VULNERABILITY OF THE POWER SECTOR OF BANGLADESH TO CLIMATE CHANGE AND EXTREME WEATHER EVENT

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This thesis was submitted to the department of Electrical & Electronic Engineering in partial satisfaction of the requirement for the award of a Bachelor of Science degree in Electrical & Electronic Engineering

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APPROVAL

This is to certify that the thesis on**, "Vulnerability of the power sector of Bangladesh to climate change and extreme weather events "** submitted by **Juwel Rana** and **Md. Minarul Islam** to the Department of Electrical & Electronic Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Electrical & Electronic Engineering and approved as to its style and contents. The presentation has been held on 2022.

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DECLARATION

This is to certify that the work presented in this research paper has been carried out by us and has not been previously submitted to any other university for an academic qualification, certificate, diploma, or degree. We hereby declare that there is no duplication of work we have accomplished. This report is the result of the efforts of Juwel Rana and Md. Minarul Islam underneath the supervision of Professor Dr. Shahid Ullah, Section of Electrical &Electronic Engineering, Daffodil International University. This work was spread over a one-semester course. EEE-400: The thesis is in line with the curriculum aimed on the Bachelor of Science in Electrical and Electronic Engineering programs.

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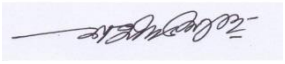

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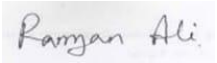

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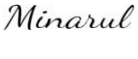

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Dedicated to

Our beloved parents

ABSTRACT

The recently growing temperature and annual rainfall in Bangladesh and Season change is increasing day by day. Especially, during the hot summer premonsoon season, rising temperatures will raise peak power demand and overall power consumption, decrease the lifetime of transformers and power plants, and increase transmission loss. Increased disruptions in the production and distribution of electricity as well as increased infrastructure damage could result from increasingly frequent and severe extreme weather occurrences. During the dry season, the river water dries up, which can disrupt the production capacity of the power plant. Power stations in Bangladesh's coastal region may experience corrosion and leaks because of increased salinity in river water brought on by ocean height rise. The detrimental effects of climate change on Bangladesh's electricity sector can be mitigated via diversified, decentralized, and climate-resilient electricity system. Planning must take adaptation and mitigation measures into account.

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CHAPTER 1

INTRODUCTION

1.1 Introductions

The weather of Bangladesh has changed notably in current years . In the last 50 years, the average temperature in Bangladesh has risen by 0.4°C due to global warming. However, the temperature in different parts of the country has increased by 2 °C. Rainfall has increased by an average of about 250 mm in the last 50 years. The trend of average rainfall and rising temperatures over the past 50 years points to fears of warmer and warmer weather in the future. Low modifications in the suggested and standard deviation figures result in significant modifications inside the opportunity of extreme occasions. Because the primary of stage weather exchange on enviroment from intense occasions, it might have extreme terribleBangladesh-specific repercussions. The effects of extra variable precipitation and severe climate activities are already seen in Bangladesh. Climate fashions are expecting more will increase in intense weather occasions within the near future. Bangladesh is one of the maximum inclined international locations inside the international to climate alternate as the U. S. A. Has a low potential to deal with the devastating influences. Research suggests the effect of weather changes may have intense implications on the agriculture of Bangladesh.

Excessive rainfall and changes in extra meteorological activity now exist in Bangladesh. This climate animosity is already intensifying, with climate change forecasting in recent times. Bangladesh is one susceptible nations inside in the world to weather alternate. The impact of climate chance is greater than previuus years, which could have a devastating effect on agricultural in Bangladesh.Climate has an important role in the electrified region of the country. In case of high temperature and high voloume of climate chance, good quality power plants need to be built for potential power and technology.

Bangladesh’s electricity could be severely damaged commercially unpaid to weather modification. The conjunction of high temperature with punishing climate trials potentially fulfills the demand for more electricity and the production of electricity at a lower efficiency.

1.2 Climate trade and energy research can be broadly divided into:

1. Radiation of greenhouse gases formed by electric plant life and
2. Weather exchange energy substructure scheduled

Bangladesh takes the bottom, consistent bycapita carbon-dioxide throwing in the world. (zero. 2 tons / less than 12 months). A smaller amount of energy-intensive sectors and the predominant usage of normal gas (almost 75%) as a source of mercantile drive are to blame for this.

Therefore, the observation of greenhouse gas secretions from the age of electricity in Bangladesh is not significant. Then again, climate change and related acute events could have a significant impact on energy production and transmission, and consumption in Bangladesh, particularly in background of Bangladesh's weak power infrastructure.Energy systems were schemed at some point in noticeably stable weather intervals, which can be stressful due to weather patterns and the associated excessive climatic activity. High gadget loss, low plant efficiency, irregular power supply, blackouts, power outages and negative control are the primary problems in Bangladesh's energy sector. Changing climate and excessive climate activities can create some more problems in power generation, transmission and distribution in Bangladesh. The influence of weather tradethenexciting climate occasions in the energy quarter may at present be manipulated in Bangladesh. In recent years, the call for strength in Bangladesh has expanded dramatically. Floods and windstorms often disrupt power supplies, power plants often break down. The multiplicity of salinity in coastal river water due to the upward pressure of the sea level has created influence to move the electric flow within the current year.

The impact of climate change can be significantly reduced if steps are taken at the right time in Bangladesh. The aim of theextant article be situatedtoward condensethe existing understanding of the probablethrough and unintendedproperties of weatherrevolutioncontinuouslypower generation, transmission and distribution and power use in Bangladesh, equallyglowingby means ofon the way to understand thinkableschemesjust beforedecrease the harmful consequences, adaptive possibilities.The situation are wantedthat this approach would advantage increment wariness withinrulecauses and organizations pursuit in Bangladesh's energy sector on

weatherpliabilitycoverage in preparation for the posterior improvement of Bangladesh's energy infrastructure.The bearings of weatheralteration on the energy sector are based entirely on historical data. Climate change and forecasts in Bangladesh can be understood from past years.

Events related to temperature and rainfall, such as cyclones, floods, river water salinity, etc., are already being criticized on issues related to climate change in Bangladesh. As a result, the impact on energy infrastructure in Bangladesh can be seen in some cases through trade assessment and data collection from relevant departments. Yearly rainfall and temperature fileswas collected from the Bangladesh Meteorological Department, as well as flood warning center data.Global data on sewage and salinity in river water has been collected from global river drainage databases.

The term is used to express high rainfall and rising temperatures, dirty salinity in river water, and drastic changes related to hostile weather. Information on Bangladesh's power zones, is collected from literature such as published magazine,objects, yearbookreviews, bulletins, pamphlets, thenvirtual databases ,of numerous businesses accountable for power generation, transmission, and distribution in Bangladesh with the (BPDB) Cellular of the (MPEMR) energy network employers of Bangladesh, etc.

The effects of another climates on electricity is recognized done the evaluation of statistics collected from the aforesaid sources, as well as other published material featuring paper and journal naration. In the next part of the study paper, an assessment of weatherrevolution and related punishingweather conditions events in Bangladesh is given.It surveys a quick depiction of the electric zone in Bangladesh. The probable impact of environment trade in the power sector of Bangladesh and the serious incidents related to it are discussed. Finally, potential strategies have been proposed to condense the catastrophic effects and increment the adaptive ability of the Electric zone.

CHAPTER 2

POWER SECTOR IN BANGLADESH

2.1 Power Sector of Bangladesh

Bangladesh's efficacy power sector has a nationwide grid with a capacity to mount 25,514 MW by March 2022 Bangladesh’s power zone is developing. In recent times, Bangladesh ongoing production of 2.4-gigawatt (GW) Rooppur Nuclear Power Plant, which is expected to be commissioned in 2023 In March 2022, with the (BPDB), 100 per cent of the population had to get access power step by step. However, step by step, power ingesting in Bangladesh is measured low. Power was announced to the United States on 7 December 1901 for the duration of British rule. Electricity is an essential supply of electricity for the country's financial sports. The total set up power generation potential of Bangladesh (e.g. captive power) has been 15,351 MW (MW) until January 2027 and 20,000 MW in 2018.

Bangladesh's biggest electricity consumers are the industrial and domestic sectors, shadowed by the industrial and farming areas. By 2022, 100% of the people had to be electrified in Bangladesh. This assistance will require Bangladesh's expected 34,000 MW of power. 2030 economic growth to hold more than 7 per cent.

Problems in Bangladesh's power sector include loss of additional devices, delays in final touching of new-fangled plants, small plant efficiency, irregular power supply, power theft, blackouts, and insufficient funds for power plant maintenance. The latest assessment shows that power outages result in a shortfall of 1.5 billion a year in commercial production, which eases Bangladesh's GDP boom by about half a section point.

2.2 Generation of Electricity

Bangladesh generates electricity using a variety of technologies. Hydro and thermal power plants are Bangladesh's two types of power plants. Five hydropower plants are operational in Bangladesh's eastern zone, with a total installed capacity of 230 MW, accounting for 1.13% of the entire generation. The bulk of the power generation relies on thermal sources, except for these units. Bangladesh currently has 79 thermal power plants in operation. Steam turbines, compression turbines, and combined cycles with steam turbines and compression turbines are among the thermal power stations.

The steam turbine generates 2,966 MW, or 14.55 per cent of total power, followed by 7,330 MW (35.96 per cent) from the combined cycle, 851 MW (4.18 per cent) from the gas turbine, and the balance from diesel and hydro turbines. In the eastern portion of Bangladesh, all thermal power plants run on gas. However, due to the lack of gas in that area, all of the power plants in the western area run on liquid fuel except for one.

Renewable energy (excluding hydro) is responsible for a exactlesser portion of Bangladesh's total energy production. In recent years, the administration has made various efforts to develop renewable energy. Renewable energy capacity currently stands at about 25,566 MW.

2.3 Transmission and distribution of Electricity

The electricity generated at various power plants across, the nation is transmitted using 230-kV and 132-kV transmission lines and substations as part of an integrated grid system. Bangladesh now has 1,144 circuit, 230-kV (km) lines then 5,255 circuit, 132-kV (km) lines for power transmission. In 2021, Bangladesh's electrical structure will have a delivery network with approximately 230/132-kV grid substations, totaling 16,085 MVA. The distribution network is made out of 33/11 kV lines. The distribution network is produced from 33/ 11-kV and 0.4-kV strains. Overall distribution positions within the country amounted to approximately 6 26.000 km, and the range of purchasers of different classes became about 4.27 core by the end of 2022.

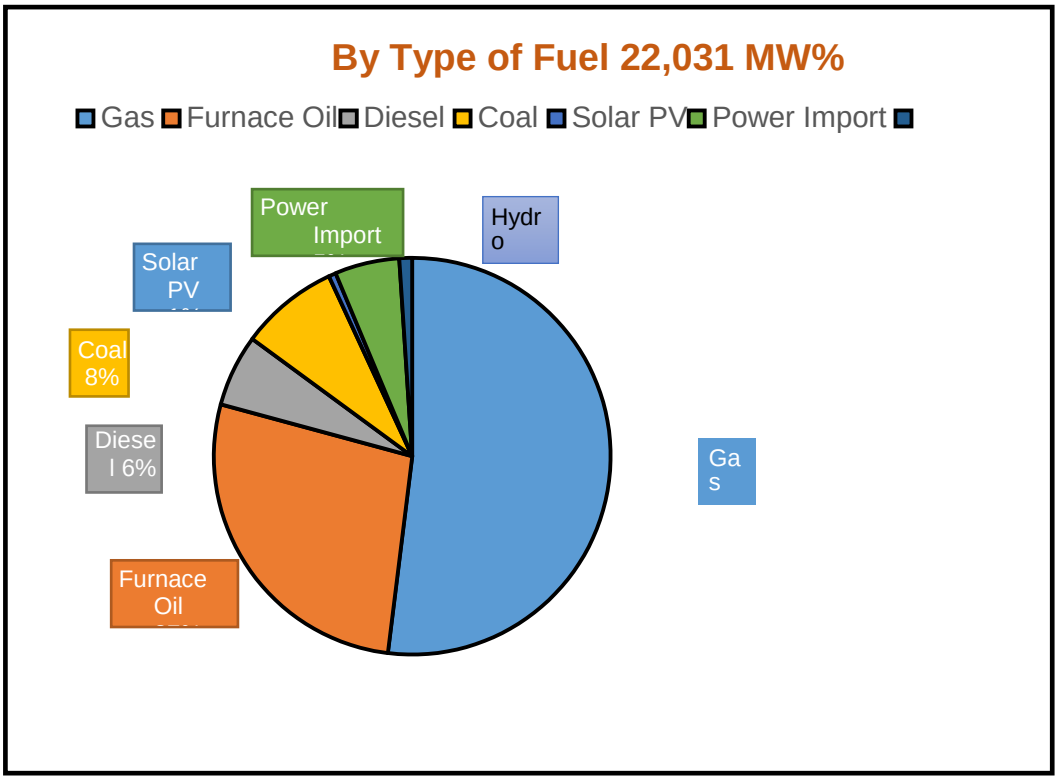

Figure 1 Installed Capacity by Fuel Type

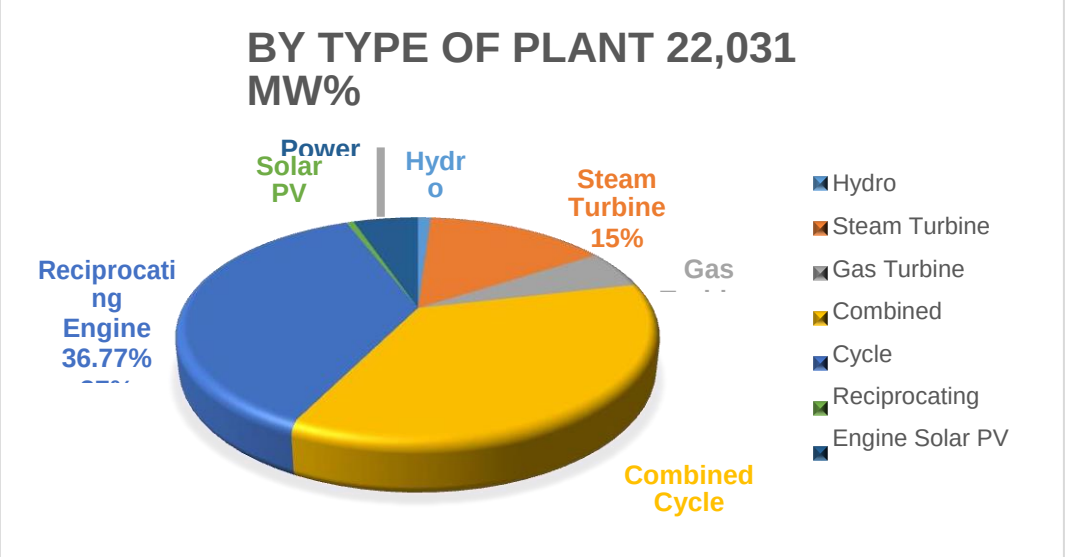

Figure 2 Installed Capacity by Plant

2.4 Power consumption and demand

A Chart in Fig. 3&4 shows the amount of power consumed by various sectors in Bangladesh. Domestic consumption accounts for 56.42 % of total electricity generated in Bangladesh, with large industrial accounting for 38.95 %, commercial (12.48 %), agriculture (1.26 %), and other sectors accounting for the remaining 12.48 percent (2.84 percent). Bangladesh's net energy demand has augmented at a rate of 8–10 % each twelve month during the past ten periods. Peak electricity demand is estimated to be around 11.489 M kWh (BPDB 2021), with available generation capacity insufficient to meet demand. At the same time, due to populace growing, progress increased connections, increased usage of modern electrical appliances, the demand for energy continues to rise.

