

Reducing the Impact of Environmental Emergencies Through Early Warning and Preparedness – The Case of El Niño-Southern Oscillation (ENSO)

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Bangladesh Country Case Study: Impacts and Responses to the 1997-98 El Niño Event

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Executive Summary

Bangladesh is one of the worst victim regions of El Niño and La Niña impacts. The existing geophysical and socio-economic settings of the country continue to increase both the vulnerability to and severity of those natural events. The country's agriculturally based production system depends mainly on climatic phenomena.

Bangladesh is perhaps the unique country in the world where casualties due to a cyclone could rise into the hundreds of thousands. Floods can devastate more than half the country, causing damage up to billions of US dollars. Nor'westers and tornadoes often demolish the economy and settlements in many parts of the country. Droughts destroy the country's food chain, food stock and agro-based production systems. A large number of households become homeless due to riverbank erosion. Earthquakes cause severe damage to human settlements as well. Scientists have found reliable correlations between El Niño and La Niña events and variability of climatic phenomena in the country which, as a result, contribute to those natural disasters mentioned above.

To reduce the negative impacts of climate-related disasters and to minimize the suffering of the people, the government of Bangladesh has established a set of mechanisms including institutional arrangements for disaster preparedness and relief & rehabilitation of the area affected or likely to be affected. For making the established mechanisms appropriately and effectively operative, an exhaustive guidebook entitled "*Standing Orders on Disaster*" has been designed outlining the activities of each related ministry, division, and major agencies and departments. The Ministry of Relief and Rehabilitation, Bangladesh Meteorological Department (BMD), the Disaster Management Bureau (DMB), the Space Research and Remote Sensing Organization (SPARRSO) and various other organizations, both at national and local levels, come together to cope with the problems of natural and climate related disasters. Still, then, there is a lack of scientific efforts and of modern technological know-how regarding proper

management of climate-related disasters including predictions, preparedness and mitigation measures.

Scientific research in Bangladesh relating to El Niño has not reached a satisfactory level. Research on the issue is mostly conducted as a result of individual initiatives. The researchers use data generated through both traditional and sophisticated methods by various national and international meteorological agencies. There is evidence of historical interests of El Niño and La Niña in the country before the onset of the 1997-98 event. The real credit of meteorological and agro-meteorological predictions during ancient times goes to a mythical woman named Khana. Her verses are said to be the envy of any scientist of any time. There were several other mythical persons who devoted themselves to the prediction of meteorological phenomena during ancient times. Scientifically, it was Sir Gilbert Walker who, during the British Rule in India, identified effects of ENSO events in this sub-continent.

Bangladesh is mainly dependent on international meteorological agencies with respect to the flow of meteorological information, including predictions and transmission. SPARRSO was the first one in Bangladesh to receive the 1997-98 El Niño information. Although SPARRSO was a bit late in transmitting this information, it received more or less wide media coverage in the country.

It has been found in this study that ENSO's teleconnections influence the climate of Bangladesh, and the Indian region also. According to the information and its analysis in the context of Bangladesh, El Niño is generally associated with drought, whereas La Niña results in increased rainfall and flooding.

The scientific views about the existence and strength of El Niño's teleconnections with climate anomalies in Bangladesh have been explained by Walker's observations during the 1920s. According to his observations, low atmospheric pressure prevails in the region from Australia to India when high atmospheric pressure prevails in the eastern tropical Pacific Ocean. The scientific reason is that wind flows from high-pressure region to low-pressure region. As a result, a huge volume of moisture comes from the Pacific Ocean to Bangladesh and India; due to the prevailing low atmospheric pressure in this area at that time, the moisture-laden air rises, causing heavy rainfall in the region of Bangladesh and India. This difference in wind flow is named the "Southern Oscillation." It is called the "Walker Circulation" also. When the sea surface temperature rises in the eastern Pacific Ocean (i.e., in the El Niño situation), then this wind flow weakens or reverses. Consequently, we see a deficit in rainfall and a possibility of drought in the region of Bangladesh. On the other hand, in the La Niña situation we face heavy rainfall, flooding, and cyclones.

