



Climate Change and Integrated Community Adaptation of Coastal Livelihoods

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ABSTRACT

Climate changes are increasing vulnerability of natural resource dependent livelihood practices of large population in Bangladesh. Extreme events such as cyclones, tidal surges, flood, river erosion and salinity stress have been severely affecting agriculture, fishing or fish cultivation and livestock rearing. Communities remain extremely vulnerable to disasters that impeded the key livelihoods in the coastal areas than any other place. The traditional agriculture cropping is decreasing in coastal areas due to variation of fresh water and salinity level and increasing abrupt weather events, tidal inundation and water logging. Large coastal population lacks of climatic information, improved crop varieties and diversified livelihoods to continue adaptation practices. In particular the marginalized and landless coastal people who have limited access to natural, social and institutional services of local govt. institutions are losing adaptive capacity in the long-run. The paper presents livelihood adaptation practices of coastal communities in Bangladesh. Particular emphasis is given on an innovative livelihood model-Forest, Fish and Fruit (Triple F) which shows integrated community based livelihood practices for short-, mid- and long-term adaptation. Drawing the discussion the paper highlights for improving the livelihood practices in a way that incorporates climatic risks in collective resource management and income generation enhance adaptive capacity of coastal community.

Keywords: *Climate Change, Integrated Community, Adaptation, Coastal, Livelihoods, Bangladesh*

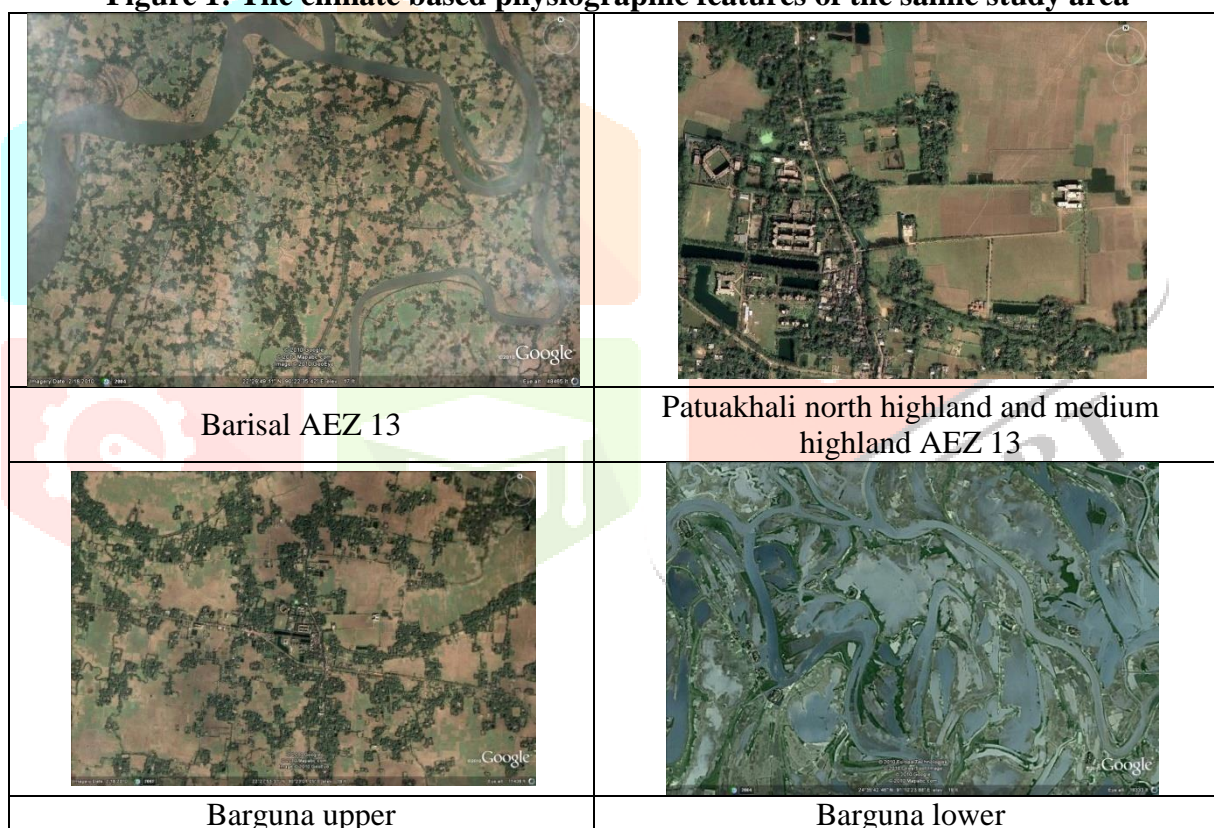
INTRODUCTION

Coastal communities are facing much more vulnerability across the globe (Shaw and Krishnamurthy 2012). Anthropogenic stress in terms of over exploitation of coral reef and fisheries and land based activities (i.e., agriculture intensification) already increased stress in natural system of the coasts. Climate change adds to lower recovery or resilience of the natural system for human well-being and livelihoods (Adger et al. 2005; Lebel 2012). Various nature and impacts of climate change shocks affect coastal livelihoods differently and govern vulnerability and adaptive capacity. Some of the disasters are fast in coastal areas in terms of its sudden affects to coastal life and livelihoods like tropical cyclone and storm surges, where others are slow in events like salinity or inundation increase, but these have long-term impacts on social and economic functions (Nicholls et al. 2007). The tropical cyclone of 2007 caused loss of valuable mangroves, social and physical resources and livelihood bases that post-disaster recovery has not yet been possible in Bangladesh (Mallick et al. 2011). With changing frequency of cyclonic wind and storm surges and inundation coastal agriculture and domestic fisheries and open fishing have been highly affected which are significant livelihoods sources to majority coastal people. Salinity level is slowly increasing over the time and causing serious threats to traditional agriculture farming and mangrove ecosystems (Moniruzzaman 2012).

High climate sensitive livelihood characteristics and different socio-economic level and access of community and households to assets determine adaptive capacity. Large coastal population is less capable to share the majority of the natural resources effectively in livelihood practices due to lack of effective coastal zone policy and regulation, collaborative resource management and local institutional capacity.

Social inequality in terms of limited resource ownership and external support affect adaptive capacity of particular poor and marginalized groups in coastal areas (Nandy and Ahammad 2012). Coastal development interventions largely focused on land stabilization, structural protection measures for disaster risk reduction (Agrawala et al. 2003) and by contrast, ignored embedded social construction and resource ownership legacy in changing climate (Nandy and Islam 2010). As result, long-term institutional inertia caused fragmented resource management which was neither integrative livelihood practices nor socially inclusive towards incorporating the emergent coastal adaptation in Bangladesh. Though protective engineering measures by building earth embankment reduced physical vulnerability to storm surges this was not planned and based on anticipatory impacts of climate change related stress like increased storm surge height and water logging on livelihood to adjust to current and future changes (Mallick et al. 2011). The paper mainly presents livelihood adaptation practices in coastal areas by drawing experiences of Bangladesh NAPA priority project implementation. Several adaptation practices are also discussed to understand the diversity of practices and strength towards long-term adaptation.