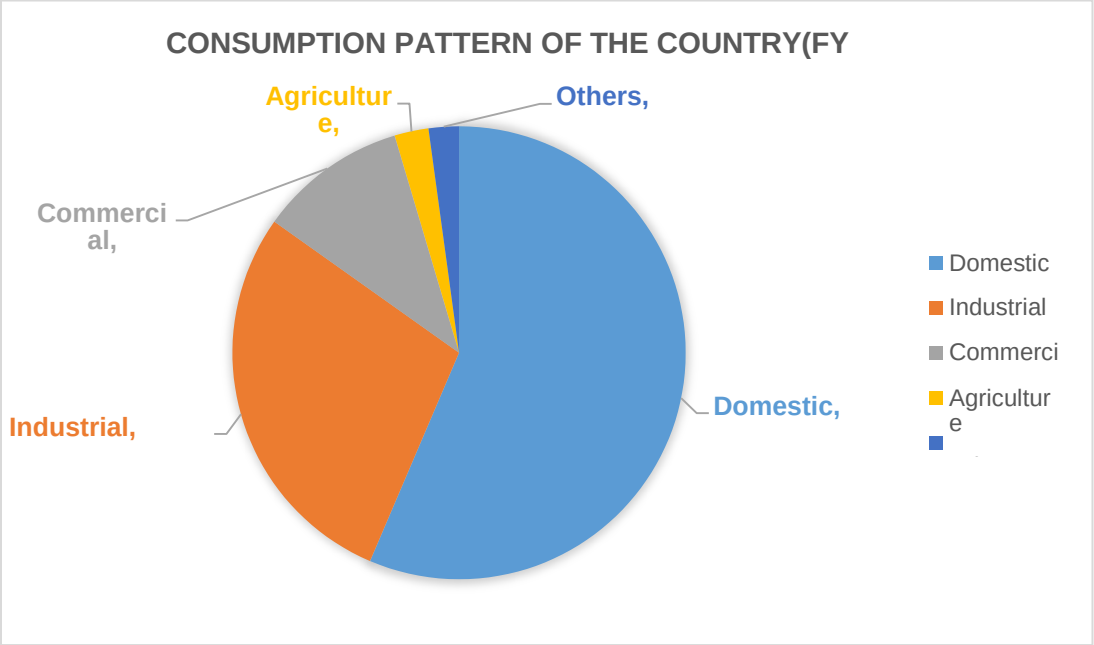

Figure 3 Total Retail Consumption: 71,471 MkWh

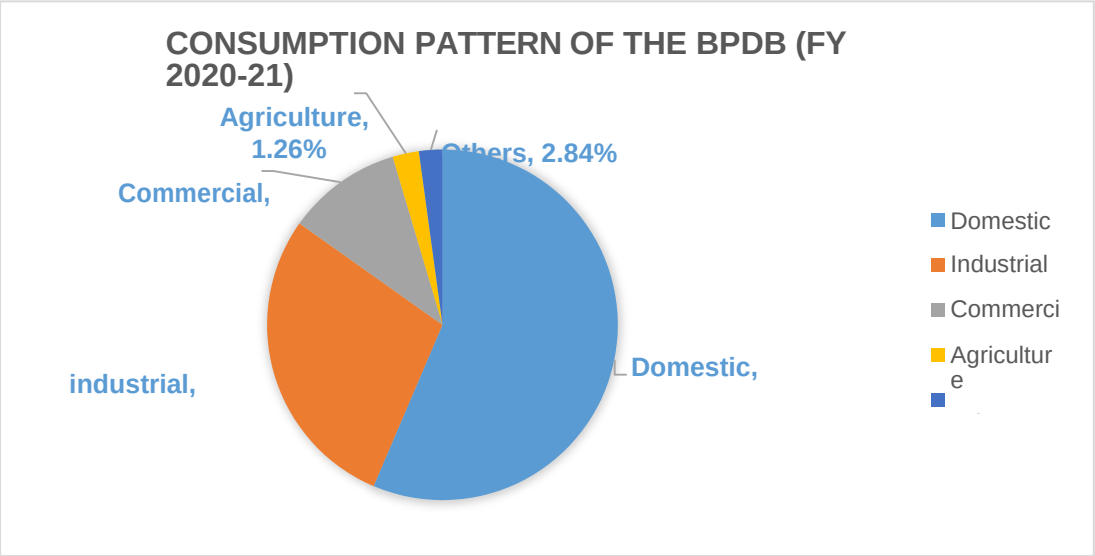

Figure 4 Total Retail Consumption: 11,489 MkWh

The demanding for energy lasts to produce by a amount of ended 500 MW per year, according to the upsurge in peak claim over the last ten years.

Seasonal fluctuation in power demand shows that demand peaks during the hot pre-monsoon summer months (March–April) owing to increased consumption in the home-based sector for planetary refrigeration and in farming for watering rice fields. During peak load hours, the compeers ability shortages consequence in frequent power outages (load shedding). Within a year, the average load shedding pattern. Frequent load shedding has a negative impact on Bangladesh's economic growth and industrial development, as well as its quality of life.

CHAPTER 3

WEATHER CHANGE AND IT'S IMPACT ON POWER SECTOR OF BANGLADESH

3.1 Climate change and its impacts on power sector of Bangladesh

Climate change will continue to be one of the world's most pressing issues in the next decades. Rapid climate change will have a harmful impact on all major ecosystems that support humans as well as economic activities that promote human wellbeing, making it an issue for sustainable development. The ablaze of relic fuel like coal, oil, and normal gas raises atmospheric concentrations of greenhouse gases (mostly CO2), causing global warming and affecting climate systems. According to scientific study, the human footprint on global warming has expanded dramatically since the Industrial Revolution because of the accelerated pace at which energy is harnessed, resulting in global rising temperatures. The main issue currently is to achieve economic development and social welfare while minimizing the damage caused by emissions that cause climate change. As a result, the power sector plays an important role in addressing climate change issue under the UN Framework Convention on Climate Change (UNFCCC). Many least developed countries suffering from energy poverty, such as Bangladesh, have seen the property of climate change, E.g. increased natural disasters also changes in climatic patterns with extreme weather occurrences. Given that a 1.7 % increase in energy consumption is required for every 1 percent increase in GDP in order to achieve at least 7-8 % GDP growth for poverty reduction2, the current state of energy poverty will have a negative impact on GDP growth and the ability to achieve the Millennium Development Goals.

3.2 Climate changing in Bangladesh is probably toward bring about:

1. Higher yearly rainfall with day-by-day warmth;
2. Greater temperature and rainfall extremes; (three) elevated flood, each in provisos of volume and incidence;
3. Expanded tropical storm and storm surge each within phrases of degree and incidence.
4. Low river drift in the course of waterless period; and

5. Elevated salinity intrusion in coastal rivers. The change are observable from the developments in rainfall, temperature, and excessive activities in Bangladesh.

It has by now been cited so as to excessive organization sufferers, small plant efficiencies, and a enormous hole between supply and exact are the principal issues within strength area of Bangladesh. Additional changeable weather and severe climate events could create a number of these issues at incredibly excessive levels. Weather modify and tremendous climate occasions might additionally have an effect on machine sufferers, strength plant performance, height insist, the transmission gadget, and strong infrastructure in a quantity of approaches. Current tendencies along with destiny projection for weather as well as excessive climate events in Bangladesh and their viable impact on strength era, using up, and transmission and distribution in Bangladesh are mentioned under.

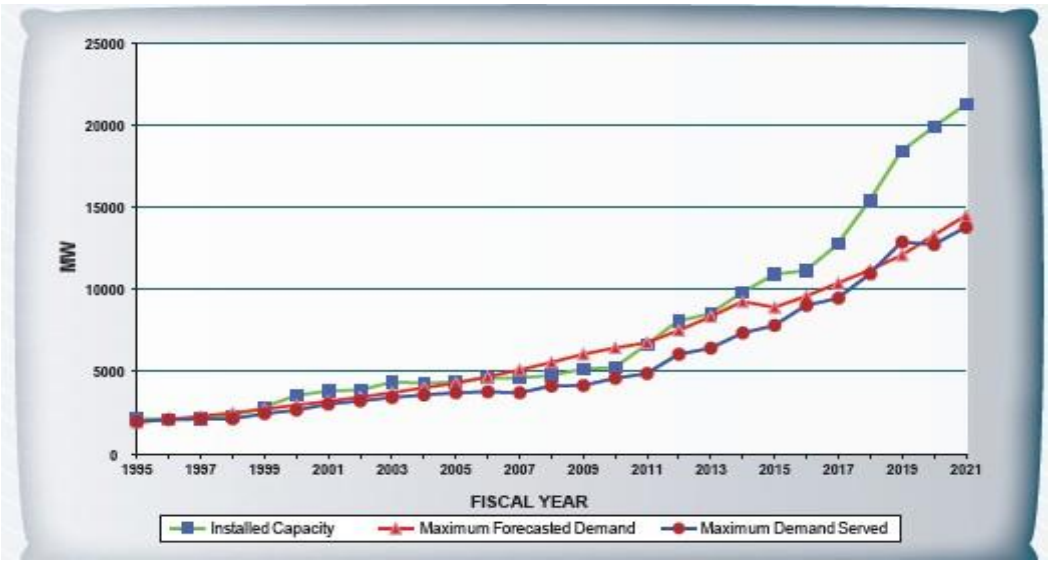

Figure 5 Install Capacity, Maximum Forecasted Demand & Maximum Demand Served (2020-2021)

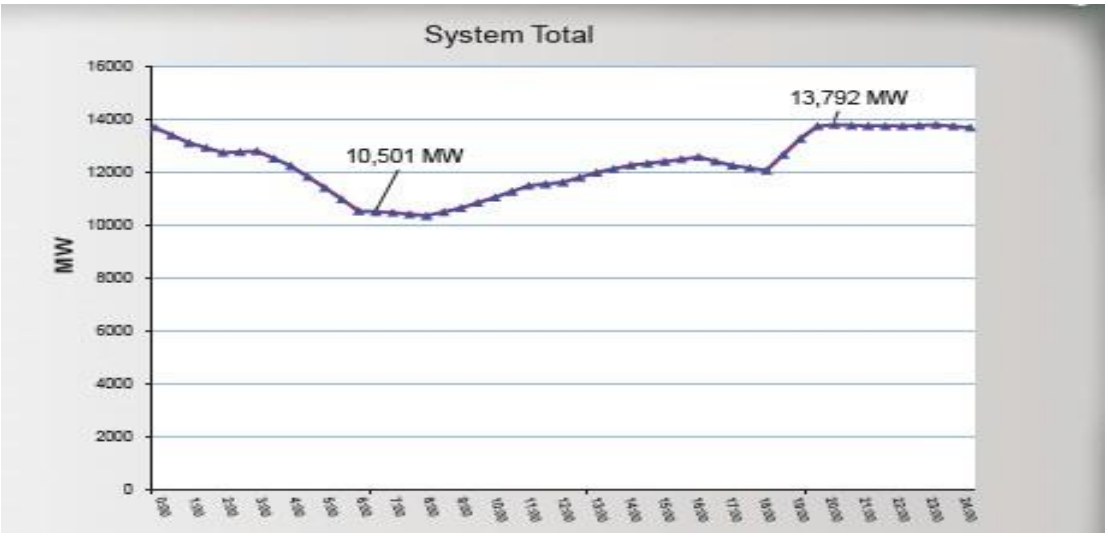

Figure 6 Daily Load Curve

3.3 Rainfall and temperature variations

The once-a-year average rainfall in Bangladesh is greater than before, at a rapidity of 5.08 mm/year between 2000 and 2021, according to a tendency psychiatry of yearly rainfall data series. If we look at the period from 1960 to 2020, our average maximum temperature has risen by about 1 degree Celsius. Space in particular may change. Similarly, the minimum temperature has also risen. In other words, the average temperature in this region has increased from zero point 0.7 to 1 degree Celsius. Bangladesh's rainfall and temperature are expected to rise much more in the near future, according to climate models. Graphs in Fig. 7a and b show the temperature and rainfall forecast by the (GCM) ran by means of the IPCC B2 SRES situation for the time 2050 and 2100 relative to the base day. Seven of the seventeen GCM model obtainable for assessing conservatory gas-induced climate change be able to replicate temperature and eight models can imitate rainfall in Bangladesh with moderate fault, according to the findings. As a result, the models are used to forecast rainfall and warmth. The models are run using the IPCC B2 (IPCC 2000), which depicts a future anywhere local solutions to financial, social, and ecological sustainability are prioritized, as well as lower greenhouse gas emissions. Bangladesh's and the surrounding region's population is expected to carry on to grow, except at a slower time than in B2 scenario. The B2 scenario's GDP prediction likewise represents an intermediate degree of economic development.

