



Environment

Living with wrath of nature

by DR. A. M. Choudhury

BANGLADESH CURRENTLY RANKS as one of the world's foremost disaster-prone countries. The situation is aggravated all the more by its being the most densely populated country in the world. Environmental disasters like tropical cyclones, storm surges, floods, norwesters, tornadoes and droughts ravage the country almost every year. During the last forty years, Bangladesh was devastated, on an average, by one severe cyclone every year. One of the severe ones in recent times was that of April 29, 1991. Material damage was to the tune of about 2.4 billion US dollars and human casualty of about 140,000 lives. A similar catastrophe in 1970 snatched away about half a million lives. The flood in 1988 caused economic loss to the extent of about one billion dollars. The loss due to the flood exceeded that due to any previous floods. And flooding is a perennial problem for the country. Every year, norwesters and tornadoes cause loss of lives and immense damage to property. Also, drought occurs quite frequently to cause extensive damage to crops. Besides, being in the seismic zone, the country is susceptible to earthquakes.

Natural disasters pose a great threat to our national economy. Disasters cause immense loss of crops which could affect food security of the country unless adequate measures are taken to replenish the loss. Thus proper monitoring of disasters and adequate measures to deal with them are of utmost importance for national economy.

In this paper causes of various natural disasters and measures to deal with them will be discussed. Finally disaster preparedness measures in Bangladesh will be highlighted.

Tropical cyclones

The tropics can be regarded as the region of the earth lying between 30°N latitude and 30°S latitude. All the tropical seas of the earth with the exception of the south Atlantic and east south Pacific give birth to deadly atmospheric phenomena known as tropical cyclones. On the average, 80 tropical cyclones are formed every year all over the globe. Bangladesh is a part of humid tropics, with the Himalayas in the north and the funnel shaped coast touching the Bay of Bengal in the south. This peculiar geography of Bangladesh causes not only the life giving monsoons but also catastrophic ravages of cyclones, norwesters, tornadoes and floods. The Bay of Bengal is an ideal breeding ground for tropical cyclones.

Though solar energy ultimately controls the terrestrial weather, the following environmental conditions have been found to be prerequisites for the development of cyclones:

1. absence of strong vertical wind shear of the horizontal wind near the cyclone centre and presence of strong vertical

shear of opposite sign on either side of this system. The difference between the wind vectors between two vertical levels is known as the vertical wind shear;

2. presence of low pressure region with cyclonic vorticity; and

3. warm ocean temperatures. A tropical storm does not form if the sea temperature is less than 27°C. Such a high surface temperature is necessary to produce a steep lapse rate for maintaining the vertical circulation in a cyclone. This condition is met throughout the year in regions of the Bay of Bengal where cyclones are formed. A cyclone can extend up to a height of 15 kilometres. All the low-pressure systems may not develop into cyclones. Some just die out whereas others intensify into cyclones.

Determination of the cyclone track: Precise forces responsible for the motion of tropical cyclones is not understood clearly and hence determination of the path of the cyclone in advance is one of the most difficult tasks in meteorology.

Recently various statistical and numerical dynamical methods have also been introduced for the forecast of cyclone paths.

Steering Principle was first applied by H. Mohn in 1870. Until 1950 forecasts of tropical cyclones were made by subjective methods based on synoptic maps and climatological behaviour. Following are some of the objective methods applied in modern times for cyclone forecasting. **Statistical methods** relate predicted movement to

shown promising results for the forecast of cyclone movement twenty-four hours ahead of landfall. In Bangladesh, Meteorology Department is responsible for the issue of cyclone warning.

Protection against cyclones:

What can be done to protect ourselves from the cyclones? A cyclone is a natural phenomenon like an earthquake or a volcanic eruption. We have to learn to live with it. We have to strengthen the cyclone warning system and adopt protective and relief measures to minimise their onslaught. SPARRSO monitors the tropical cyclones on an hourly basis with the help of the remote sensing equipment installed and passes the information to all concerned agencies including Bangladesh Meteorological Department, Bangladesh Air Force, Prime Minister's Office, Ministry of Disaster and Relief, and so on. With the help of the facilities at SPARRSO, we can determine the location, the intensity and the future course of motions of the cyclone. As a matter of fact no cyclone in the Bay of Bengal can escape the notice of the remote sensing equipment of SPARRSO. An integrated computerised method of cyclone warning system needs to be developed.