Figure 1: The climate based physiographic features of the saline study area



Indicators of Risk in Bangladesh

Global Assessment Report 2009 of United Nations International Strategy for Disaster Reduction (UNISDR: GAR 09) identified five categories of countries (very low, low, medium, high & very high) that share common characteristics in terms of the countries' economic vulnerability and resilience to natural disaster loss and their development limitations, particularly their capacity to benefit from international trade. Bangladesh is in the 'high' category. GAR 09 observes that risk cannot be modeled deterministically due to the scarce nature of data on exposure of economic assets. Therefore in trying to understand the risk of any country, there is a tendency to use proxies. GAR 09 observes further that in addition to hazard severity and exposure, a range of other risk drivers related to economic and social development play a crucial role in configuration of disaster risk. Of these, Population density, Human Development index, income, literacy, poverty, inequality, access to technology and access to natural resource are considered relevant. Yusuf and Francisco (2009) have suggested that "Adaptive Capacity = f (socio-economic factors, technology, infrastructure)". UNISDR's Country Summary Report therefore endeavors to profile each country based on

selected proxies. In Table 1 below shows the proxy indicators of Bangladesh which reveals how much vulnerable Bangladesh is to climate change.

Table 1: Major Indicators for Bangladesh

Demography	
Population(millions)	164.4
Country Ranking	7
% Urban Population	25
% below 15 years	34.6
% 15 – 64 year	61.4
% over 65 years	4
% (15 – 49) Living with AIDS	0.1
Economy	
GDP at purchasing power parity (PPP) Rank ⁵	47
Gross Domestic Product (GDP) per Capita \$ ⁶	1300
\$ External Debt per \$ GDP ⁷	316.17
Sovereign Risk Rating ⁸	-
Poverty & Disparity in Income	
% population below \$1 income per day ⁴	35.9
% population undernourished ⁴	30.0
Gini Coefficient ⁹	33.4
Human Development	
HDI ¹⁰	0.543
HDI country rank	146
Ratio of Female to Male Youth Literacy ⁴	0.9
Education Index ¹⁰	0.530
Country Rank for Education Index ⁴	163
Access to Technology	
ICT Development Index (IDI) ¹¹	1.26
IDI Country Rank	138
Telephones and cellular subscriber per 100 people ⁴	2.6
Personal computers per 100 people ⁴	1.2
Internet users per 100 people ⁴	0.3
Ecosystems	
Land area covered by forest (%) ⁴	6.7
Protected areas (%) ⁴	1.3
Risk Rating	
Multiple Mortality Risk Class (0 – 10)	9
Economic Vulnerability	High

OBJECTIVES OF THE STUDY

In this context the present piece of research has been formulated with the following objectives:

1. To identify the elements of mitigating climate change disasters
2. To find out risk factors relating to Agro-Ecological Zones of diversified cropping pattern and AEZ productivity
3. To identify the agribusiness factors needed for recommended crop diversification programs

METHODOLOGY

Research methodology is a collective term for the structured process of conducting research. It usually encompasses the procedures followed to analyze and interpret the data gathered. This research study is descriptive-cum-empirical as well as suggestive in nature. The study is survey type. The present study has been included secondary resources consisting of books, newspapers, periodicals, articles from national and international level. Internet sources have been used for the research. Attempts have been made to include the latest information whenever available. At the same time primary data have been collected through interview with some officials and experts on the topic.

Source of Data: Data were collected from the capital and the field level conducting interview, discussion and observation using primary source i.e. interview with the respondents from the selected study areas. Primary data were collected through interview. Data were also collected from secondary source through literature review i.e. reference books, newspapers, periodicals, articles from national and international level. Internet sources have been used for research. An attempt was made to include the latest information whenever available. The nature of the study requires combining analytical and empirical approaches in the methodology. Accordingly, both qualitative and quantitative information and data were required. In order to generate database of the study, all necessary information were collected from different primary and secondary sources. Data were also analyzed and presented through the use of necessary figures, tables and charts.

Tools of Data Collection: In the empirical study field work plays an integral role. The study relied on four main data collection tools namely: in-depth interview guideline/checklist; observation of respondent, cross checking of data collected from field using mobile/telephone and review of related documents. All these tools are closely related. Although different approaches were applied in this study, the main purpose was to ensure that they complemented each other. The findings were presented in table and narrative way because this thesis is both quantitative and qualitative in nature.

Methods of Data Collection: Researcher conducted the face to face interview with the respondents of the study areas. As per the plan for data collection the researcher communicated the concerned officials by emails, telephone/ mobile phone for appointment with the respective respondents. The researcher took help of his colleagues and friends during conducting data collection.

Variables

A. Site Variables

1. Barisal
2. Khulna
3. Noakahli
4. Chittagong

B. Respondent Variables

1. Govt. Officers
2. Teachers
3. Elites
4. Farmers

C. Disaster Events

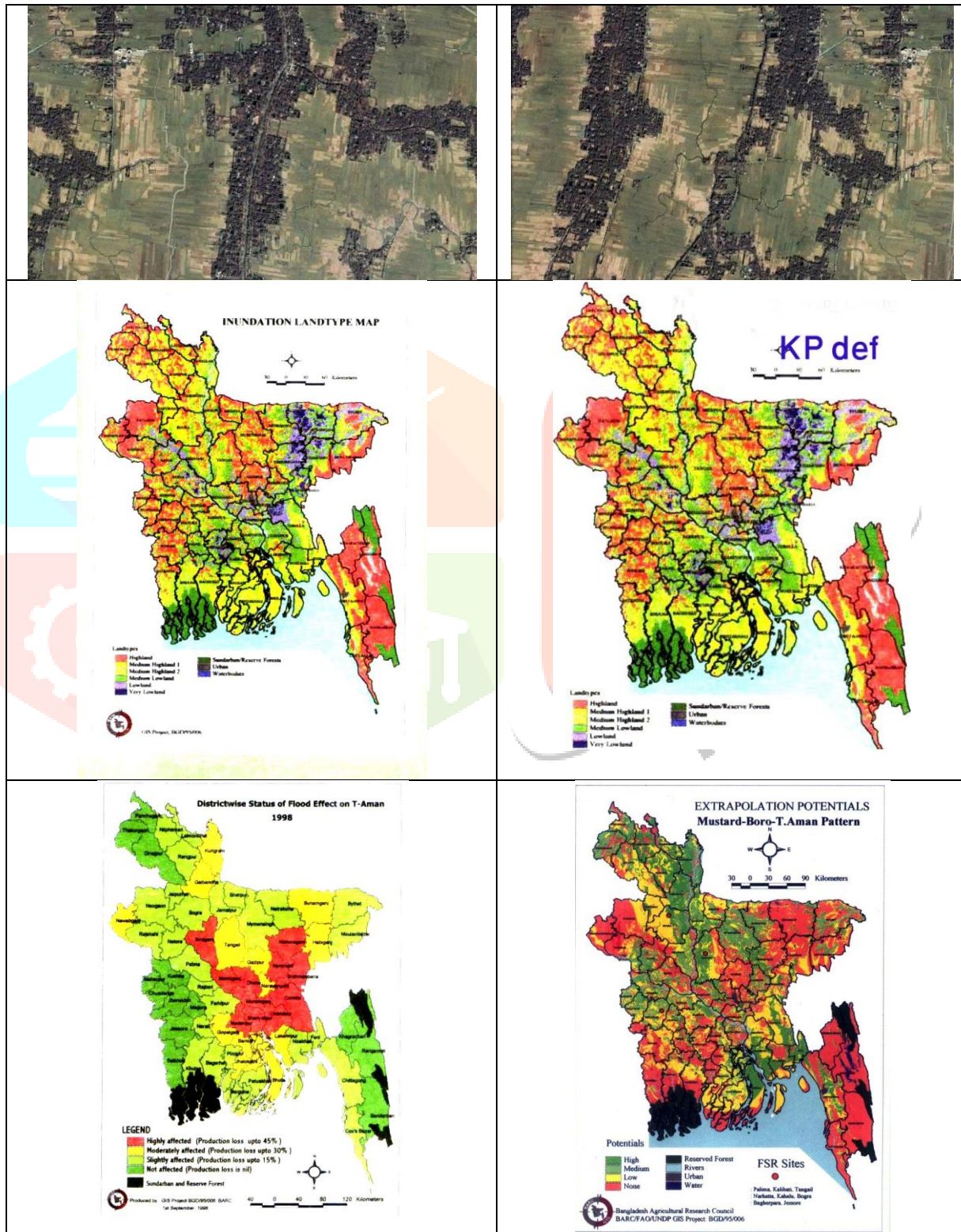
1. Flood
2. Cyclone
3. Storms
4. Droughts