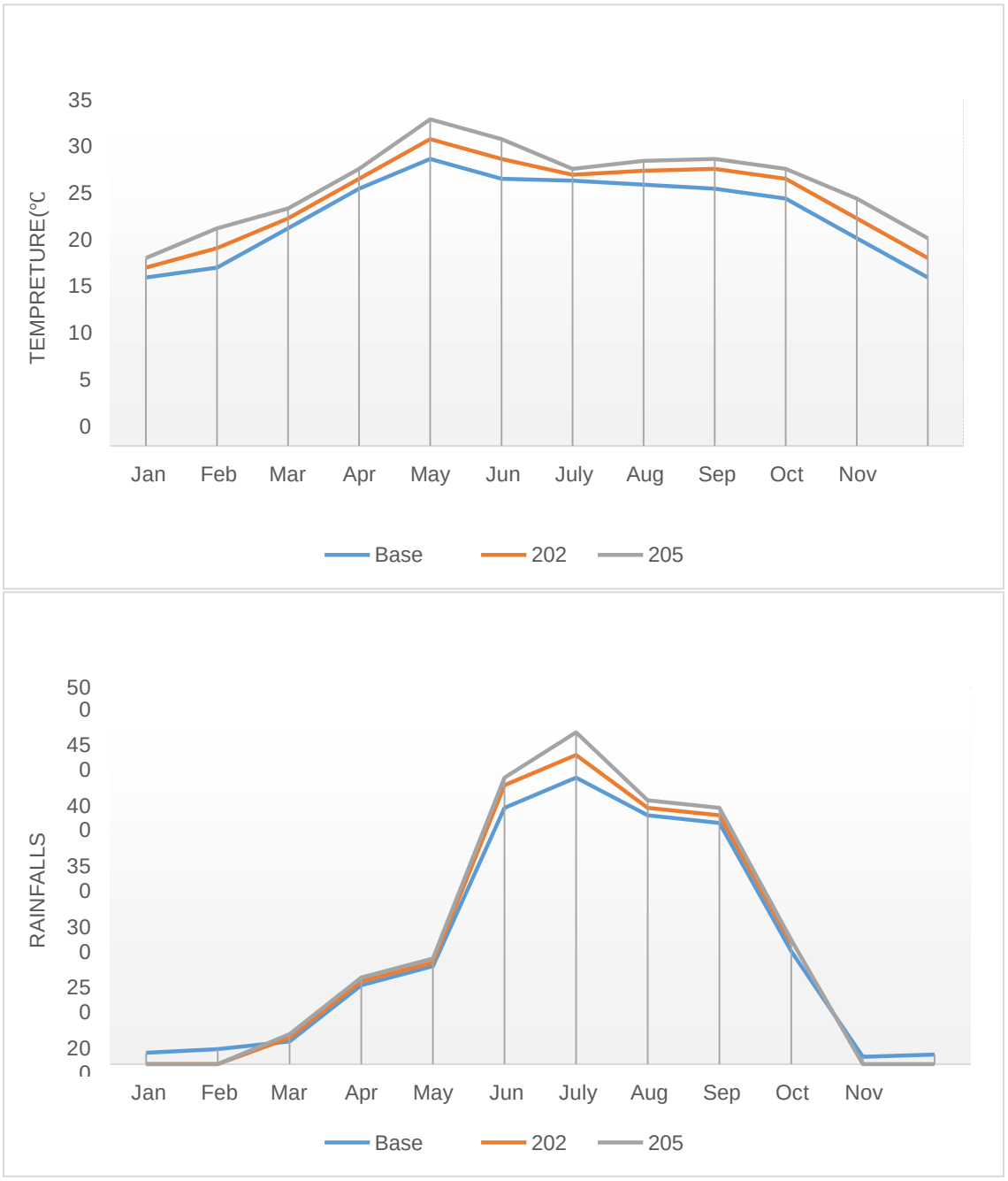

Figure 7 Predictable modify in A warmth and B rainfall in Bangladesh

The region's mid-to-long-term policy is to reduce greenhouse gas emissions to levels near to the B2 scenario. As a result, the current analysis uses the expected climate under the B2 climate scenario. Bangladesh's temperature is expected to rise steadily, according to climate models. The models predict a 1.4 °C increase in temperature in 2050 and a 2.4 °C increase during that time period. In the event of precipitation, the models predict a yearly increase. Because the atmosphere in excess of land warms further than the heavens over oceans during the summer monsoon,

most climate models predict that precipitation would rise. In the wintry weather months of December, January, and February, the models show a reduction in precipitation. In 2100, the largest rise in rainfall is anticipated for August, at concerning 1.2 mm/day, and the upper limit drop in rainfall is predicted for December, at around 0.4 mm/day. Advanced temperatures be able to have several detrimental effects on Bangladesh's electricity insist as well as the country's power transmission and distribution system.

3.3.1 Growing warmth and electricity insist

Among the upward push of warmth, rising developments within a wide variety of warm existence have additionally be experiential in Bangladesh. Improved warmth with warm being will purpose extra utilization of energy intended for area cooling. It is going to reason growth in total energy intake over and above the climax call for electricity. Seeing that the main reason for recurrent power screw-ups in Bangladesh is the energy insist rush forward for the duration of high load hours, it's much more likely that there will be greater electricity screw-ups in Bangladesh due to weather changes than nix tasks being in use to grow the generation by means of the augment in insist because of the upward push of warmth.

3.3.2 Augmented irrigation requirements and climax electricity demanding

Groundwater is the primary starting place of irrigation in mainly elements of Bangladesh, particularly at some stage in the dehydrated period. Electric pumps are typically used to extract the most groundwater and irrigate refined land. Ever-growing groundwater removal intended for irrigation throughout dehydrated period in recent time have induced groundwater stage to drop to the quantity of now not being completely replenish in the renew period. These reasons are overdraft in some parts of Bangladesh. It has been mentioned that the irrigation rate for the duration of the monsoon rice-growing season will be increased from 8.5 mm/daytime inside the base time to 8.9 mm/daytime in 2050 and to 9.3 mm/daytime in 2100. Since present be a right-away relative among groundwater degree and pump charge, pumping not in the extra water in fewer point in time to assemble the irrigation call for resolve result in extra declination of the groundwater stage. Accordingly, extra electricity could be

necessary to maintain the give up of groundwater for enough irrigation. It will purpose a boom in top energy call for and greater load dropping at some stage in the premonsoon summer time in Bangladesh.

3.3.3 The rise in temperature and the loss of electrical transmission

In Bangladesh, transmission loss accounts for 11.11% of total electricity fed into transmission lines (BPDB 2020-2021). Furthermore, the sharing scheme, which comprises major distribution lines, distribution transformers, secondary distribution lines, and service drops to individual users, loses around 8.48% of total electricity. In Bangladesh, copper cables mostly transmit power. Copper has a temperature coefficient of +0.393 % ℃ at room temperature. This means that as the temperature rises by 1℃ , the resistance rises by 0.393 %. Line and transformer losses will increase by around 0.786 % with a 2℃ increase.

3.3.4 Temperature increase and transformer life expectancy

In the transmission line grid, transformers are the nearly all vital and decisive tools. Increased temperature has a significant impact on a transformer's lifetime.

According to the operation environment, transformers are designed by a specific load score at a specific ambient warmth.

In Bangladesh's grid, transformers are frequently completely loaded. In the summer, rising temperatures may cause the external temperature to exceed the transformer's rated temperature.

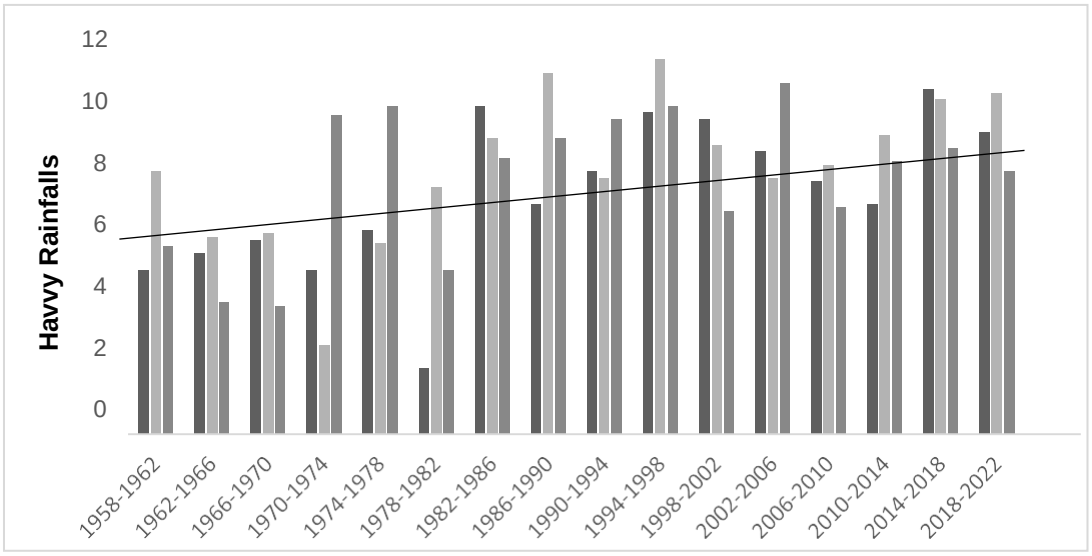

Figure 8 Charts related to rainfall in Bangladesh over time (1958-2022)

The aging rate of transformers would be accelerated if they were operated over the rated temperature for longer durations. As a result, a 2°C or greater increase in temperature may reduce transformer lifetime.

3.4 Severe rainfall and temperature events

Bangladesh has seen a rise in severe rainfall and warmth measures, according to every day rainfall and warmth statistics. Figure 8 depicts the charts in Bangladesh's serious rainfall days from 1958 to 2021. It has been discovered to the number of serious rainfall existence ([20 mm]) in Bangladesh has grown by 1.4 days each decade between 1958 and 2021. In Bangladesh, increased yearly rainfall and high rainfall events may result in more rain-related floods.

Figures 8a and b illustrate the charts in the figure of hot existence (highest warmth [33℃]) and warmth wave regularity (successive three existence with a upper limit warmth more than the 92th percentile) from 1958 to 2021. At a 99 percent confidence level, it was discovered that Bangladesh's hot days had grown by 1.16 days/year. In other areas, the frequency of heat waves has also risen dramatically.

The tendencies in the quantity of boiling days (upper limit warmth [30℃) and warmth signal regularity (uninterrupted 3 existence with upper limit hotness more than the 92th percentile) for the period 1958–2019 are shown in Fig. 9a and 9b, in that order. It has been determined that the hot days in Bangladesh have increased by means of 1.16 days/year at 9.9 % stage self-assurance. The warm signal incidence has too accelerated extensively in a number of seats.

Weather fashions additionally are expecting a similarly growth in intense weather occasions in Bangladesh. Thru the imitation of inconsistency and limits of each day rainfall all through the Indian summer season torrential rain, can (2004) predict a boom in the strength of weighty rainfall activities in Bangladesh. An examination of the frequency distribution of daily monsoon rainfall over the Indian subcontinent inside the version simulated information advocate that the intensity of extreme rainfall occasions is likely to be higher within the destiny due to the improved convective pastime at some stage in the summer season (Lal and Aggarwal 2001).

Because of the increasing demand of cooling systems during extreme temperatures, significant power disruptions are common. During the unusually hot summer days of 2011, when the average temperature rose to 35 C, power disruptions hit their worst-ever level in Bangladesh's history.

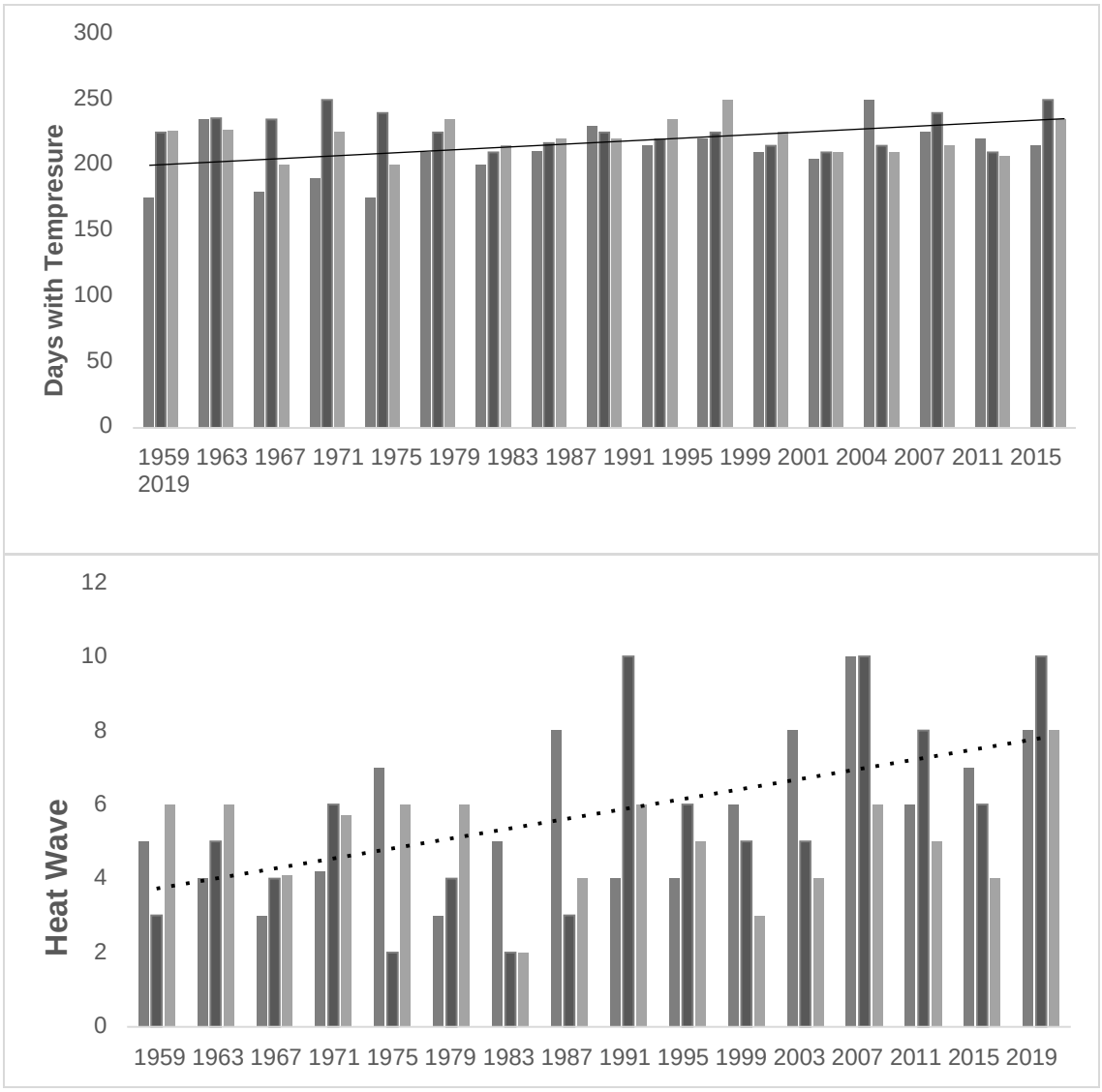

Figure 9 Chearts in A warm days and B temperature signal frequency in Bangladesh

This prompted 4–5 hour load shedding within the towns and 8–10 hour inside the rural area every day . Severe warmth too reduce the provide, as strength undergrowth also ought to sprint on inferior power yield owing to the high warmth of cool water in use as of waterway in the course of warmness effect or tremendous warmth existence. Intense rainfall know how to too purpose large authority outage. Sylhet city experienced 1394-mm rainfall on Jun, 2004, and 1456.02-mm rainfall on Jun 27, 2022, in 24 hour, which induced havoc in the electricity supply creating electricity outage in the city Sylhet metropolis of Bangladesh

3.5 Growing trends in excessive climate measures

Extreme climate occurrences such the same as floods, drought, and storms contain be linked in the direction of rising rainfall and temperatures in Bangladesh. Floods in 2004, 2007, 2014,and 2022, as well as whirlwind and tidal surges in 2000, 2004, 2007, 2014,and 2020, show an increase in the incidence and harshness of disastrous proceedings. In 2007, the super cyclone SIDR broke all previous records for coverage and wind speed. In 2022, in the city of Sylhet in Bangladesh was flooded twice in a single year.