Strongly built houses have to be constructed high above the sea level to serve as shelter places. People from the low lying areas in the coastal region can be evacuated into these shelters in the event of a cyclonic hit. Coastal embankments have to be made to protect life and property from the onslaught of storm surges.

western part of the country to about 200 inches in the north-eastern part. At Cherapunjee in Assam very near to the Sylhet border the average annual rainfall is about 500 inches, the highest in the world. But the average rainfall in Bangladesh generates annually only 100 million acre feet of water whereas 1.1 billion acre feet of water comes from outside the country. Thus about 90 per cent of the water carried by our river system, the Brahmaputra, the Ganges, the Meghna and other smaller rivers is brought from outside the country. These rivers carry water from an area of about 600,000 square-miles of which only 7.5 per cent lies in Bangladesh. Water enters in Bangladesh through three major channels but the discharge takes place through one major channel. The river system has evolved to carry the normal flow of water generated in the catchment area. Whenever the inflow of water is greater than the carrying capacity of the rivers (and this happens very often) flood results. The magnitude of the flood depends on the magnitude of excess water that is generated.

Besides the primary cause, namely rainfall in the catchment area, there are other factors which may aggravate the floods. They are:

- snow melting in the Himalayas.
- hydrographic changes in the Brahmaputra basin.
- 2.4 billion tonnes of sediments carried by the river system of Bangladesh every year reduces the water carrying capacity of the rivers, which worsens

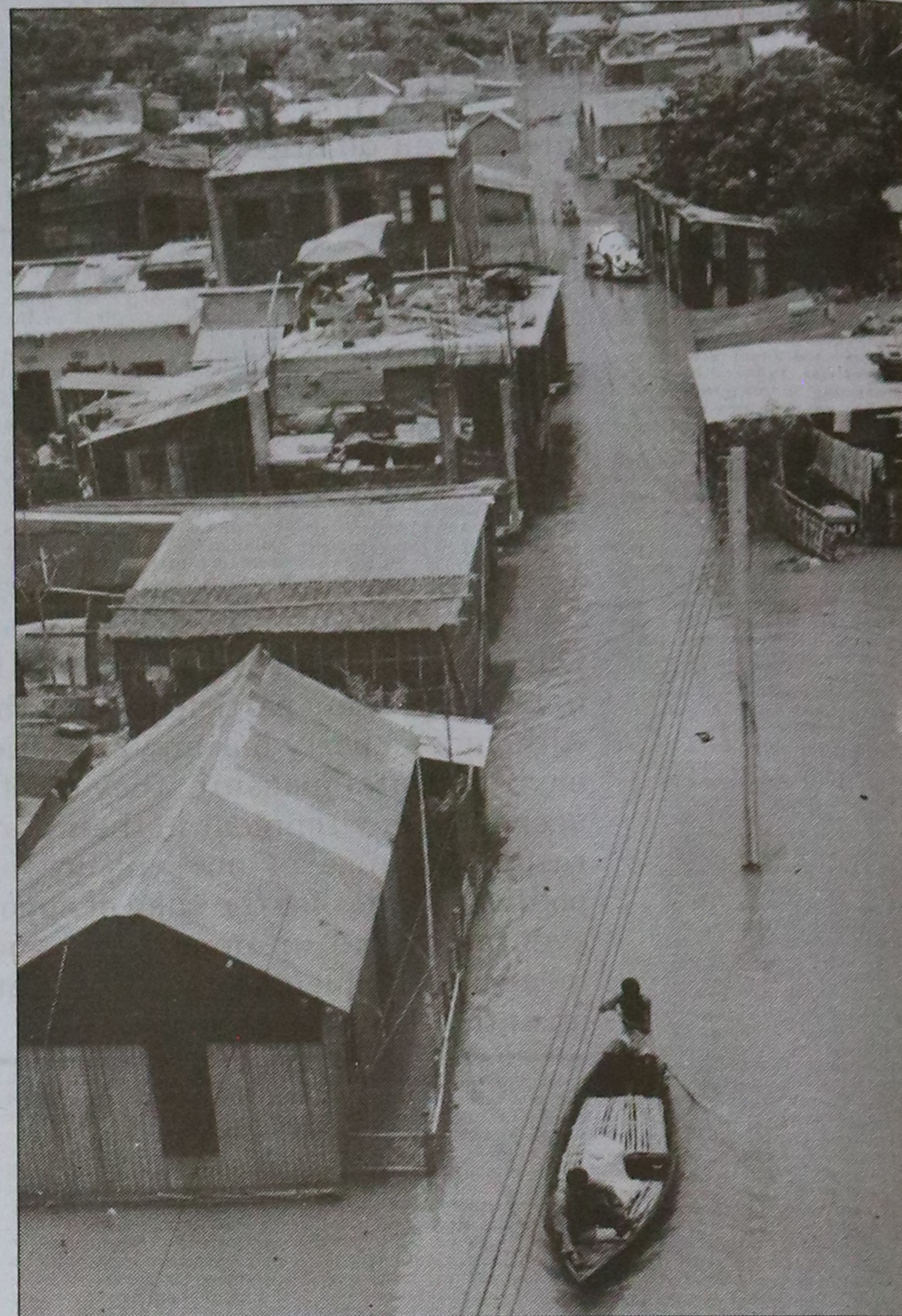
It has been found that Southern Oscillation Index (SOI), which is a measure of the difference between pressure anomaly between Tahiti Island in the Eastern Pacific and Darwin city in Australia and is a measure of the El Nino phenomenon, can be used to make advance forecast of floods and droughts. SPARRSO has been using this index in making advance prediction of floods and droughts in Bangladesh during the last few years.