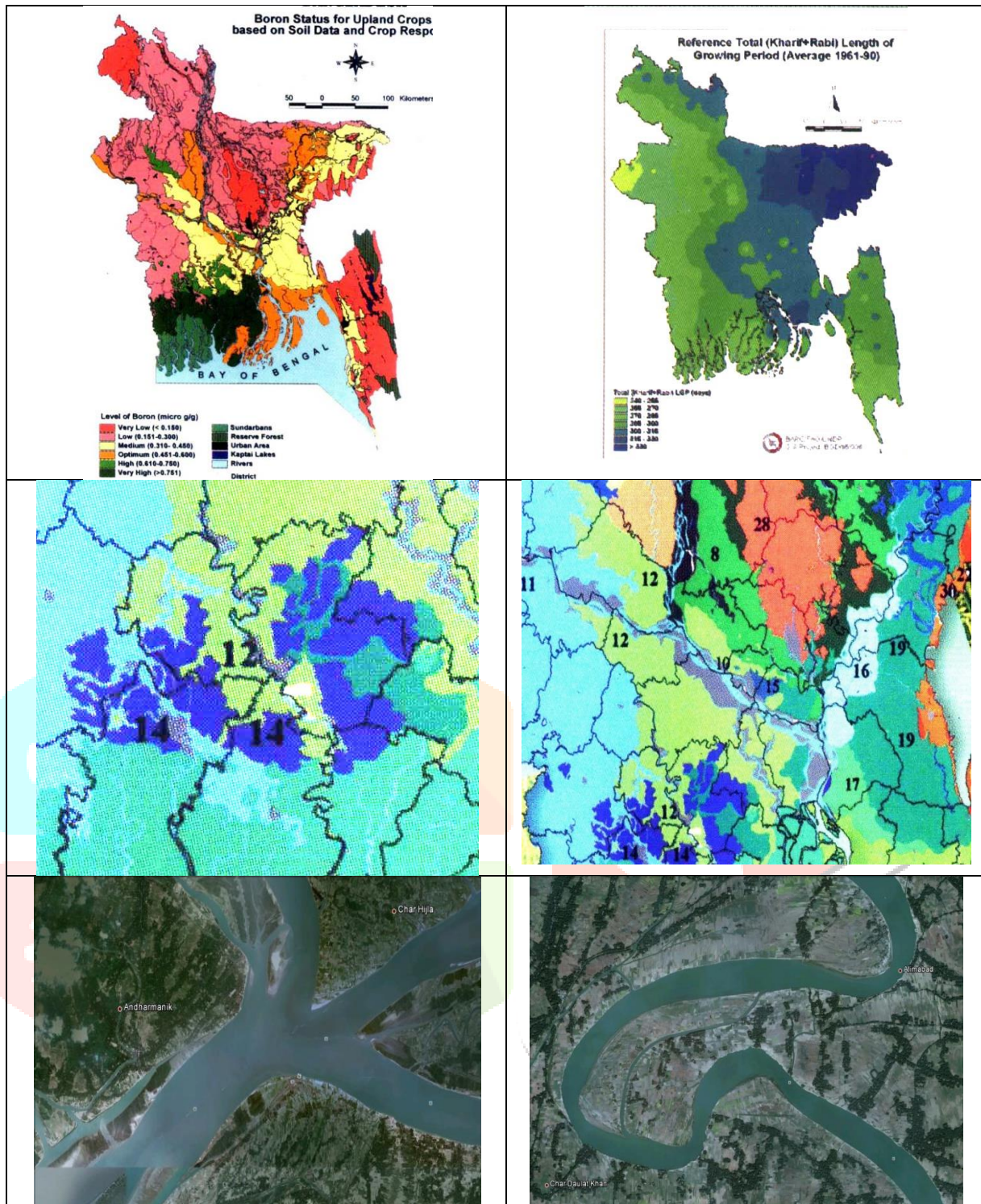
D. Age Group

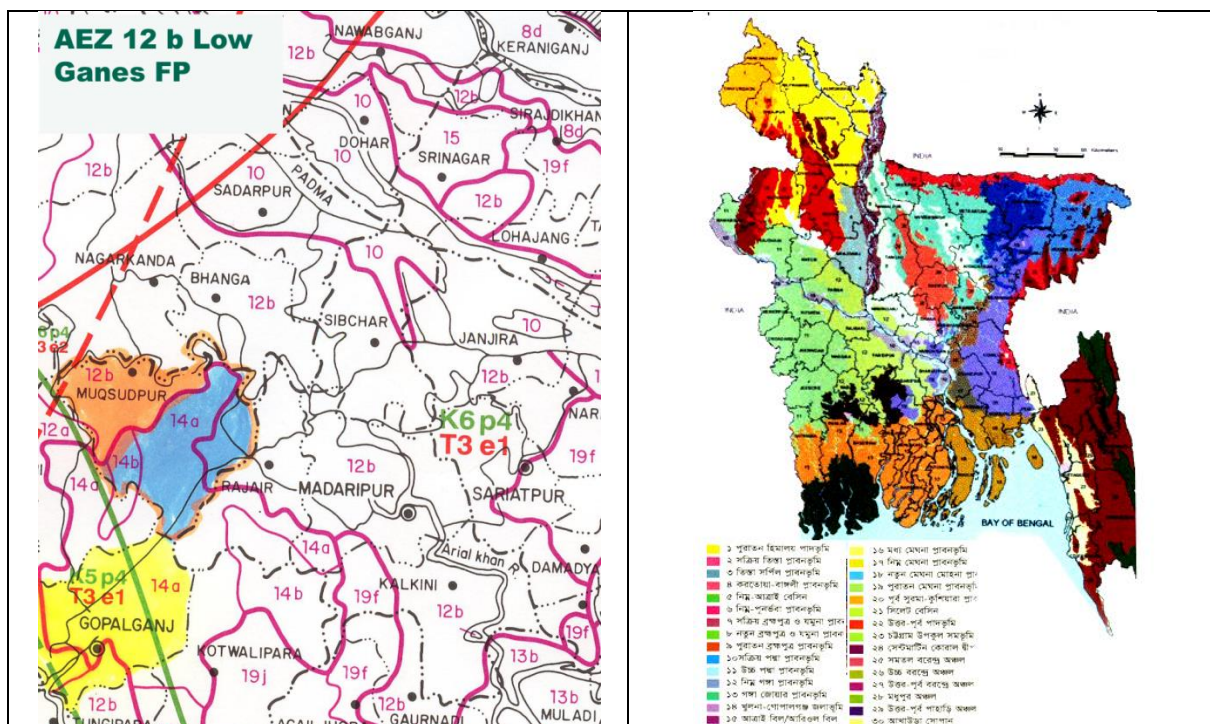
1. 65+ year
2. 40-65 years
3. 25-40 years

Data Analysis: Collected data were tabulated and analyzed by using computer program SPSS & Microsoft Excel.

