate amounts of water, light, and nutrients accordingly. Although this design vision is ahead of the curve, riding the 'Internet of Things' wave, its foundational idea is similar to, perhaps adopted from, the floating farms constructed to withstand rising seas and uphold agrarian

livelihoods in Bangladesh. The farm could potentially yield 8.1 tons of fruits and vegetables and 1.7 tons of fish annually.

(Forward Thinking Architecture)

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