3.5.1 Tropical cyclones

Main whirlwind contain radically greater than before within Bangladesh into new decades. Throughout the stage 1978-2016, a sum of 131 humid whirlwind (TCs) shaped into the Bay of Bengal, viewing once a year denote incidence of 3.6 TCs. Bangladesh be strike through 33 humid cyclone, which comprise regarding 25 per cent of the sum numeral of cyclone formed during that period. According to the present information, an standard of 1.15 humid cyclones strike Bangladesh yearly. The sharing of land-falling cyclone throughout the period 1961-2013 over diverse region of Bangladesh shore is exposed in bench 1

Noakhali and Chittagong, along with the eastern portion of the Meghna Estuary, were affected by around 26% of Bangladesh's cyclones, and the south-eastern coast of Cox's Bazar, Teknaf, and surrounding areas by about 29.5%. (Table 1). The coastal zones in the south-central and south-western regions were affected by 16% and 28%, respectively. The Meghna Estuary and the south-eastern coast were impacted by tropical cyclones most frequently in the month of May (pre-monsoon), and the central and western coasts were hit in the months of October and November, according to these 23-year records (post-monsoon).

3.4.2 Projections of tropical cyclones and rising sea surface temperatures

Recent research indicates that an upward tendency under climate change conditions can be attributed to the rising frequency of strong TCs. These are theoretical and very detailed dynamical model projections. The maximum sustainable wind speed (MSWS) and sea surface temperature (SST) relationship for the Atlantic Ocean indicates, among other things, that a 1 °C rise in temperature will raise the MSWS by 4%, a 2 °C rise by 10%, and a 4 °C rise by 22%.

Sl. No:	Coastal area	Tropical cyclones striking the coast in number	Sum amount of Tropical cyclones (%)
1	Sundarbans coast (Satkhira, Khulna and Bagerhat)	17	27.5
2	Central coast (Barguna, Patuakhali, Pirojpur, Barisal,Bhola)	10	16.4
3	Meghna estuary, east central coast (Eastern Bhula, Noakhali & Chittagong)	16	26.2
4	South- eastern coast (Southern Chittagong Cox's Bazaar and Teknaf)	18	29.5
	Total	**61**	**100**

Table 1 Distribution of land- falling Cyclones in Different coastal Regions during ((1961-2015

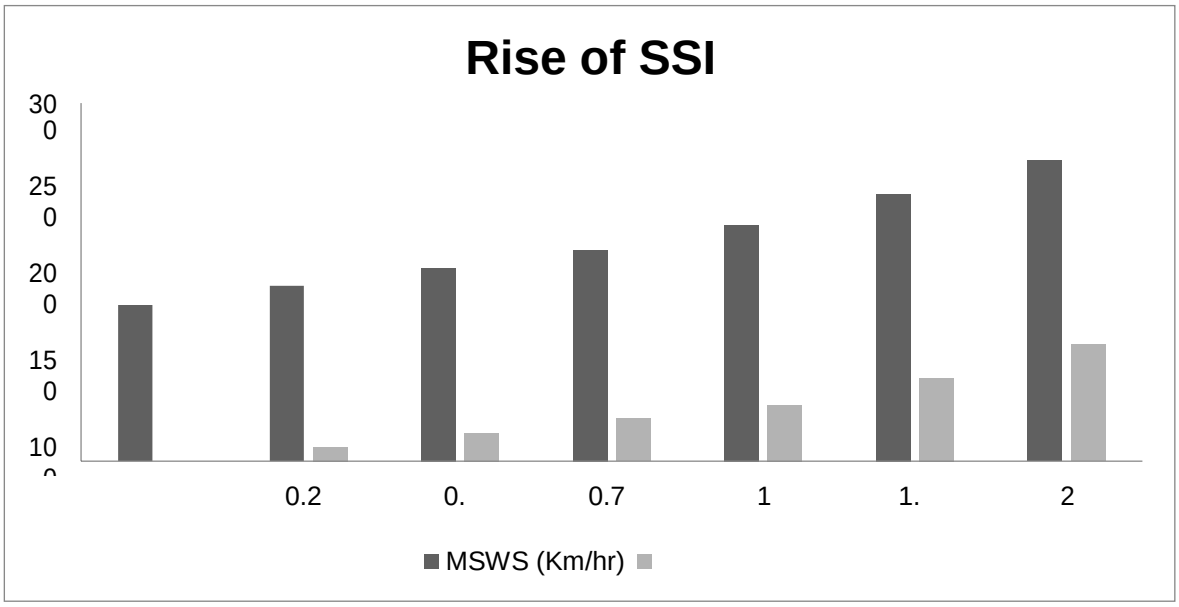

Figure 10 Average Sea Surface temperature SSI in the Bay Bengal and tropical cyclones (MSWS)

A 36 percent increase in the frequency of tropical cyclones in the pre-monsoon season and a 48 % increase in the post-monsoon season can be seen, according to the high-resolution regional climate model (HadRM2) for the Bay of Bengal (run with an annual increase in greenhouse gas concentration of 1.0% for 2041-2060 from 1990 onward.Existing modeling studies do, however, consistently demonstrate a 6-to-34%

drop in the frequency of tropical cyclones on a global average. Increasing sea surface temperatures (SST) in the Bay of Bengal would cause the wind speed of TCs to intensify further. This means, that more intense TCs are likely to occur in the Bay of Bengal. If the SST in the Bay of Bengal the maximum sustained wind speed, (MSWS) will increase by 69 percent if the SST in the Bay of Bengal rises by 1.5° C by 2050. (Table 1)

3.4.3 El Nio/la Nia-southern oscillation (ENSO) projection of tropical cyclone:

From a historical standpoint, it has been noted that many of the significant cyclones that affected Bangladesh occurred during an El Nino or La Nina year. Table 1 displays the top cyclones (Since 1960) and El Nino/La Nina events over those years to give some context:

The aforementioned timeline (Table 1) demonstrates that the majority of the significant storms that struck Bangladesh during various times occurred during an El Nino or La Nina event year or during a transitional period from one event to the other. Therefore, it is now possible to ask whether El Nino and La Nina occurrences worsen the risk of cyclonic activity in Bangladesh. Yes, according to the existing evidence!

Currently, the ENSO reaction to global warming varies significantly amongst models, and the science is still rather equivocal in this regard. However, recent research indicates that because of greenhouse warming, intense El Nino occurrences (such as those that occurred in (1982–1983, 1997–1998, and (2015–16) may double in frequency in the future and occur around every 10 years rather than every 20. El Nino/La Nina incidents have been reported to occur more frequently recently than they did between 1950 and 1980 (data on El Nino/La Nina events are not available before 1950), and this trend is likely to continue in the future. Therefore, an increase in the severity of strong cyclones in Bangladesh is a potential consequence of a changing climate.

3.5 Severe cyclones and power plants

In 2007, following the powerful tropical cyclone SIDR, Bangladesh witnessed its worst-ever blackout. For varied lengths of time, each of the big power plants tripped and unsuccessful. Restoring the entire generation took two days. The majority of the power plants were able to resume producing electricity, but the heavily damaged power cables and poles made it difficult to maintain a reliable supply of electricity.

The complete supply was restored in two to three days, and in the severely impacted southern districts, it took much longer.

3.6 Severe cyclones and renewable wealth infrastructure of Bangladesh

Bangladesh experiences significant wind flow throughout the year due to its subtropical climate. Wind energy production has good potential in Bangladesh's coastal region. Bangladesh's geographic location is also perfect for efficiently using solar energy. In Bangladesh, tropical cyclones provide the biggest obstacle to the production of renewable energy, particularly wind energy. There is always a chance that cyclones could harm the wind turbine. The 1,000-kWp capacity Wind Battery Hybrid Power Project, Bangladesh's largest wind power generation project, was repeatedly severely damaged by tropical cyclones from the Bay of Bengal. It is located in the coastal region of the southeast District. The Super Cyclone SIDR passed across Bangladesh's coastal regions while the project was being implemented. Above the dam in front of the project, the tide surge was 10 to 15 feet higher. The high waters covered everything, including supplies. Strong waves swept apart some 3-ton steel towers. All civil constructions that were fully finished were utterly ruined. The implementation work resumed following the SIDR and was finished by 2007. The project was once more badly damaged by Tropical Cyclone Nargis, which had winds of 200–240 km/h. It took about 3 months to re-start the power generation (Rahman 2009). The first biggest solar photovoltaic system of Bangladesh installed on a coastal island in Bangladesh was destroyed in the 1991 cyclone (Islam 2002).

3.7 Severe cyclones and power sharing

Bangladesh's power distribution system has been severely impacted by recent cyclones. The effects of the five most recent cyclones on Bangladesh's power distribution infrastructure. Bangladesh's electrical transmission and distribution system was severely damaged by hurricane SIDR's strong winds. Several transmission cables and substation components were damaged by persistent high winds and falling trees. For nearly a whole day, the entire country's electricity supply was disrupted. The distribution system took more than a month to fully restore. The power sector suffered a total loss of US$ 13.4 million. In April 2009, Cyclone Bijli generated high waves and a tidal surge of up to three meters above usual. With heavy rain and winds of up to 100 km/h, the storm pounded 14 southeastern coastal districts of Bangladesh.

Hundreds of electricity poles were uprooted or destroyed, leaving portions of the southeast without power for an extended period of time. Cyclone Aila struck Bangladesh's southwest coast in May 2009, uprooting several electric poles, downing power lines, and causing extensive power disruptions (Sources: national newspapers). Climate change may have a negative impact on Bangladesh's electricity distribution infrastructure in the near future due to increased storm frequency and severity.

CHAPTER 4

FLOODS IN BANGLADESH

4.1 Flood in Bangladesh

The regularity of irregular flood in Bangladesh has augmented considerably in the history a small number of years. Figure 10 shows the flood events in the last 55 years in Bangladesh. It is clear from the figure that flood severity has increased in Bangladesh in recent years. Bangladesh may see more severe flooding because of climate change, according to future peak releases. Recent increases in mean peak discharge in the main rivers of Bangladesh indicate significant changes in the spatial as well as the depth of inundation in Bangladesh. Most of the climatic models project an increase in rainfall in monsoon in south Asia, which may cause more extreme floods in the region (IPCC 2007). The floods of 1998 that inundated nearly 70% of the country area and the floods of 2007 that occurred twice in a single year indicate increasing flood severity in Bangladesh. Bangladesh's power distribution was impacted in a variety of ways by recent floods. Table 2 lists the effects of Bangladesh's most recent catastrophic flooding on power distribution.. All the extreme floods caused the power supply to shut down, especially in urban areas. In 1988, 18 electrical power substations were flooded. Due to heavy flooding in 1988 and 1998, 2,000 km of 11-kV power lines had to be deactivated. In several areas of Bangladesh, severe floods in 2007 washed down power poles, disrupting the provision of energy (Sources: national newspapers).

Due to its location on the Brahmaputra River Delta (also known as the Ganges Delta) and the numerous distributaries flowing into the Bay of Bengal, Bangladesh, a country of many rivers, is particularly susceptible to flooding. Bangladesh suffers from the increasing belongings of floods owing to water irregular from close by hill, the buildup of the inflow of water from upstream catchments, and nearby serious rainfall improved by drainage congestion because it is located in such a sink and is fewer than 5 meters on top of mean sea height. This issue arises in Bangladesh every year. Coastal flooding significantly impacts Bangladesh’s landscape and people, which frequently occurs in conjunction with riverbank bursts. Due to its large seacoast and 80 percent floodplain, Bangladesh is extremely vulnerable to recurring

widespread damage. While more durable barriers made of reinforced concrete are being constructed, many embankments constructed by local farmers are only made of dirt and turf. Flooding typically happens from June through September, during the monsoon season. Relief rainfall brought on by the Himalayas is added to the convectional rainfall of the monsoon. Another important inflow is Himalayan meltwater. Over seven million dwellings are destroyed, over 5,000 people are killed, and concerning 26,000 square kilometers (10,000 square miles) of Bangladesh are flooded each year. As was the case in 1998, the impacted region during catastrophic floods may approach 75% of the nation. This volume represent 95 percent of the twelve-monthly inflow. By contrast, only about 187 trillion l (1.87×1011 m3; 6.6×1012 cu ft.) of streamflow is generated by rainfall inside the country during the same period. The floods have caused devastation in Bangladesh throughout history, especially in 1951, 1987, 1988 and 1998. The 2007 South Asian floods also affected a large portion of Bangladesh.