Study Sites: Physiographic characteristics







RESULTS AND DISCUSSION

The results obtained from present research are sequentially produced here as per objectives. The results are given in the Tables and Fig.

Table 1: Elements of mitigating climate change and disasters% response in favour

	Barisal	Khulna	Noakahli	Chittagong	Mean
Unplanned industries	25	71	36	89	55
Industrial pollution	41	53	37	69	50
Use of motor vehicle	28	57	45	84	54
Excess use of natural resources	57	88	51	82	70
Deforestation of forests	25	21	39	47	33
Intensifying agriculture	28	35	71	54	47
Mean	34	54	47	71	51

The results given in the Table 1 and Fig 1 to 3 shows that the overall awareness and response of the problem was only 51%. It indicates that the elements of climate change and disasters are not clear to the resident peoples and even the educated citizens.

Fig 1: Elements of mitigating climate change and disasters as per sites.

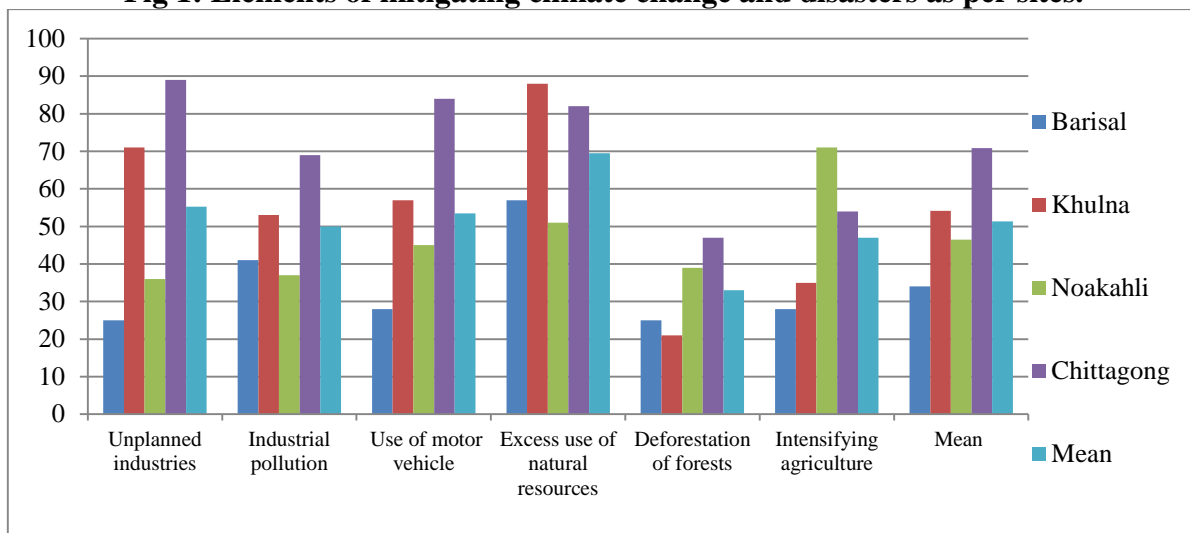


Fig 2: Elements of mitigating climate change and disasters as per manipulations.

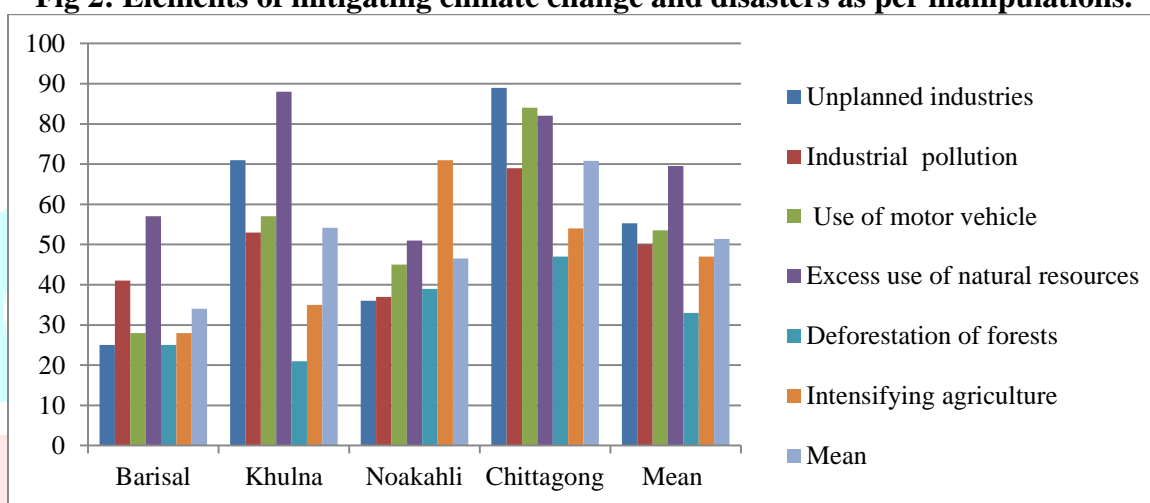


Fig 3: Elements of mitigating climate change and disasters as per manipulations.

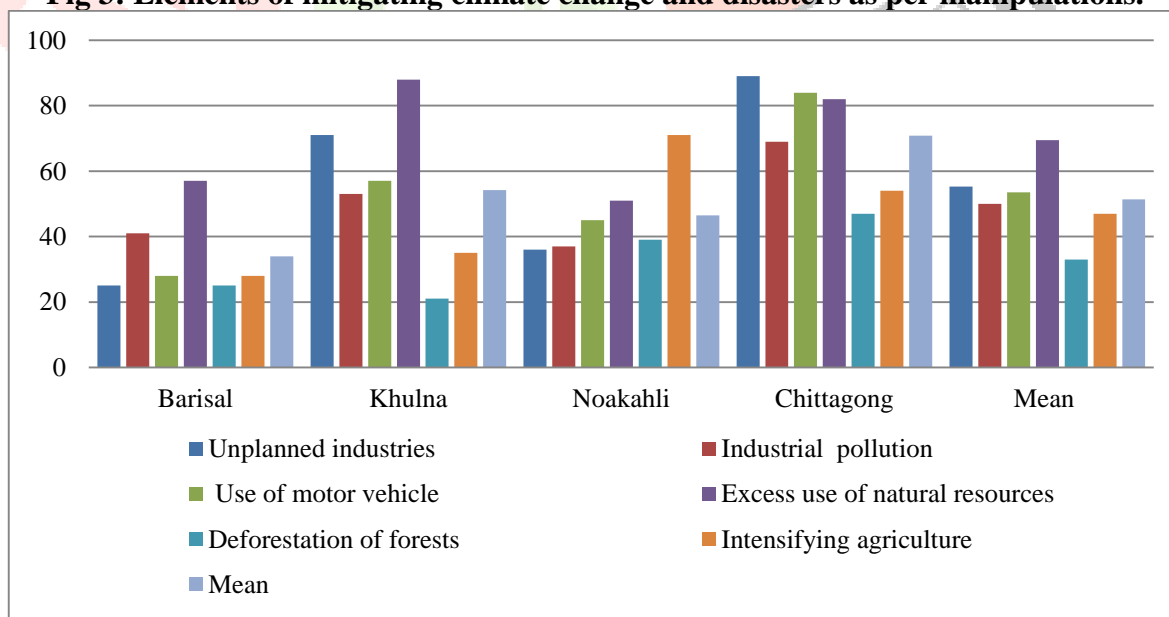


Fig 1 to 3 show that unplanned industries and excess use of natural resources caused intensive disasters.