The data and information presented in the Bangladesh study clearly support the view that there is a relationship between ENSO, drought, and flood. In the study of Bangladesh monsoon rainfall, there is generally a decrease in rainfall in El Niño years in each of the seasons: the pre-monsoon (March-May), monsoon (January-September), the post-monsoon (October-November) and the winter (December-February).

The time series data of yearly rainfall of four selected recording stations in Bangladesh for a period of 43 years (1950-92) show a negative and decreasing tendency in rainfall during El Niño events. In El Niño cases, the decreasing tendencies of rainfall were observed to be 70% at Jessore, 67% at Dhaka and Barisal, and 72% at Srimangal.

The El Niño phenomenon led to a severe drought in South Asia and there was severe shortage of rainfall in Bangladesh in 1997. Our analysis shows a positive correlation between the negative value of the Southern Oscillation Index (SOI) and drought in Bangladesh. On the basis of historical records, experts believe that the major famines of the region have been connected with El Niño's occurrence.

Some interesting features have come out about the teleconnection between the ENSO cycle and flooding in Bangladesh. The most catastrophic floods occurred in Bangladesh in the years of 1954, 1955, 1974, 1988 and 1998. The years 1954, 1955, 1988 and 1989 were with positive SOI (ENSO cold events, or La Niña), whereas 1974 and 1987 were El Niño years. The main El Niño occurred in the preceding year, but in these years negative anomalies were not that strong. In the major El Niño years, i.e., 1951, 1957, 1972, 1976, 1982 and 1986, Bangladesh did not experience any catastrophic flooding. Thus, one can come up with the hypothesis that during major El Niño years, at least during the first year of El Niño (the year of onset), Bangladesh can be spared from catastrophic floods. The years 1963, 1965, and 1969 were moderate El Niño years and in those years moderate floods were observed in Bangladesh. Therefore, the conclusion may be drawn that during La Niña and weak El Niño years, Bangladesh can be a victim of flooding. In the case of a high positive value of the SOI, Bangladesh may face severe floods.

Research also shows that Bangladesh has not been struck by any catastrophic cyclone during strong El Niño years. And it is also observed that when the SOI index is small (positive or negative) and when the 28.5°C isotherm stays left of 165°E longitude, the chance for Bangladesh to be hit by a cyclone is quite high.

The 1982-83 event is considered to be one of the strongest El Niño events of the twentieth century. A significant amount of excessive rainfall in the selected stations under study was observed in the preceding and following years of this event. On the other hand, a significant rainfall deficit was observed in both El Niño years, i.e., 1982 and 1983. This resulted in a drought in Bangladesh, which caused losses in agricultural productivity and production. As a result, the poor and marginal farmer classes were negatively affected. Moreover, it created subsequent negative impacts on several socio-economic areas such as poverty, migration, social unrest, food reserves, foreign currency reserves and overall economic development.

It is evident from our study that Bangladesh was affected in 1997-98 by El Niño and the subsequent La Niña. Due to the impact of the 1997-98 El Niño, Bangladesh experienced a 60% deficit in rainfall in June 1997. As a result, the southeast monsoon wind was delayed by one month and the country faced a short drought condition until June 1997. Moreover, unprecedented and unusual foggy weather during the winter and high temperatures during the southwest monsoon of 1998 were observed.

A deficit in rainfall was observed in all the selected stations under study, except one (Khulna). This deficit amounted to -5.4%, -20.4% and -6.7% in Cox's Bazar, Dhaka, and Sylhet, respectively. Due to the rainfall deficit and the subsequent short drought during the main growing season, Aman production decreased by 25-30% in 1997-98. This resulted in a food crisis and a high price for rice, a deficit in revenue collection, higher inflation, and pressure on the 1998-99 national budget for which the government had to curtail development expenditures.

The 1997-98 El Niño also created negative impacts on the country's poverty situation, rural-urban migration and environment. Subsequent La Niña impacts resulted in a severe and prolonged flood in Bangladesh in 1998, where about 51% of the total land area was inundated and approximately 31 million people (i.e., 26% of the total population) were affected. The total loss as a percentage of the GDP was 6.64%, which adversely influenced the economic growth rate of the country.