Norwesters and tornadoes:

Though cyclones are the most devastating storms affecting Bangladesh, there are other kinds of storms which affect Bangladesh. Of these, mention may be made of Norwesters and Tornadoes which cause a lot of destruction of lives and property.

Norwesters come mainly from the north-westerly direction (and hence the name) and are land-based. They are a very common phenomenon in Bangladesh during late Chaitra and Baishakh months and are known in Bengali as *Kalbatshakhi*.

Another kind of storm very similar to a tropical cyclone but is of much smaller dimensions and very destructive is known as a Tornado. A tornado is also a low-pressure region where strong winds blow around a centre in an anticlockwise direction in the Northern Hemisphere and clockwise direction in the Southern Hemisphere. But unlike a cyclone a tornado develops on land. A cyclone lasts for days whereas a tornado lasts for a very short du-



Denuding deluge: A yearly phenomenon

There is report that sea level is rising in the Bay of Bengal at three times faster than estimated earlier. There is report that in some US coast the rate is even ten times faster. These are very alarming. The Antarctic ice which did not melt earlier may start melting suddenly and set a chain reaction which will be disastrous and there is already evidence that this has started happening in some places in the Antarctic and the warming has been as much as 10 degree Celsius in those places. Bangladesh should start giving more importance to this problem than given hitherto.

one or more parameters in an empirical way. **Dynamical techniques**, on the other hand, make use of some forms of the equation of motion to predict numerically the motion of cyclone from an observed initial state of the atmosphere. **Hybrid model** in which output parameters from a dynamical model are used in a statistical model.

SPARRSO has installed a model named **TYAN** for predicting the track of a cyclone based on climatology of Bay of Bengal Cyclones for the last one hundred years. The model has

Plantation of trees along the coastal area can also diminish the fury of the storm surges.