Table 2: Risk factors relating to Agro-Ecological Zones of diversified cropping pattern

	Flood	Cyclone	Storms	Drought	Mean
Govt. Officers	28	45	36	28	34
Elites	83	54	58	53	62
Teachers	87	63	76	68	74
Farmers	54	37	23	76	48
Mean	63	50	48	56	54

The results found on the risk factors to AEZ and diversified cropping pattern are given in the Table 2 and Fig. 4 to 6. The Results show that Local teachers were most positive to the disaster events specially for flood and drought.

Fig. 4: Risk factors relating to AEZ and cropping pattern as per respondents

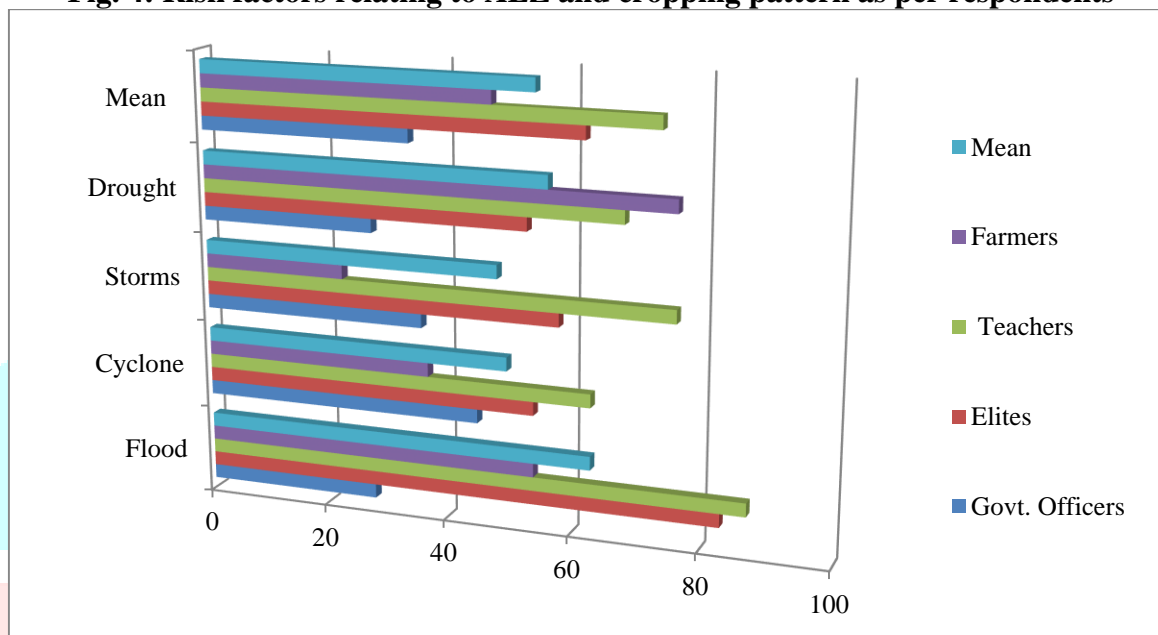


Fig 5: Risk factors relating to AEZ and cropping pattern as per disaster types

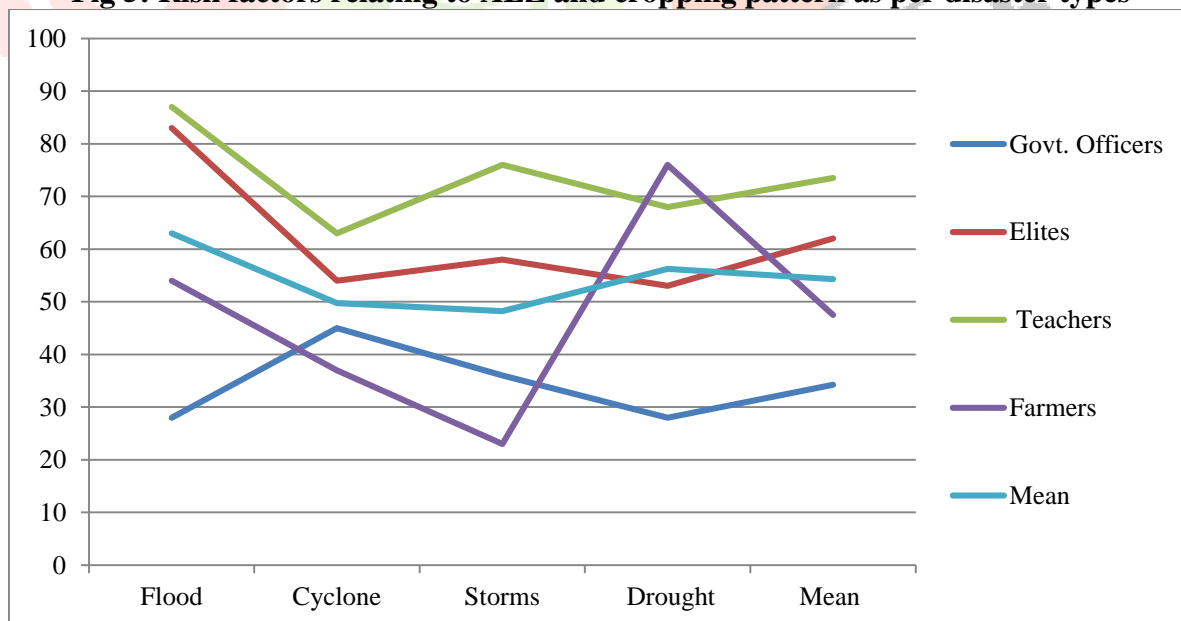


Fig 6: Accumulative type graph of risk factors relating to AEZ and cropping pattern as per disaster types