It was noted that there was only one statement issued by the Agricultural Information Services, with the title "Agricultural Weather Forecast: Actions Suggested for the Farmer." This was published in the *Daily Newspaper* on 15 September 1997. After the appearance of El Niño impacts, a detailed statement was prepared by the government on damages, losses, requirements of goods, and services for relief and rehabilitation. The statement was issued on the government's web site. A joint research project was undertaken by SPARRSO and the Bangladesh Agricultural Research Council (BARC) on the "Development of Models for

Predicting Long-Term Climate Variability and Consequent Crop Production as Affected by El Niño-La Niña Phenomena." In response to proper disaster management in Bangladesh various institutional arrangements and mechanisms are now effectively operating at both the national and local levels.

Bangladesh could not yet develop powerful institutions like those in Western Europe and North America to forecast a complex climate-related disaster like El Niño, but the institutions established at the national level such as the Space Research and Remote Sensing Organization (SPARRSO), the Bangladesh Meteorological Department (BMD) and the Bangladesh Water Development Board (BWDB) by the government of Bangladesh for monitoring and forecasting disasters as well as El Niño, are trying their best to monitor and forecast climate-related disasters. Forecasts made by them in the recent past on climate-related disasters and El Niño episodes were almost 100% correct.

Although the El Niño forecasting-by-analogy approach in Bangladesh by the concerned organizations does not exactly correspond to the findings, the relationship (similarity) of the two entities is positive indeed. Since the present technology in Bangladesh is not in a position to identify the uncertain impacts of an El Niño episode, the country has to rely on the latest ideas and technology from developed countries for responding to the negative impacts of El Niño and La Niña events in Bangladesh. Regular exchange of information with specialized organizations in the developed countries and proper understanding of mechanism of the ENSO phenomenon would enable the country to more precisely forecast, plan, and monitor well ahead of time in order to face natural disasters like cyclones, drought, and floods.

In order to strengthen the concerned organizations in monitoring and forecasting climate anomalies in the future, a further initiative would not only enable the scientists in Bangladesh to forecast and monitor this phenomenon more accurately but would also help reduce and mitigate the colossal impact of El Niño events through early warning and preparedness. This study suggests a number of policy recommendations which should be implemented in due course. For better understanding and the undertaking of appropriate mitigation measures against possible impacts of El Niño and La Niña events, more intensive studies need to be carried out *in the region*.

Top Ten Lessons

- Teleconnections in Bangladesh between drought and El Niño are strong. El Niño in Bangladesh is generally associated with droughts and La Niña results in increasing rains and floods.
- Information on the ENSO warm event/cold event cycle is useful for society to minimize damage from droughts and floods.
- Bangladesh is dependent on outside sources for El Niño and La Niña forecasts and monitoring. These sources are highly essential for early warning and preparedness.
- There had been little scientific research on ENSO in Bangladesh before the 1997-98 event.
- Bangladesh has to depend on getting the latest ideas and technology from developed countries; there is a need for mutual trust between Bangladesh and industrialized countries.
- El Niño's drought impacts on downstream (out-year) development expenditures persist well after the El Niño event has ended.
- Bangladesh is becoming more prone to calamities. That is why there must be a readiness on the part of the government to institutionalize effective prevention and mitigative measures.
- Bangladesh requires education and training for personnel dealing with the prediction and monitoring of the ENSO cycle.
- Research facilities must be enhanced in order to improve impacts studies. International assistance in this regard is very important.
- A regional disaster management action plan should be established within SAARC

(South Asian Association for Regional Cooperation) or some other regional framework.

Other Lessons

- Bangladesh institutions are now interested in the planning and early warning of the extremes of the ENSO cycle.
- Effective post-disaster reviews are required after each major disaster.
- The social and geophysical settings are important for Bangladesh [the country can suffer from drought and flood in same event (with El Niño or La Niña)].
- Undertake cost-benefit studies for El Niño response measures.
- Bangladesh takes into account folk wisdom in its consideration of climate extremes.
- More intensive public awareness and education programs on ENSO must be carried out in disaster-prone communities.
- Bangladesh needs to establish a permanent disaster management organization.
- Local responsibilities in dealing with ENSO's extremes need to be increased.
- The government of Bangladesh needs to support more national studies related to ENSO extremes.

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