4.2 Benefits of flooding

Bangladesh's agricultural sector depends on minor flooding because the sediment left behind by floodwaters fertilizes crops. Natural flooding substitute's artificial irrigation, which is time-consuming and expensive to construct since rice cultivation requires water. Floods wash away salt that has accumulated on fields because of rapid evaporation, keeping the land fertile. In El Nino years when the monsoon is disrupted, the advantages of floods are obvious. As El Niño becomes increasingly frequent, and flood events appear to become extreme, the previously reliable monsoon may be succeeded by years of drought or devastating floods. Despite all of this, flooding also has a very positive effect and it is that corn grows on the bananas, with the flooding corn can grow to benefit the agriculture and economy in the area.

4.3 Types of floods:

While the issue of flooding and the ongoing efforts to limit its damages are prevalent throughout the entire country, several types of floods have recently occurred regularly, affecting different areas in their own distinct way. These flood types include

- Flash floods in hilly areas
- Monsoon floods during monsoon season

- Normal bank floods from the major rivers, Brahmaputra, Ganges and Meghna
- Rain-fed floods

4.4 Historic floods

Destructive flooding has a long history in the nation and has had a highly negative effect on both lives and property. Six significant floods in the 19th century were documented: 1842, 1858, 1871, 1875, 1885, and 1892. Eighteen major floods occurred in the 20th century. The effects of those in 1951, 1987, 1988, and 1998 were disastrous. More floods that are recent include 2004 and 2010. The catastrophic floods of 1987 occurred throughout July and August[4] and affected 57,300 square kilometers (22,100 sq. mi) of land, (about 40% of the total area of the country) and were estimated as a once in 30-70 year event. The places that were severely impacted were those norths of Khulna, below the confluence of the Ganges and Brahmaputra, and on the western side of the Brahmaputra.

The flood of 1988, which was also of catastrophic consequence, occurred throughout August and September. The waters inundated about 82,000 square kilometers (32,000 sq. mi) of land, (about 60% of the area) and its return period was estimated at 50–100 years. Rainfall together with the synchronization of very high flows of the three major rivers of the country in only three days aggravated the flood. Dhaka, the capital of Bangladesh, was severely affected. The flood lasted 15 to 20 days.

In 1998, over 75% of the total area of the country was flooded, including half of Dhaka. It was similar to the catastrophic flood of 1988, in terms of the extent of the flooding. A combination of heavy rainfall within and outside the country and synchronization of peak flows of the major rivers contributed to the flood. Over a thousand individuals died and 30 million people were left homeless. Flooding contaminated crops and livestock, and contaminated water led to cholera and typhoid outbreaks. Due to damage from the water, few hospitals were operating, and those that were had too many patients, which led to common injuries going untreated and dying. 700,000 hectares of crops were destroyed, 400 factories were forced to close, and there was a 20% decrease in economic production. Communication within the country also became difficult.

Even though they were not as bad as the floods in 1998, the 1999 floods were nevertheless exceedingly dangerous and expensive. Between July and September, there were numerous fatalities and widespread homelessness because of the floods. Foreign aid was required to cover the cost of the severe destruction. The entire flood lasted approximately 65 days. Two-thirds of the country was under water during the 2004 flood, which was remarkably comparable to the floods of 1988 and 1998. When rain caused the rivers in northwest Bangladesh to overflow their banks in early October 2005, dozens of villages were submerged. The floods that hit Bangladesh in 2007 affected 252 villages in 40 districts causing millions of people to become homeless. Floods also occurred in 2015, 2017 and 2022.

4.5 Year of disaster with floods and landslides 2017

In 2017, After the early floods in Haoran, heavy rains caused landslides as well as seasonal floods, with regular intervals of low pressure and cyclones at sea, causing disasters in all parts of the country throughout the farewell year.

In addition to the small earthquakes, tidal surges, thunderstorms, thunderstorms and other hostile weather conditions throughout the year, a huge amount of forest resources have been destroyed due to the Rohingyas taking shelter in Cox's Bazar in the south-west of the country.

At the beginning of the year, an earthquake in Tripura shook the whole country. And the last half is abnormal rainfall, the highest in a decade.

In May, there were more than 50 deaths due to lightning. Cyclone 'Morar' signaled danger at the end of May after the heat wave. Heavy rains in the mountains in June killed more than 150 people, including the capital and the city of Chittagong; Boats were crossing the roads of these two cities.

In July-August, most parts of the country are inundated by monsoon floods. The forest was cleared in the mountains in September to build a settlement for the fleeing Rohingyas.

And low pressure and cyclones were rampant along the coast throughout the year. The people of the central part of the country have been affected by the continuous rains due to the effects of low pressure and cyclones.

Although Bangladesh is a disaster-prone country, the unusual weather in recent years has repeatedly made it difficult to make all kinds of preparations for the future.

–Premature floods and heavy rainfall in the mountains of Haoranchal this year were relatively unusual. Keeping the issues in mind, everyone should be quite ready for agriculture and livestock.

"Reviewing the data of the last 30 years, it can be said that April-May next year may be very hot. Early floods may also hamper Haoranchal. Elsewhere, there are fears of minor cyclones, though not major floods. All in all, we have to be ready now to avoid the damage of the disaster. ‖

4.5.1 Premature floods in Haor

In early April, flash floods inundated large haor areas in Sylhet and Sunamganj, Netrokona and Kishoreganj.

The food ministry estimates that about 600,000 tonnes of paddy has been lost in the haor districts due to the floods. However, according to the private sector, the amount of crop loss is 22 lakh tons.

April was the wettest month in 35 years. There was misery in villages, towns and ports.

The normal rainfall for this month is 4,053 mm; But this time the rainfall exceeded the record by more than 9 thousand millimeters. Clouds came down in the sky of Dhaka on 23 April.

At the beginning of the monsoon, 139 mm of rain fell in 24 hours on 12-13 June in Dhaka. On 13 July, a record 103 mm of rain fell. On the night of July 26, with only 8 mm of rain, the city dwellers had to suffer from waterlogging and traffic jams throughout the day.

364 mm in 24 hours at Sitakunda outside the capital on 20 July; Rangamati received 343 mm of rainfall on 12 June.

Many roads in Dhaka were submerged in three hours of rain on August 3, the capital city saw so much rain in a short time after 10 years. On that day, 123 mm of rain fell in a short time.

4.5.2 Depression-Cyclones and Mora

Hurricane Mora was among the four-point heatwave during the summer season. In April and May of this year, two cyclones named Marutha and Mora formed in the Bay of Bengal.

In addition, except for August in the second half of the year, the sea pressure is formed almost every month. Therefore, besides issuing warning signals in the rivers and seaports of the country, in most cases, people are suffering from continuous rains due to low pressure.

The Cox's Bazar-Chittagong coast was hit by a 'mora' after a deep depression turned into a cyclone in late May. Normal work was stopped at Chittagong Port, Shah Amanat Airport, a few answers were taken at the shelter.

The hurricane, which struck at 10 a.m., destroyed a large number of houses in various coastal districts, killing seven people. More than 50 missing persons drowned in the Bay of Bengal were rescued by the navy and local fishermen and 33 boatmen and fishermen were rescued by the Indian navy.

The storm affected 2 lakh 6 thousand people in Cox's Bazar, Chittagong, Noakhali, Laxmipur, Feni, Chandpur, Barisal, Pirojpur, Patuakhali, Bhola, Jhalokati, Barguna, Khulna, Satkhira, Bagerhat and Rangamati-18 districts.

32 districts affected by floods, Many upazilas in at least 13 districts were inundated by the first flood of the season in the second half of July after early floods in Haor. The August floods inundated large areas of 32 districts and affected more than a quarter of a million people.

Although the spread of these floods was less, it surpassed the floods of 197 and 1996 in terms of loss of life. According to the Ministry of Disaster Management and Relief, about 72 lakh people were affected by the floods in 32 districts of the country. 140 people have died due to flooding and other causes of floods.

4.6 Bangladesh: Floods and Landslides - May 2022

Millions of people are stranded in the Sylhet division due to heavy monsoon rains and water from upstream flooding in northeastern India, which has also sparked a humanitarian crisis. According to the Flood Forecasting and Warning Centre, more

than 84 percent of Sylhet and over 94 percent of Sunamganj are underwater (FFWC). The disaster occurred as the residents of the division were still getting over recent, unanticipated floods that hit in late May.

This unexpected flash flood and water shortage have an estimated 4.3 million people in seven northeastern districts affected: Sylhet, Sunamganj, Moulivazar, Habiganj, Netrakona, and Brahmanbaria. Flooding has left many homes isolated, while others have sought refuge in public spaces. In those households, there is a significant risk to the safety and security of women and girls. As many as 25,000 people have been taken to around 450 shelter centers in Sylhet; at the same time, 65,000 people were evacuated to 200 shelter centers in Sunamganj in a combined effort of the Army, Navy, and Fire Service, and the local authorities. The light flood not only affected the northeast but even the northern districts. In a news conference, the GOB stated that the flood had affected 64 Upazilas in 10 districts around Bangladesh. (UN RC Bangladesh, 19 Jun 2022)

An estimated 6.8 million people in Bangladesh's northeast have been impacted by heavy monsoon rains and flash floods. (14, 32) safety centers have received 459,567 evacuated residents. There have been reports of power outages and problems with ground and air travel. Because of the safety centers' inadequate equipment, educational and medical facilities have been impacted, and safety concerns have been raised. Government agencies and humanitarian partners are distributing relief supplies, but the relief efforts are running into logistical problems. In order to assess the situation and support the government-led response, the Humanitarian Coordination Task Team (HCTT) collaborates closely with partners (20 June 2022, OCHA).

According to the Government of Bangladesh's first reports, there has been a significant amount of displacement, with 481,827 individuals moving into 1,605 institutional shelters throughout four districts in the flood-affected area (Sunamganj, Netrokona, Sylhet, Moulvibazar). 1.6 million children are in danger due to a high risk of drowning, VACW, including gender-based violence and IPV, and family breakdown brought on by overcrowded shelters. In the last 35 days (17 May 20 June 2022), the National Health Emergency Operations Centre and Control Room of DGHS recorded 2,492 cases of diseases and injuries (UN RC Bangladesh, 22 Jun 2022).

4.7 We want effective measures to protect the river

Bangladesh is a riverine country. Water is its life; But just as other rivers have been filled due to the Farakka and Teesta dams, the inflow of water from India has caused floods. Recently, floods have occurred in Teesta basin due to rise in water in other rivers of India including Teesta. People have lost their crops and faced disaster again. Due to lack of effective measures to protect the river, the development is hampered a lot.

Water is a very important resource for Bangladesh. The prosperity of Bangladesh depends on this water management. Bangladesh floods almost every year, and due to climate change, storm surges bring salt water upstream from the sea.

No effective system has yet been developed to protect the river. According to the Water Development Board, Bangladesh has 405 rivers and 57 inter-connecting rivers. But the rivers are disappearing due to pollution and encroachment. Currently 230 rivers are flowing. Sadly, two-thirds of the 30 rivers in the southern region, such as the Kapotaksha, Shivsa and Pasur rivers, have become unnavigable. People walk across these rivers during low tide. While this is the condition of the rivers in the Bhati region, the condition of the rivers in the northern region can be easily estimated. The climate projection models predict that rainfall in Bangladesh and the neighboring areas would decline throughout the dry season. The climate projection models predict that rainfall in Bangladesh and the neighboring areas would decline throughout the dry season.

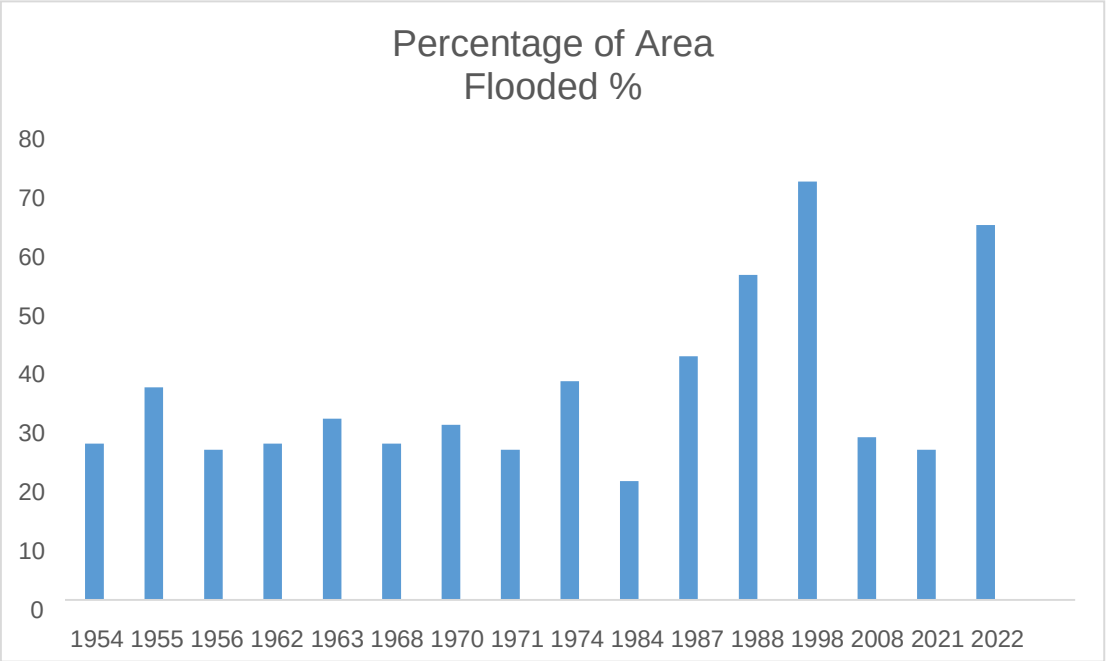

Figure 11 How terrible is the flood situation in Bangladesh (1954-2022)

Due to the continuous withdrawal of water from the Ganga amid numerous dams and projects upstream, including Farakka, char is spreading daily in the Padma in Bangladesh. This char is consuming part of the water, thereby narrowing the main flow of the river. According to information, India is diverting 90% of the water of the main Ganga and its tributaries to implement its numerous irrigation and hydropower projects. Due to this, only 10 percent of the water is flowing in the river. In 56 years, the flow of the Ganges has reduced by 20 percent. According to estimates, 1 kWh of electricity requires 95 l of water on average. Low river flow brought on by climate change can harm plants even when the majority of them are situated in a region that experiences strong tidal action during the dry season producing water scarcity in power plants, which will later hinder production. Not only Farakka, India has built at least 33 major infrastructures including Ganga-Padma concentric dams, reservoirs, cross dams, regulators. Along with it there are innumerable other small and big structures. In this kind of project, India is continuing the extensive irrigation program by diverting the water of the Ganges through thousands of kilometers of canals.