Floods

The primary cause of flood is rainfall in the catchment areas of the rivers in Bangladesh. Situated in the monsoon belt with the Himalayas in the north, Bangladesh falls in the region of very heavy rainfall. About 80 per cent of the rainfall occurs during the five-month period from June to October. The annual rainfall varies from about 60 inches in the

- the flood.
- deforestation in the catchment area tends to aggravate the flood.
- construction of unplanned roads, railways, barrages, embankments etc. also create obstacles to the flow of water and aggravate the flood.

Flood forecasting and warning: The government has taken up both structural and non-structural measures for flood mitigation. In this respect regional and international co-operation has been sought. Struc-

ration. A tornado is formed because of the interaction of two air masses, one moist and warm air and the other dry and cold air resulting in extreme form of instability. Tornadoes often form a series and travel in almost parallel paths. The whole tornado moves at a speed of 25-30 miles an hour, whereas the maximum wind in a tornado could be 300 miles/hr.

Since the horizontal diameter of a tornado is so small and it forms so suddenly that it is difficult to recognise a tornado

nomenon or a purely local phenomenon. Sometimes drought occurs in large part of the globe and sometimes in many parts of the earth simultaneously. Excess rainfall may occur in some parts of the earth and drought may occur in another part. This may be due to the atmospheric teleconnections. Drought is again a recurrent phenomenon. There are records of severe droughts in history. In Bangladesh, drought of 1979 is the severest in living memory. In the seventeenth century, repeated drought and consequent

places from year to year. Especially during the pre-monsoon period, decrease of rainfall may seriously affect various crops. For example in 1979 rainfall during January to May was about one-third of the normal though for the whole year, rainfall was only about 10 per cent short of the normal. As people have adapted their crop to average climatic conditions, substantial decrease of rainfall may seriously affect the crops and other activities. Though a severe drought like the one that occurred in 1979 is not very

It has been found that Bangladesh temperature has risen by 0.2-0.3 degree Celsius during the last 40 years and the global temperature has risen by 0.7 degree during the past hundred years. The International Panel of Climate Change (IPCC) predicted a rise of sea level of 20 cm by the year 2030. However, recent observation of the sea shows that both in the Bay of Bengal and elsewhere in the globe that sea level is rising by an amount faster than predicted by IPCC. If the sea level rises by one metre, Bangladesh might lose as much as 17 per cent of its land area to the sea and that is the most dreadful thing that could happen. Our study has shown that rainfall in Bangladesh is increasing at a rate of 8mm a year during the last 30 years. That means that severe flooding can occur more frequently than before. Recent happenings have shown that this is indeed the case. As a matter of fact extreme weather events could occur more frequently in Bangladesh as a result of global warming. Thus we see that a catastrophic cyclone that could occur after hundred years or a catastrophic flood that could return after 50 years are occurring every 10 years.

Earthquakes There is ample evidence from various geological studies that the earth's crust is in motion both horizontally and vertically. The modern theory of this aspect of the earth's surface is called plate tectonics.

Earthquakes occur in regions of the earth's crust, which are undergoing deformation. The region is deformed, energy is stored in the rock in the form of elastic strain. This continues until at some point the accumulated strain exceeds the strength of the rock. Then fracture or faulting occurs. Of the theories of earthquakes, perhaps the elastic rebound theory is the most successful one. This states that opposite sides of the fault rebound to a position of equilibrium and the energy is released in the form of heat, in the crushing of rock and in the vibration of elastic waves. The waves or vibrations, which are generated at the moment of fracture, produce the shaking which is experienced in earthquake.

The major earthquakes that have affected Bangladesh since the middle of the last century are the Cachar Earthquake of January 10, 1869; the Bengal Earthquake of July 14, 1885;