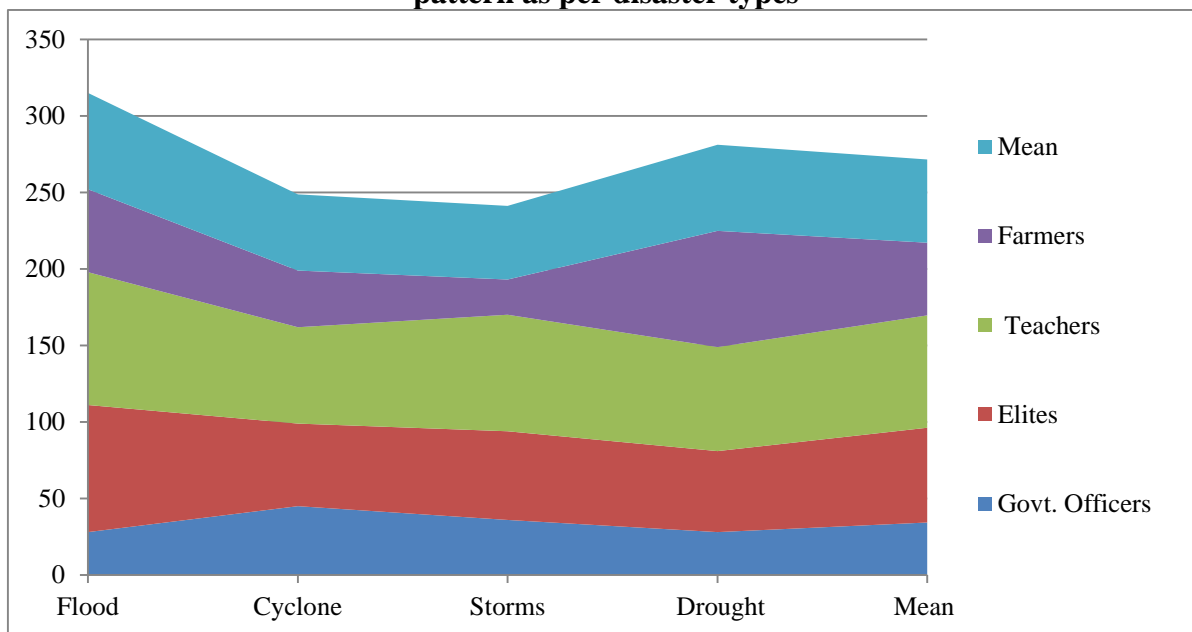


Table 3: Agribusiness factors needed for recommended crop diversification programs

	Flood	Cyclone	Storms	Drought	Mean
Rice cropping systems	64	24	76	37	50
Homestead and Ber system	68	54	75	84	70
Fish gher	83	38	58	77	64
Pond Farming systems	67	28	33	19	37
Mean	71	36	61	54	55

The results given in the Table 3 and Figs 7 to 9 shows that homestead and ber system of floating agriculture sustained better those other systems in most of the site based situations.

Fig. 7: Agribusiness factors needed crop diversification programs as per cropping systems