The adverse reaction and damage caused by the lack of water in Bangladesh, shows that about two crore people in the northern region are affected by the lack of irrigation. About four crore people and one-third of the area in the southern region are affected by lack of irrigation water. Irrigation is not possible in 56 percent of Ganga

direct project areas. Fertility of land is reduced due to excess salinity. About 21 percent of shallow tube wells and 42 percent of deep tube wells in the country are not being used.

After the Ganges water agreement in 1996, the share of Ganges water in Bangladesh has been less than 20 thousand cubic feet per second. But before the Farakka Dam, Bangladesh did not get less than 70,000 cusecs of water during the dry season. Thousands of hand pumps have become useless as the groundwater level has dropped. But despite all these difficulties, after half a century, the Farakka Dam has not yet been reviewed.

After 40 years of construction of a dam, it has to be reviewed. But the age of Farakka Dam is over 50 years. The damage caused to Bangladesh due to Farakka Dam should be highlighted now. Ganges is an international river. Bangladesh has the right to this river. It is not an India issue as it has spilled over into Bangladesh. That is why it is now necessary to highlight the harmful aspects of India's unilateral construction of dams on the Ganges River.

4.8 Salinity levels in river water and sea level

Increase Figure 12 depicts how a coastal river's salinity changed over time. Bangladesh between 1967 and 1997. Salinity has increased by 124% in some areas of Bangladesh's coastal region during the past 30 years, according to a study by the Soil Resources Development Institute (SRDI, 1998). According to reports, by 2100 the sea level in Bangladesh's coastal region will rise by one meter (World Bank 2000; Frihy 2003). The decline in freshwater availability caused by saltwater intrusion will be one of the main effects of sea-level rise on water resources. A reduction in rainfall and low river flow during the dry season may aggravate the salinity levels in the coastal rivers of Bangladesh.

Thousands of gallons of fresh water must be supplied each day to Bangladesh's coastal water-cooled power stations in order to keep them operational. This process has turned into an odyssey, as freshwater becomes a rare commodity with tidal waters of the sea intruding further north every day. The flow of fresh water from the Ganges

River has stemmed, especially during the lean months. Tides are extending inland as a result, making the coastal area saltier. Sea level rise due to climate

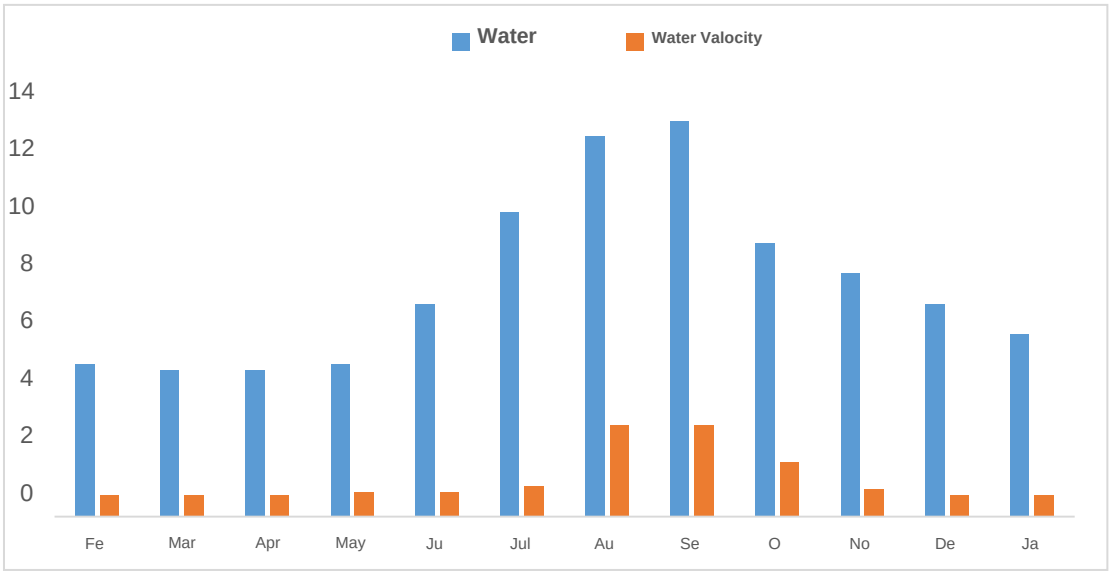

Figure 12 Annual water level, velocity GIDD-2020

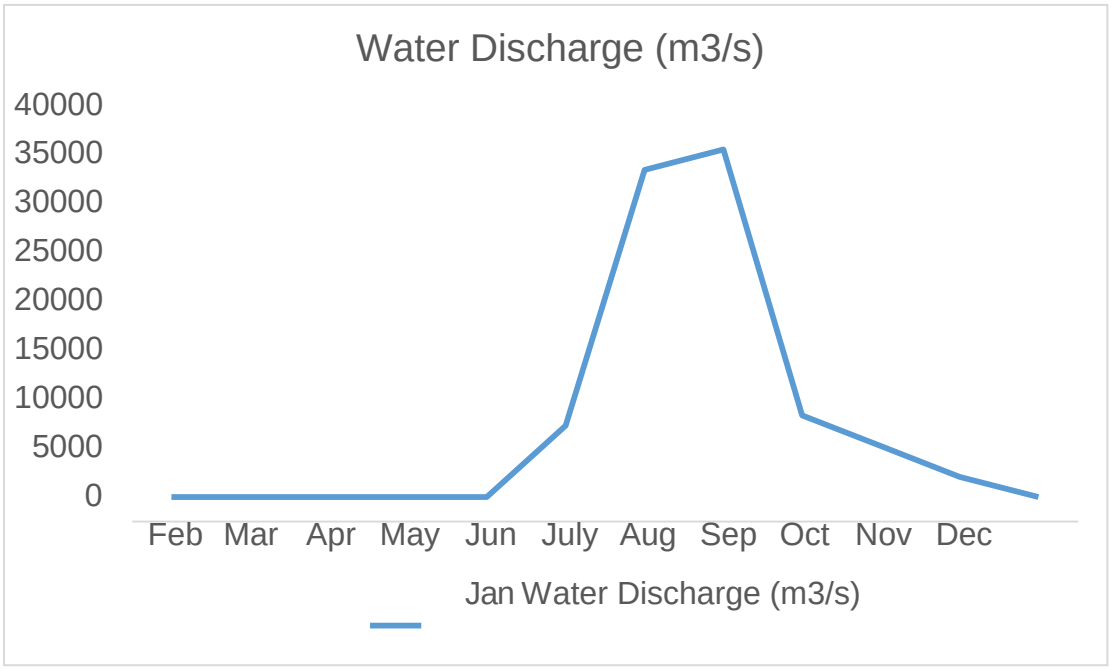

Figure 13 Annual discharge of the lower Ganges River during study time

4.9 Adaptation measures

There is no alternative to adaptation to the adverse effects of climate change. Climate change is a natural process. Nature is constantly changing in its own way. Adaptation is the adaptation to a changing climate.

Adaptation is closely related to climate change. Climate change can be resisted, so being adaptive to it is the way to go. An effective adaptation process requires a variety of capabilities. This ability is not only economic ability. It also includes technical, social and cognitive or experiential skills.

Undoubtedly, building a sustainable adaptation system requires a sustainable economic base. Technology will be needed. However, more than that, it is necessary to consider the context or type of adaptation and use appropriate technology.

Economic investment is the main driver for this technological adaptation. Bangladesh is the most climate prone country. Bangladesh is one of the countries that will face the most damage due to climate change in the future.

Bangladesh is already a natural disaster prone country. Every year various natural calamities such as floods, cyclones and river erosion strike here. The natural and socio-economic losses of these regular disasters are extensive. Which at the same time is creating new threats to the environment.

International environmental law calls for inter-state assistance to enhance adaptation capacity. States have also emphasized adaptation by enacting legislation in their respective jurisdictions.

In the last 5 and a half years, the government has allocated Tk 2900 crore to deal with the adverse effects of climate change in our country. These funds have been allocated through various ministries. This climate adaptation also has structural steps. An environment is to keep environmental pollutants under control. A process called mitigation or mitigation is said to reduce the amount of pollutants in the environment. The key is to use more efficient and environmentally friendly technologies using new and renewable energy. It is an adaptive process to police the development of the environment using the same effective technology by changing the behavior of the users.

In addition, taking effective measures to reduce the emission of other environmental polluting gases and financing for green economy or development is also covered by its international law.

Appropriate strategies must be adopted before undertaking the adaptation process. Adaptation should be part of national budget and economic planning. Governments will include adaptation in their climate action pledges. It will not be successful if it is not coordinated with strategy and economic planning.

Tackling environmental pollution can never be achieved in a single effort. Because the environment is international. Therefore, there is a need for coordination in the international arena as well. Again, in the national sphere, it should be reflected in the plans of all ministries and institutions of the state. Many ministries in our country do not have any program on climate. As a result, a kind of inconsistency can be observed in this case. We have a law called the Climate Trust Act. According to section 5 of this law, a trust is to be formed, the aim of which is to increase the adaptation capacity of the people or communities affected by climate change, to improve the quality of life and to take the necessary planning and implementation activities to deal with the long-term risks. The main point of this section is to increase the climate adaptation capacity of people. Again in sub-section (b) of the same section, it is stated that the purpose of forming this trust is to adopt or undertake necessary activities for adaptation, mitigation, technology development and transfer, capacity building and finance to deal with adverse effects on people, biodiversity and nature due to climate change. But the effective implementation of this law is not visible in our country. Not that it is not working at all. However, the activities we are supposed to have as the most climate vulnerable state are not being observed.

Section 7 (d) of the same Act states that funds shall be allocated for research activities in accordance with the policy made by the Board of Trustees for adaptation, mitigation, technology transfer and finance and investment to address the effects of climate change..etc.

But we have no effective research to achieve this goal here. What is there is also done by private initiative. Adaptation process is not adopted based on research. Other matters of climate are next.

However, adaptation is not the only way to address climate risks. Reducing environmental pollution or reducing greenhouse gas emissions is paramount. The developed world must come forward together. Because they are the main emitting countries.

Not all countries in the world are equally responsible for climate change. Developed countries are more responsible. Developed countries that emit more gas need to step up and lend a hand in climate change mitigation or adaptation.

When developing new power systems and reformatting old ones, adaptation and mitigation methods must be evaluated and taken into account in order to make them climate-proof. It is crucial to think about how to adjust to potential negative effects. To ensure a varied, decentralized, accessible, and inexpensive contemporary power system that is more climate change resistant, medium and long-term cost-effective measures must be developed. It is important to make information about climate change, extreme weather events, and the spatial distribution of their effects accessible so that vulnerability may be quickly identified.

A spatial decision support system can be developed for this purpose. A Geographic Information System (GIS) maintains the spatial location of sampling points and provides tools to relate the sampling data contained within a relational database. Therefore, GIS can be used to develop a spatial decision support system to deliver climate change impact and vulnerability information in an understandable format such as maps, reports, etc., to help the development and planning authorities in policy formulation in terms of climate change vulnerability risk reduction in Bangladesh.

Climate change issues should be considered in the development of all new power infrastructures in Bangladesh. Future power plant sites should be selected based on the availability of water during the dry season, salinity in river water, and a potential increase in the severity of cyclones. To reduce the impact of the non-availability of sufficient water for cooling especially during the dry season, power plants should be designed with the capacity of water reuse for cooling and steam generation. The amount of freshwater required for cooling and steam generation can be decreased by recovering water from condensers and heat exchangers, reducing evaporation losses, and improving the energy efficiency of cooling equipment and building envelopes (CCSP 2007). Power system structures in the coastal region should be designed and

developed by considering the impacts of increasing trends of storms, floods, and water levels. Given that, storms and floods are expected to become more severe and frequent in the future, strengthening the power supply structure is important (CCSP 2007).

Cyclones have often uprooted electricity poles and damaged power lines in the coastal region of Bangladesh, which caused the area to experience prolonged power disruptions. Particularly for the coastal region, decentralized power systems should be taken into consideration instead of centralized ones. Currently, Bangladesh like most the other countries generates most of the electricity in large centralized facilities and transmits electricity long distances through the national grid. Disruptions in the national grid due to natural disasters often cause widespread power outages. A decentralized power system generates electricity from many small energy sources and supplies power to a localized microgrid (Chambers 2001). Distributed power systems are very easy to maintain and much easier an alternative for adaptation in the context of rising extreme events because it means to change, redesign, or replace. Generation and distribution of power at the local level in coastal zones can be helpful to resume supply soon after the disaster. Burge-mounted plants can be planned for the coastal region, which can be moved to the freshwater zone when salinity increases in river water. It can also be taken to a safe location during severe storms or floods.

Severe storms and prolonged floods often affect the power supply system in urban areas, especially in the capital city of Bangladesh. Overhead power lines often need to be de-energized due to floods and storms, which affect urban life and the economy severely. Power distribution systems can be shielded from hurricanes and floods and made less susceptible to outages by installing underground distribution cables. Though the costs associated with its installation as well as future expansion and repairs are very high, it has been reported that underground construction might be the least-cost approach in regions where overhead power lines are vulnerable to storms, as the expense of replacing poles over their lifetime may be more than the cost of underground installation (ESMAP 2000).

The home and irrigation industries are the two that use the most power in Bangladesh and are the most vulnerable to climate change. Power consumption will increase in the domestic sector due to the rise in temperature, as more energy will be required for

space cooling. Especially, there will be an increase in peak power demand in pre-monsoon

summer season. To handle the scenario of peak demand, peak hour power plants can be created. You might use a method to lessen your reliance on power to adapt to the situation. The gas supply should be extended all over the country to reduce pressure on electricity for cooking.