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tural measures of flood control are storage reservoirs, embankments or levees, channel improvements and bypasses or floodways etc. Some of these measures have already been undertaken in Bangladesh. For immediate benefit to public, non-structural measures are accomplished at a much smaller cost and time. For flood forecasting a network of hydrological stations connected with telemetering gauges or by telecommunication or teleprinter links with the forecasting centre has been established by the Water Development Board. Available hydrological data consist of discharge, water level and rainfall records. Historical records of data have been analysed to prepare forecasting procedure. For major rivers, correlation of water levels or discharges between upstream and downstream stations are utilised in preparing forecasting procedure. For rivers with smaller catchments rainfall-runoff relation, flood routing, co-axial graphical correlation methods are used. Extensive modelling of flood in our river system is necessary for effective forecasting. The Flood Forecasting Centre of Bangladesh Water Development Board has considerably improved its facility for the issuance of flood forecasting. It uses the remote sensing data along with ground data and has introduced numerical models in flood forecasting. Remote sensing data have been used by SPARRSO to delineate the flood-affected areas.

either in the surface weather map or in the satellite picture and hence forecasting of a tornado well ahead of occurrence becomes very difficult. We have observed that certain cloud features as obtained from satellite pictures and some other meteorological parameters like the Showalter or Total Stability Index may indicate the occurrence of a tornado but again it is very difficult to pinpoint the place, time and severity of a tornado occurrence. Surface meteorological observations are taken usually at certain specified towns whereas a tornado can occur anywhere. A network of radars and frequent satellite observations may be very helpful in the early detection of tornadoes. Extensive research is needed on tornadoes to make any forecast possible.

Drought

Though Bangladesh is a land of abundant rainfall, drought is very familiar to us. It is difficult to define the term drought precisely and hence any definition is rather subjective. It simply means lack of water and may be defined as lack of sufficient water to meet requirements. Thus drought can be of various kinds according to various requirements.

Drought history: The scourge of drought may be regarded as an integral part of the world climate. Wherever there is rainfall, there is drought also. Just like there is excess of rain causing floods, there is inadequate rain causing drought. Drought is by no means an isolated phe-

crop failures occurred in Scotland which in the opinion of some forced the union of Scotland with England. In the 19th century repeated drought occurred in many parts of USA and Canada. In the sixties, drought occurred in various parts of India and in the late sixties and early seventies, there was drought in the Sahel region of Africa.

Bangladesh climate: Bangladesh is situated in the active monsoon regions of the world with an average rainfall of about 90 inches per year. But the rainfall distribution is not uniform throughout the year. Most of the rainfall i.e. about 80 per cent occurs during the monsoon period i.e. June to October. About five per cent rainfall occurs during November to February and about 15 per cent rainfall occurs during March to May. This shows that the months November to February are very dry and may be regarded as permanent drought months. But this does not mean that Bangladesh has an arid climate because aridity in these four months is amply compensated by abundant rainfall during the rest of the year. However, the amount of rainfall varies considerably from year to year and from region to region. In some areas in the north-western part of the country the amount of annual average rainfall may be as low as 50 inches whereas in the north-eastern part, average annual rainfall may be as high as 200 inches. There is a lot of variation of rainfall at different

frequent a study has shown that milder droughts occur in Bangladesh after an interval of 5-10 years. The years 1950, 1951, 1957, 1958, 1966, 1967, 1972 and 1979 were years of less rainfall in Bangladesh. Some drought occurred during the post-monsoon season in 1997. Drought condition prevails in some part of the country almost every year for some of the time. Some of the droughts in Bangladesh seem to be related to El-Nino phenomenon and based on this index, droughts have been successfully predicted in Bangladesh. Droughts cause severe loss of crops in Bangladesh and its advance prediction would be very helpful in taking protective measures like extra irrigation etc.

The Greenhouse effect

Man through his activities has started acting as an agent of climatic change. He is releasing enormous quantities of carbon dioxide (CO₂) by burning both fossil fuels and non-fossil fuels (including burning wood). Part of the CO₂ is absorbed in the ocean and part is released in the air. It is estimated that since 1860, the CO₂ content in the atmosphere has risen by about 25 per cent and will continue to rise further in future and may double by the middle of the next century. CO₂ and other greenhouse gases can increase the temperature of the lower atmosphere by re-emitting back part of the radiation emitted by the earth. A global rise of 2-3 degree Celsius has been predicted by the middle of the next century.



Catastrophic cyclone: Bracing the brunt in the cycle of seasons