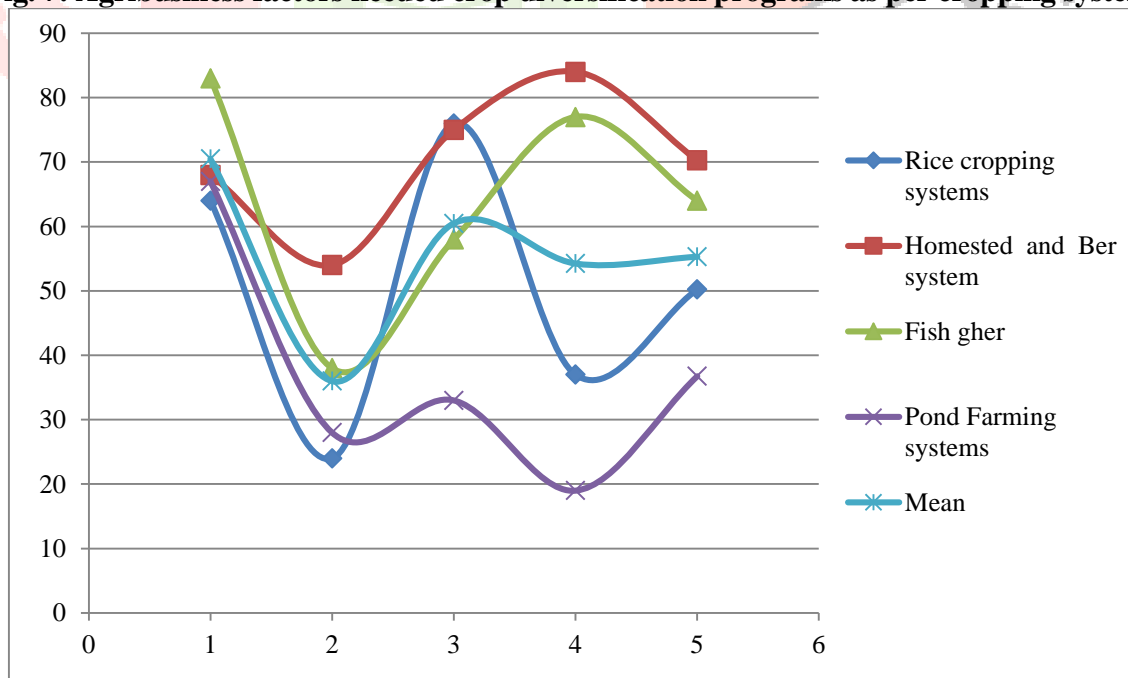


Fig 8: Pie chart showing the Agribusiness factors as per disaster events

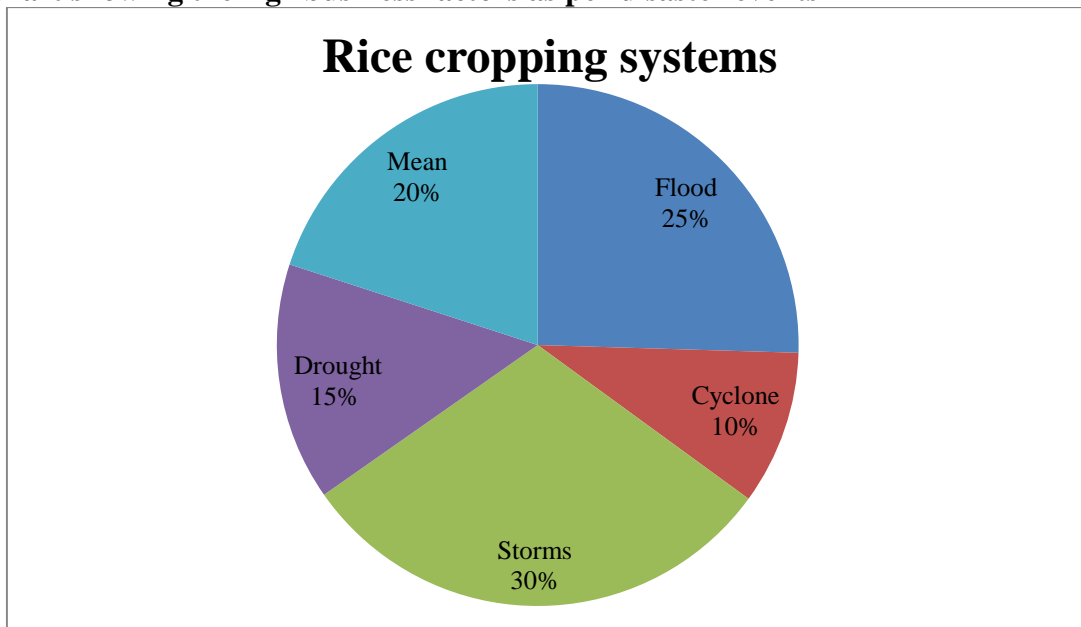


Fig 9: Detailed line graph on the Agribusiness factors as per cropping index

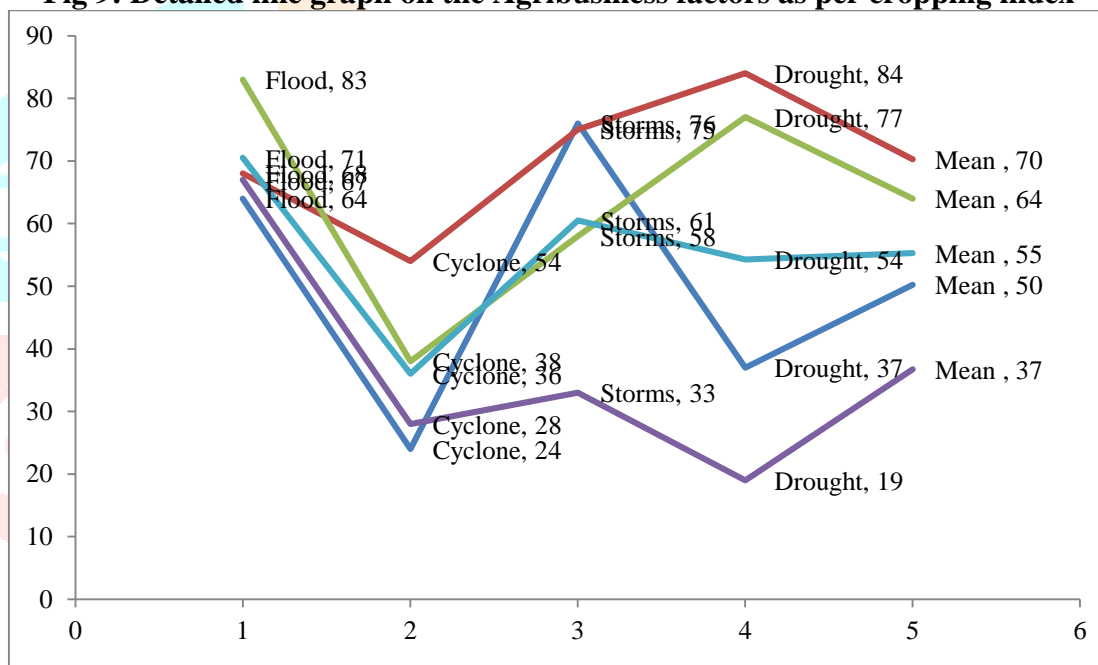


Table 4: Kind of natural disasters now increasing –Interactive factors

	Rain fall	Erosion	Sea level raise	High tide	Salinity	Mean
Flood	77	64	76	54	83	70.8
Drought	13	19	11	74	38	31
Temp	45	27	32	69	47	44
Storm surge	53	16	68	78	35	50
Water logging	79	32	26	72	42	50
Mean	53	31	42	69	49	49

The results show that the kind of natural disasters now increasing were found to be Flood and high happening frequently. Followed by storm surge water logging.

Fig. 10: Natural Disasters now Increasing –INTERACTIVE factors

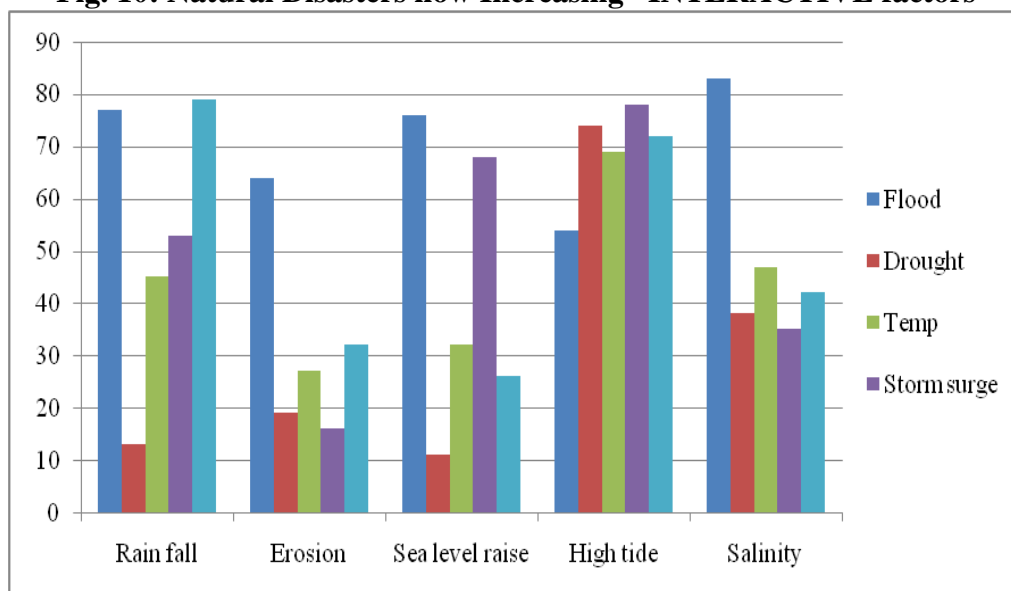


Fig. 11: Pie Chart of Natural Disasters now Increasing –Interactive Factors

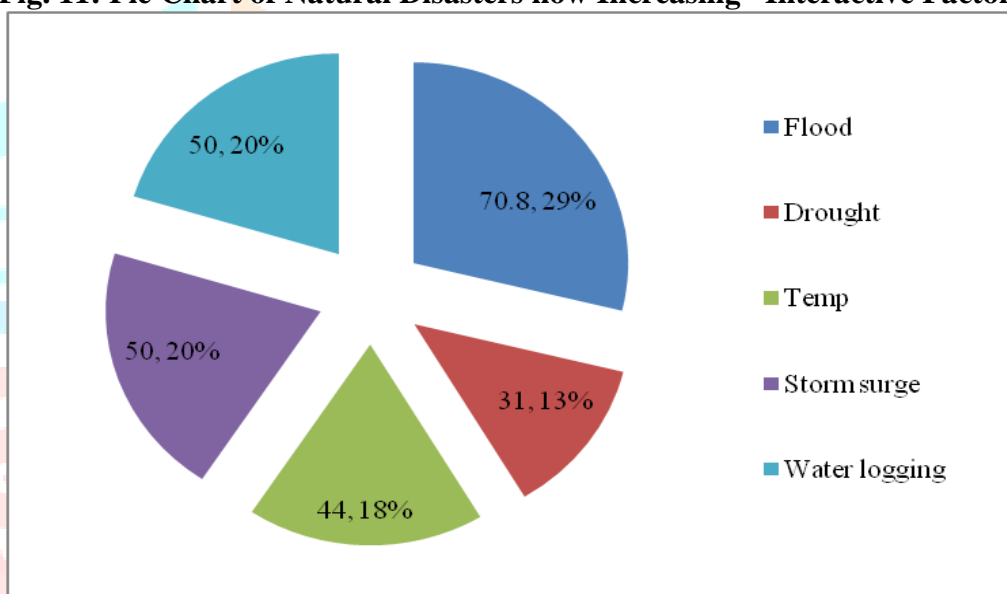


Table 5: What is the probable effect of climate change?

	Unplanned industries	Industrial pollution	use of motorized vehicle	Excess use of resources	Deforestation of forests	Mean
Drought	13	19	11	74	18	27
Temp	45	27	32	69	47	44
Storm surge	53	16	68	78	35	50
Water logging	79	72	86	72	82	78.2
Mean	47.5	33.5	49.25	73.25	45.5	49.8

The results given in Table 5 show that the most significant findings of the climate was indicated by prolonged water logging and excess use of natural resources.