The use of gas-operated household utilities should be encouraged. As it has been mentioned that space cooling will be the main cause of the surging electricity demand in the context of climate change in Bangladesh, energy-efficient cooling systems, energy-efficient building construction, etc. should be encouraged. Reforestation and increased green areas to reduce the urban heat island effect can also be helpful to reduce the temperature rise and the demand for power for space cooling. An efficient power management system and load distribution planning should be implemented to balance power generation and demand.

Increased demand for irrigation will be another factor in the rising electricity demand in Bangladesh. Policies like limiting the amount of electricity available for irrigation during peak hours, promoting irrigation at night, etc. can be helpful to adapt to the situation. Some other measures like encouraging water harvesting to reduce the use of electricity for pumping groundwater for irrigation, reuse of water in crops lands and increasing crop water productivity, and use of gas-operated pumps in irrigation can also be effective to reduce the impact of higher demand of power in irrigation.

Prospects of adaptive measures depend considerably on the level of knowledge of possible climate changes and their implications for power generation, distribution, and consumption. There is currently very little information regarding how Bangladesh's electricity sector will be affected by climate change to assist such understanding. Quantitative information about climate sensitivity of power consumption, power distribution losses, water use for the cooling systems in power plants, etc. is very limited. Analysis of historical data to it is crucial to simulate how climate parameters affect power systems and forecast the effects with numerical values under the anticipated climatic circumstances. More research to expand the knowledge base is therefore essential.

4.10 How much Bangladesh is ready for natural disaster management:

Due to its geographical location, Bangladesh has been affected by natural disasters at different times. These disasters include floods, cyclones, tidal surges, thunderstorms, tornadoes, river erosion, coastal erosion, droughts, cold spells, etc.

Besides, Bangladesh is at risk of earthquakes due to its position between the seismic zone i.e. Eurasian Plate, Indian Plate and Burma Plate. Due to global warming, Bangladesh's position is very fragile.

Due to the reality of climate change, the level and severity of natural disasters is increasing day by day. Although our role in climate change is negligible, Bangladesh is suffering from its serious adverse effects. Due to poverty and overcrowding, the impact of climate change is severely affecting the lives and livelihoods of the people in the coastal and riverine areas of Bangladesh.

Bangladesh is one of the countries affected by climate change and the impact of climate change is much more severe for Bangladesh due to poverty and overcrowding. According to the World Risk Report-2011, Bangladesh ranks 6th and 15th in the world in terms of disaster risk and danger. Due to the adverse effects of climate change, unplanned urbanization, unplanned human intervention in nature, river governance, etc., the risk of disaster in Bangladesh has increased several times. At different times, natural disasters have caused loss of life and property, on the one hand, and economic losses. This situation is undoubtedly holding back Bangladesh from its development progress.

The risk and loss of disaster is a huge obstacle in the way of human life and earning a decent livelihood. Especially for the poor community, who make a living from extreme hardship.

Disasters do not only affect the country or nation affected by the disaster; Rather it has resulted in widespread adverse effects worldwide. Changed technology, socio-economic context, unplanned urbanization, environmental and geographical disasters, climate change, HIV-AIDS outbreak, geological disasters and increasing population growth have intensified the risk of global disasters. This ongoing trend of change is a major obstacle to the sustainable development of the world economy and developing countries.

The Disaster Management Act, 2012 has been enacted with the aim of alleviating the overall disaster of the people, providing emergency humanitarian assistance, rehabilitation and rehabilitation programs to the aggrieved people more efficiently. There are also various laws in Bangladesh that deal with disaster risk reduction and disaster management.

One of the ten development priorities of the Government of Bangladesh's Perspective Plan 2010-2021 formulated in 2010 is to protect the environment, effectively address the problems caused by climate change and take effective measures on all issues that pollute the environment. It further said that since disaster management is related to the environment and climate change, it is necessary to implement an integrated disaster mitigation, preparedness, response, recovery and rehabilitation program to reduce the risk of climate change-related disasters.

Following the massive floods of 1986 and 1996 and the cyclones and tidal surges of 1991, the government has decided to replace the traditional concept of disaster management with disaster risk reduction, which includes disaster and risk identification, public preparedness and disaster response initiatives. Instead of the earlier concept of relief and rehabilitation, a structured framework for risk management with public participation has been formulated.

CHAPTER 5
EXTREME FLOOD CALAMITY ADDED ON THROUGH WEATHER ALTERNATE IN BANGLADESH

5.1 Extreme flood calamity added on through weather alternate in Bangladesh

Bangladesh is one of the world's most disaster-prone countries, and climate change is increasing the governing factor of disasters. It is planned to be the country most affected by climate change, and the risk of a major hydro-meteorological disaster is increasing. This country's geographic location renders it more vulnerable to natural disasters such as floods, cyclones, earthquakes, and other natural disasters. Floods and cyclones are common occurrences that can result in massive losses of life, property, and livelihood. Bangladesh is one of the world's largest deltas, it is mostly known as a flood plain country, with an area of 148,460 sq. km, and river and inland water bodies cover 6-7 percent of which. In reality, Bangladesh's rivers are among the most notable characteristics of the country's geography. Bangladesh occupies the majority of what is known as the "Bengal Delta," with a network of 250 rivers still living in this country. Aside from that, the flood plains of the GBM basins (Ganges, Brahmaputra, and Meghna) and some other minor rivers make up nearly 80% of the country. During the summer monsoon, which lasts from June to October, the GBM basins receive over 80% of their rainfall.

Every year, an average of 12. Lakh 81 thousand 4 hundred (Mm3), of total run off flows across Bangladesh and into the Bay of Bengal. Floods in Bangladesh occurs due to rainfall in seasonal wetlands.During the monsoon season, the Himalayan ice melts and there is heavy rainfall.. The annual discharge was estimated to be 1,369,000 m3, with more than 90% of the water coming from outside the nation, causing massive floods in Bangladesh. Every year there is normal rainfallduring the monsoon season, inundates 20–30(per cent) of the land, whereas this happens, the cataclysm is classified as a catastrophe, as were the floods in 1988, 1998, 2004, 2007, and 2017, 2022. Flood frequency, size, and length have all increased significantly during the last few decades, according to historical records. For example, after 1974, all big floods that affected more than 30% of the country occurred.

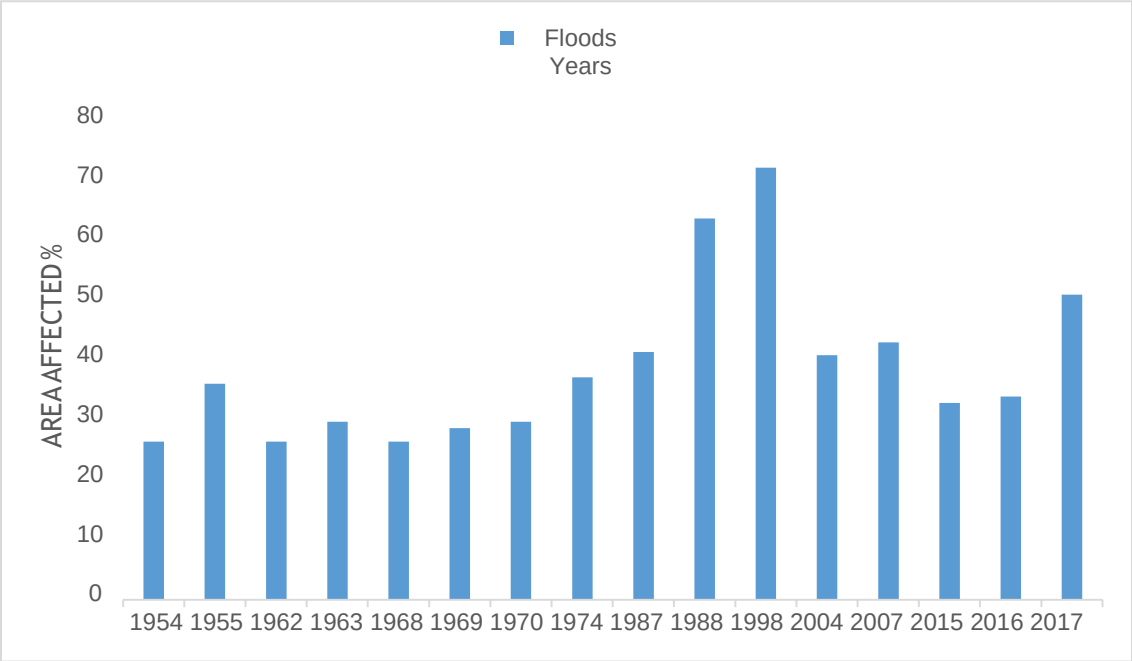

Figure 14 Extent of flooding in Bangladesh

In South, East, and South-East Asia's overpopulated mega delta areas, in particular, there would be a higher danger of coastal flooding due to rising sea and river flooding, according to the fourth assessment study by Working Group II from 2007. Startling prognosis, particularly for the Asia, where the river basins—the Ganges, Brahmaputra, and Meghna , most vulnerable of future floods. The survey also predicted that, by 2080, more individuals, particularly in overpopulated and low-lying areas where adaptive aptitude is comparatively close to the ground, are expected to be inundated annually due to sea level rise.

However, some academics have hypothesized that developing nations will suffer greatly as a result of climate change, which has a substantial negative influence on those nations. Bangladesh is particularly vulnerable to climate change, thus it is a pressing concern for this nation as well . Bangladesh, a low-lying underdeveloped nation, is considered to be among the nation’s most susceptible to climate change . Additionally, between 30% and 70% of the nation may be submerged by a flood each year. Additionally, the world's water cycle will be amplified because of climate change, which will increase the risk of flood calamity. Flood risks have already increased globally during the past 30 years. Bangladesh is also dealing with this accumulating tendency of the floods due to the changing nature of the climate. Nearly 60% of Bangladesh's land area is less than 6 meters above mean sea level. Researchers predicted that climate change would alter the nature of flood disasters,

exaggerating not just their intensity but also their duration and scope around the globe, particularly in Bangladesh. However, because of climate change, Bangladesh now frequently experiences extremely high flood levels. Floods in 1988 and 1998, for example, caused devastation and inundated 61 districts, or roughly 68 percent of the region. Additionally, the catastrophic flood of 1988 persisted for nearly 90 days. If emissions continue at their current rate, one researcher estimates that Bangladesh would be 0.5–2℃ warmer by 2030. Additionally, the climate model indicates that by 2030, the mean monsoon rainfall will likely increase by 10–15% due to climate change. Therefore, changes in many forms of nature and intense floods will result in significant losses to homestead settlements, agricultural, public infrastructure, as well as human livelihood and life.

5.2 Life after the flood for Char Village residents

Char land is a type of terrain that forms in two to three years and is made up of a continuous process of riverbank erosion and sediment deposition in major rivers and coastal zones. These islands (chars) of the world are home to around 10% of the world's population. Additionally, it is believed that 4–5 percent of Bangladesh's population lives in the char's land, which has an area of nearly 7200 km2. In this nation, there are 226 tiny and 56 large chars. The inhabitants of these areas are the most at risk because of the variety of their environments, making Bangladesh's char land prone to multiple disasters. Due to yearly floods, erosion, and efforts to combat poverty, around 12 million char dwellers in Bangladesh are severely impacted. The majority of academics claim that disasters have a negative impact on the residents of char land since the flood disaster brought on by climate change did not affect everyone in society equally. In contrast, the char land is sparsely populated and fragile, and roughly 80% of its residents are extremely poor and without access to their own property.

It has already been proved that the bad network suffers extra by the disaster. Accordingly, it's been launched that the inclined char land negative people are expected to be hit most stringent through flood catastrophe; individuals belonging to this category do not have ok defensive measures and also no functionality and potential to cope with the losses from the flood disaster.

The residents of the majority of Bangladeshi villages have very limited economic resources and are unable to obtain even the most basic services. Farmers and fishermen make up more than 70% of the population of Char Land. However, several poor indications of these households' income exist, such sharecropping, agricultural day labor, livestock raising, etc. However, the flood and riverbank erosion is still destroying their houses, farms, and harvests. Additionally, the food insecurity is making the vulnerable char dwellers even more vulnerable.Due to the periodic flooding, the residents of Char face a serious issue with the provision of clean drinking water.

However, the current study's main objective was to identify what caused the flood tragedy in Fulchari Upazila, a sub-division of Bangladesh's Gaibandha district. Additionally, the study looks at how the flood disaster affected Char Land households' livelihoods and coping mechanisms.

5.3 Flood influence on the research area's "flow"

Flood has a terrible effect on the study area, and it has already been shown that it has a wide variety of conflicting effects on people's livelihoods. Due to the frequent flooding in the study area, especially during the monsoon season, it is a prevalent trait. Over the past few eras, this area has been more and more inundated and subject to flooding. The current study has sought to determine the direct and indirect effects of flood in the study area by creating a flood disaster flow, which is shown in Fig. 3, before looking at how flood impacts livelihood. The 2017 flood in Fulchari Upazila brought about similar effects to those of the earlier flooding in the study region, which happened in 1988, 1998, and 2007. Even though flooding generally has some good effects, the most vulnerable populations—those who have already had prior flood disasters—are disproportionately impacted. According to the report, the majority of the farmers in the burned region were severely impacted by the 2017 flood, and their cropland was nearly completely wiped away. In addition, the majority of the houses were submerged, resulting in massive losses of household liquid assets, animals, poultry, etc. Farmers had no alternative work during the 2017 flood, and they were unable to provide for their families' basic requirements because the water stagnated for two or three months in the char area. The farmers were unable to facilitate crop production as a result throughout this time. Additionally, persons who worked in

various occupations, such as farm day laborers, small company owners, general laborers, and service workers, also had trouble managing their businesses. They have suffered from physical and mental health issues while losing a sizable sum of money. On the other hand, because of the flooded institutions and roads, schoolchildren were unable to get to class.

Most of the kids left school during this time as a result of financial difficulties and protracted stagnation. The char dwellers suffer more to get available water and sanitation amenities during the flood because these are their top concerns. People consequently experience a wide range of health problems, including diarrhea, fever, colds, etc. Beyond these challenges, one of the surprising revelations is that during the flood, children, pregnant women, the elderly, and those with disabilities suffer enormous difficulties. According to the survey, there were deaths related to the 2017 flood, with children and the elderly constituting the majority. When performing the focus group session, the majority of respondents claimed that the flood season lasts at least 3–4 months. Since there is a lack of money, the impoverished community is forced to live in worse conditions because of lost income and property damage.

As a result, they are constantly looking for money to meet their family's needs. There are occasionally those who contracted illnesses both during and after the flood. We regret to report that the afflicted people did not receive adequate rehabilitation from the authorities; as a result, they occasionally have to sell their breeding cattle and jewelry. To get out of this dilemma, they had to rely on a local moneylender, but because of the exorbitant interest rates, it was impossible for the affected people to repay the loans. As a result, it takes the affected individuals around a year to repay the money. Then again, they take to prepare, for the coming flood. Therefore, it has been documented that this flood impact flow is dynamic and makes the char land people fragile.

5.4 Flood's effects on livelihood and people's coping mechanisms

As of right now been there is evidence that Bangladesh is the most flood-prone country in the world, and millions of people, as well as hundreds of individuals, are affected by this are nearly every year, there is displacement. A repeated flood calamity, according to some academics, is mostly caused by the area's distinctive

geography. Bangladesh is one of those nations where most people are at risk of flooding. The majority of Bangladesh's Char region residents are most at risk from flooding disasters, and they have a life in poverty and a lifelong commitment to fighting floods. The locals appeared to blame floods for their poverty, and the neighborhood assumed that this impoverished individual would always be affected by floods. They also suffered financial and asset losses because of the frequent flooding, and their ability to deal with the flooding was constrained. Numerous types of studies have already revealed the considerable influence of floods on people's livelihoods. Fig. 15 shows the impact of a flood as well scenario for the research domain. The goal of this study is to examine how the floods have affected people's livelihoods, with a particular emphasis on employment and income.

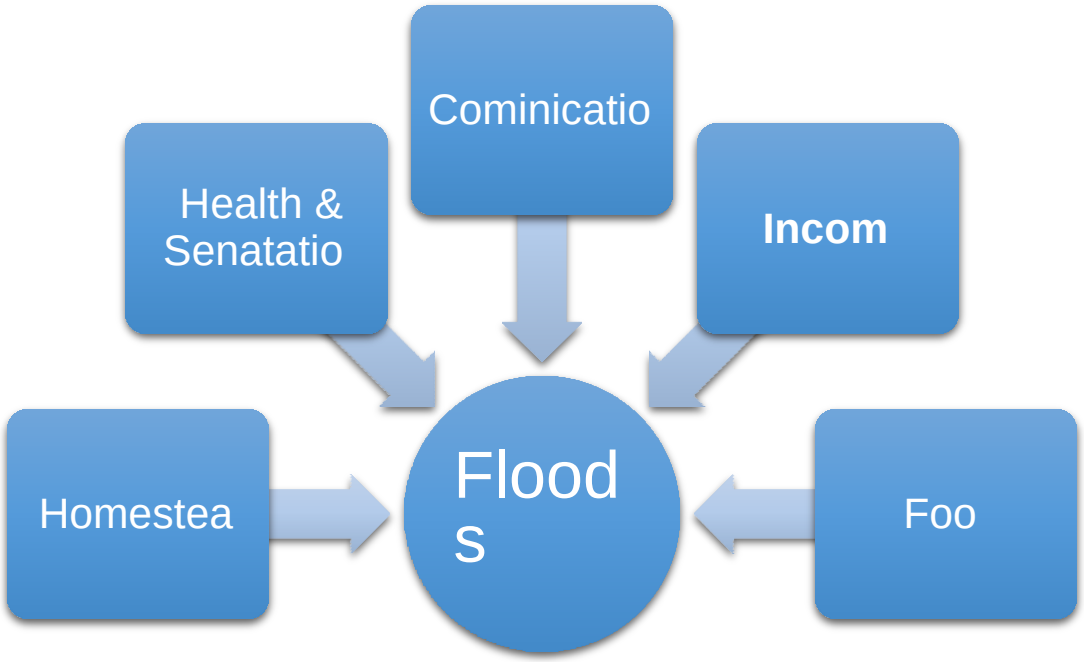

Figure 15Flood damages char land households.

5.4.1 Impact on occupation and income

Flood disasters are a constant and terrifying menace, especially to Bangladesh's char village poor communities. One of the most obvious signs that someone is poor is their occupation and income. The ability of the impoverished to deal with the loss of income brought on by the floods is insufficient. The extent, frequency, and duration of disasters substantially influence the char land population's occupation. One of the

Gaibandha District's most susceptible areas is the study area. People cannot live peacefully here due to a recurring flood disaster.

The intensity of flood impact depends on the kind of occupation. In this area, most of the people directly or indirectly rely on agriculture. According to the field survey, 64.6% people of the study area are involved in agriculture, 13.7% are engaged as day labor, on the other hand, 9.7% people engaged in fishing activities and 8.8% respondents are involved in business-related purposes. Only 3.2% of respondents are involved in a service. Almost 80% of the households of this union are living under extreme poor. Most of the family belong nuclear family, and the average size of the family is 4.87 people. Besides, the literacy rate is very low (about 20%), which is the lowest within this district. As already indicated, homes are becoming more and more susceptible as a result of poverty, large families, and inadequate education. The research area's primary source of economic activity is agriculture. Crop damage, revenue loss, reduced work hours, and other effects are typical flooding phenomena in the studied area. The Fulchari Union Parishad reports that during the 2017 storm, crops were ruined by flooding to the tune of approximately 100%.Moreover, almost the identical stages of loss occurred with inside the different Upazila of Gaibandha district.

Due to siltation after flooding with inside the observe area, the soil of the char land is growing extra barren, and day with the aid of using day, the manufacturing is turning into decrease than the land, which become now no longer tormented by the flood. In addition, riverbank erosion is one of the major intimidation of char land human beings, each year; human beings are dropping agricultural land hugely due to this flood of this area, and the char dwellers had been pressured to transform their regular profession for his or her livelihood. 51.4% of human beings had turn out to be jobless, and 24.6% of human beings had modified their occupations because of the flood in 2017. Since the majority (64.6%) of human beings have been engaged with agriculture, they rely upon this profoundly. They have been the maximum affected human beings due to the fact they lose their profits and profession. There have been 39.7% of agricultural-associated profession individuals who turn out to be jobless because of the flood in 2017.

During the flood, they modified their profession and began out as rickshaw pullers, boatmen, fishermen, and day laborers. 5.1percentof day exertions had dwindled their

profession because of flood in 2017. Respectively, (4.8) percent and (1.5) percent of modest enterprise with carrier owner human beings reduced their profession because of interruption of the verbal exchange device and advertising chances.

A flood is any such type of herbal catastrophe that now no longer most effective pressure human beings to modify their profession however additionally undesirably affected human being's profits. From the sphere survey, the observe found out that earlier than the flood, the human being's common profits become round 3650 BDT according to month, and ninety two human beings earned an profits become round 2k–4k BDT according to month. On the alternative give, the family.

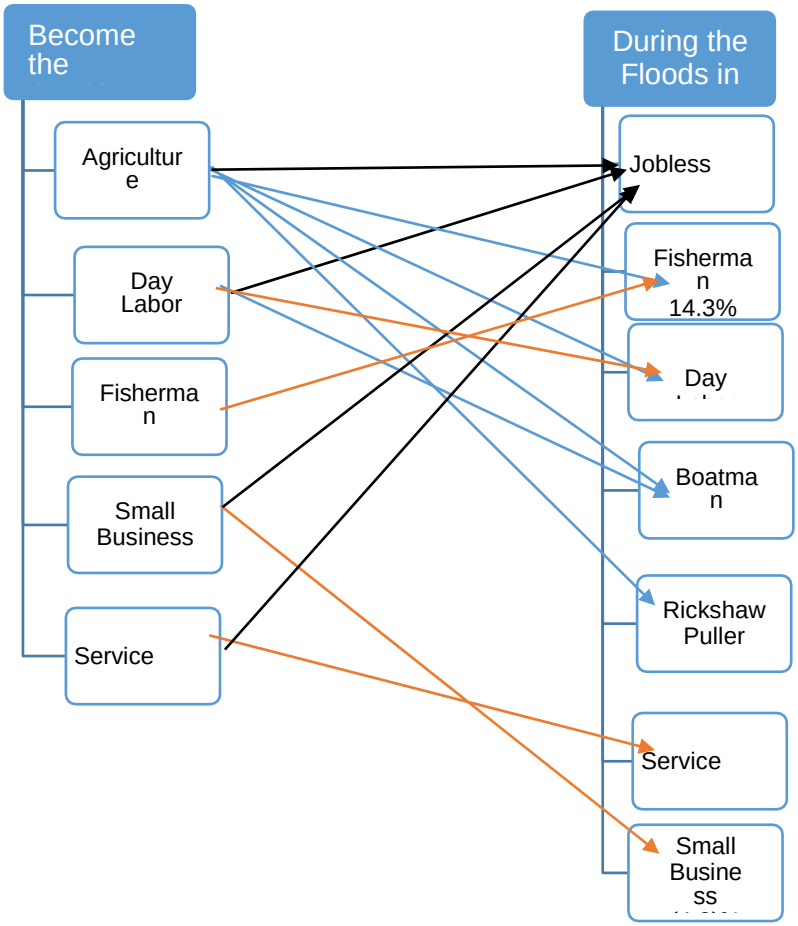

Figure 16 changing of livelihood owing to flood in 2017.

5.4.2 A way out of the economic crisis

The often exaggerated humans owed to flood with inside the have a look at vicinity, regularly take awesome tasks together with loan, save, trade of conservation outline, and sold and mortgaging of important possessions to comply in reply to the refuse the earnings. Owing to economic adversity, the humans of this vicinity with inside the usual durations hypocrisy preserve coins intended for stopping the future flood since of the reality they will be dwelling beneath poverty.

As the humans of this vicinity at some stage in the flood, they lose their career further to earnings-generating activities. The majority household seek to deal by means of a flood thru manner of manner of lowering their consumption of food and every day prime desires. On their own profits they not enough to contract with the floods. Therefore, cash plays the majority important role in mainly dosasters. Char dwellers are humans, those who likes in Bangladesh undergo greaterin this situation. The humans of the have a look at vicinity recommended at some stage in region surveys, or about 75 (per cent) of households have reduced food intake. exceedingly at some stage in a flood disaster in 2017. Along with this, it became moreover observed that the impacted Char Land residents undergo a cumulative amount of food troubles because of reduced income introduced on thru manner of manner of the dearth of valued property that make large health and vitamins troubles. For this resonance, people in this neighborhood include in use on more than a few economic tasks to deal with the condition caused by 2017 floods.

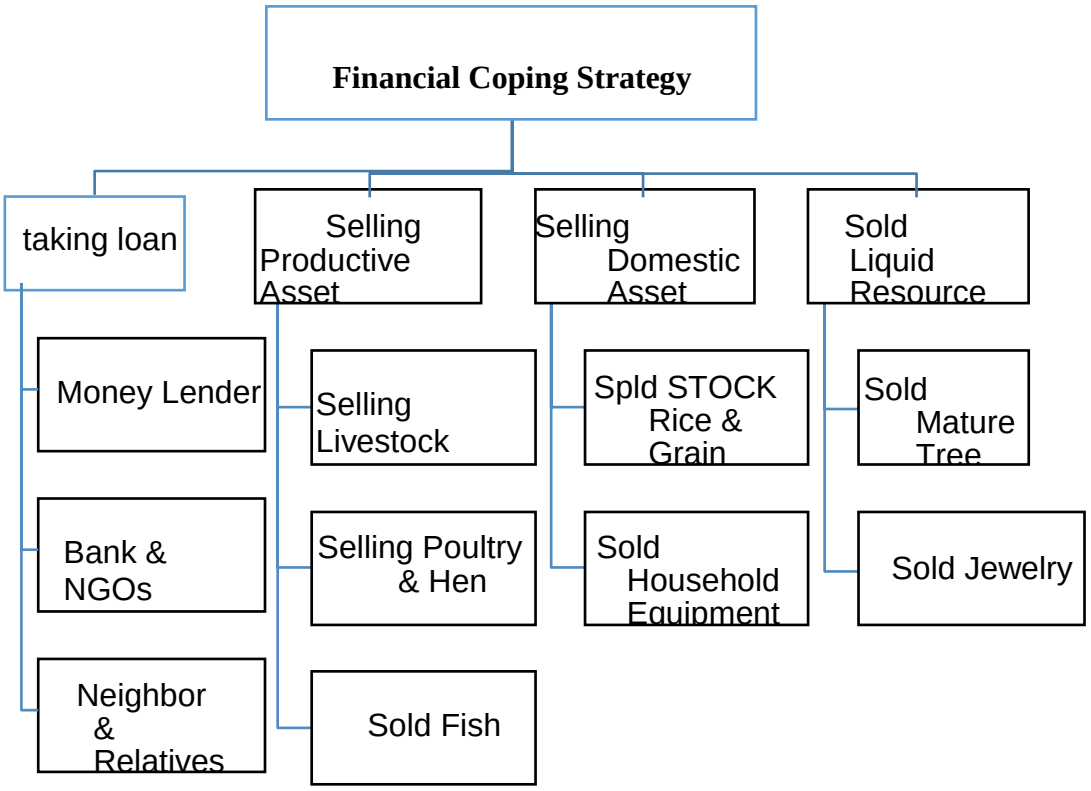

Figure 17 Financial coping strategy followed by people in char lands

CONCLUTION

For subtropical reasons, warm weather in the energy area of Bangladesh, will now no longer gain from growing temperatures because of weather alternate. Rather, climate alternates will have some of the worst influences on energy generation, transmission, and distribution in Bangladesh. Intake of energy, specifically in the course of the monsoon warm summer time of year, discounts into performance of energy plant life, greater sufferers in transmission and distribution, greater harm to energy infrastructure because there are tropical storm floods possibly to appear in Bangladesh. The influences can be an awful lot more intense and diverse, as we nonetheless do now since there is information speed evaluation of weather conditions sympathy of energy generation, distribution, intake within Bangladesh. Most studies are wanted to become aware of the weather-touchy sector of the energy machine in Bangladesh. Research ought to also be conducted to become aware of the adaptive degree just before lessen the terrible influences. Although present exist some large issues in the energy area of Bangladesh, which need immediate attention, alternate troubles ought to additionally exist in use keen on contemplation, specifically in making plans for latest energy transportation improvement in addition to reform the time communications. In good time interest be able to appreciably lessen the terrible influences of weather and energy.

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