Fig. 12: Probable Effect of Climate Change

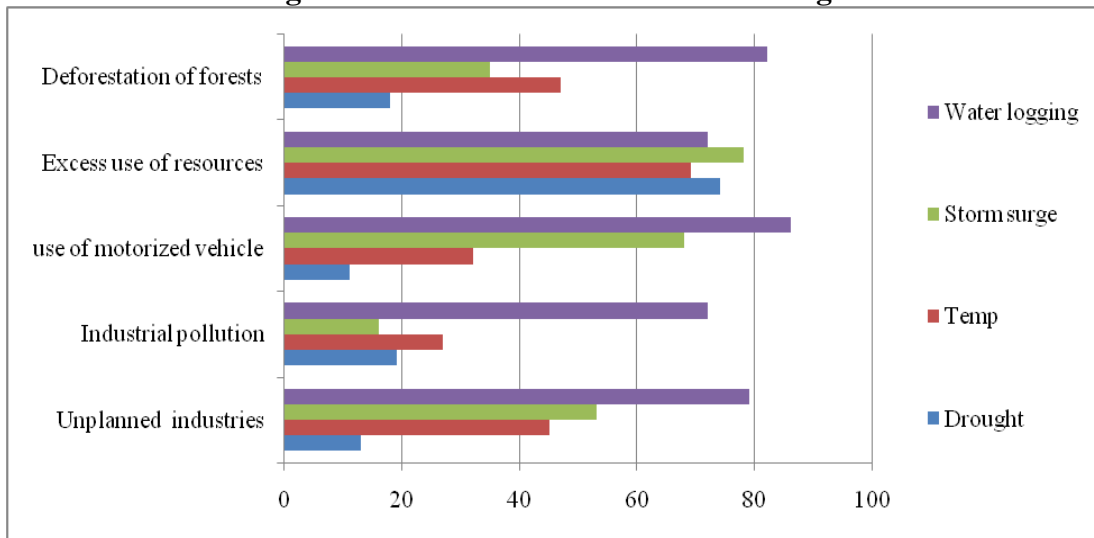
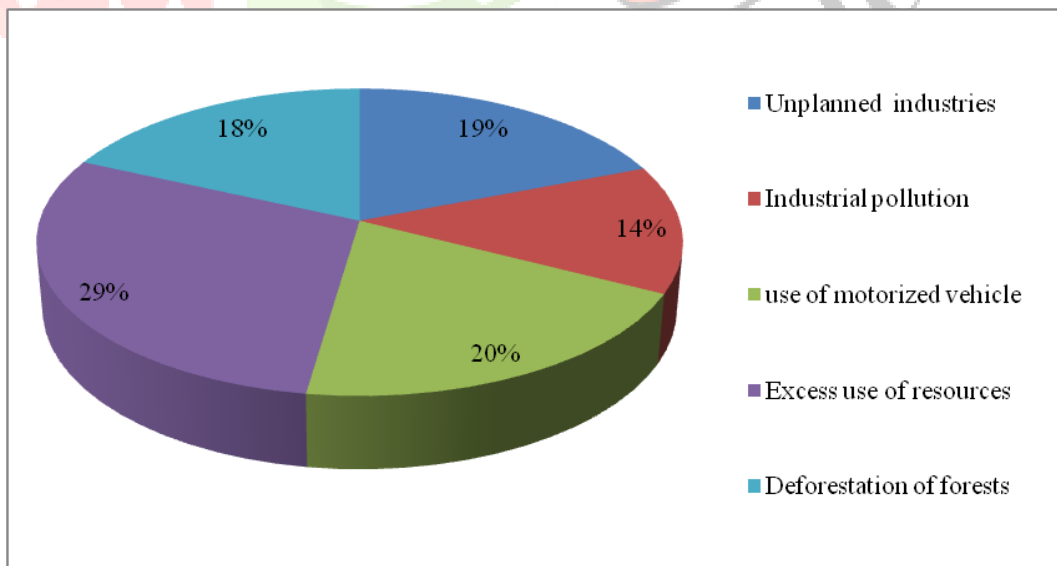
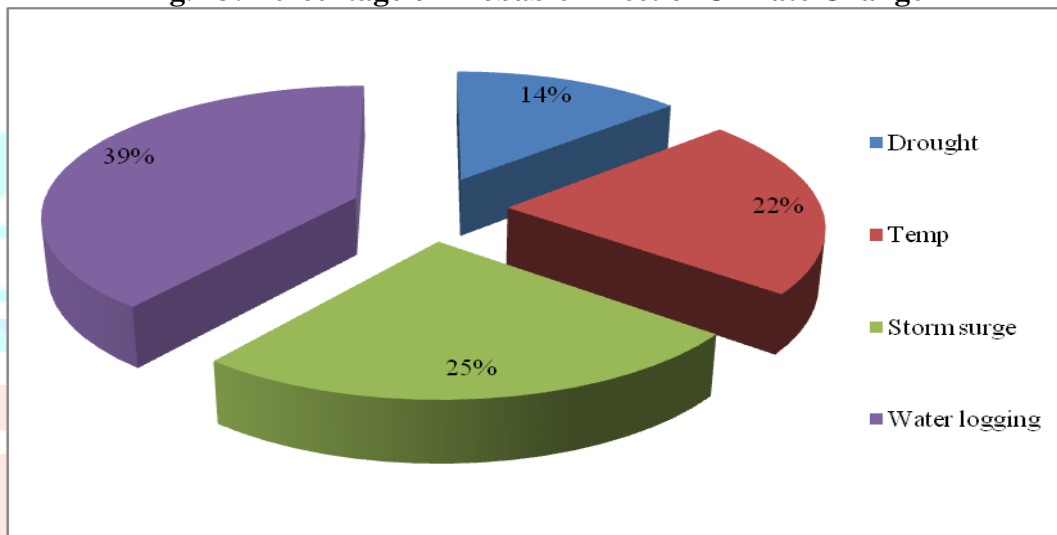


Fig. 13: Percentage of Probable Effect of Climate Change



PROBLEMS

In terms of agriculture: Hazards like salinity, variations in rainfall, dry spell, temperature and drought causing substantial reduction in food production and affecting rural livelihoods. As agricultural production reduced most of the people suffer from food security, mal nutrition and livelihood insecurity.

In terms of fisheries: It is reported by Haque (2007) that seasonal variations of rainfall and temperature have diverse implications on fishing, hatchery operations, fish production and livelihoods of a wide range of people directly and indirectly involved with fisheries and aquaculture.

In terms of livestock: Livestock are affected by air temperature, humidity, wind speed and thermal radiation which influence their growth, milk production, reproduction, health and wellbeing. Moreover due to grazing facilities and shortage of food that makes unfavorable environment for the livestock. Sometimes, cattle and poultry suffer from heat stroke and affected by different diseases like black quarter, anthrax and so on.

In terms of human health: Due to lack of safe drinking water, people of coastal areas uses pond water that also leads to various water borne diseases such as; dysentery, diarrhea etc.

In terms of environment: Climate change causes environmental degradation. Natural disasters destroy the forests that cause huge losses of bio-diversity. Many plant and animal species destroy due to habitat loss.

Impact on women to climate change;

- Impact on the lives and health of women;
Warning information was conveyed by men to men in public places; women were not hear the message clearly or allowed to leave the house. A few studies following the cyclone and flood disasters of 1991 revealed that, among women aged 20-44, the death rate was 71 per 1000 compared to 15 per 1000 for men (UNEP-2005). Women death rate was high because diseases, injuries, drowning, slipping, large trees and structure falling on women, malnutrition, lack of warning information, medical facilities, pure drinking water and sanitation facilities.

- Impact on women's physical security and dignity
Women in Bangladesh still experience various types of violence; physical, sexual, and emotional violence increase during and after a disaster (UNDP-2002).

1. Domestic violence
2. Harassment and loss of privacy in flood and cyclone shelters
3. Harassment in relief ques

- Impact on women's economic livelihoods

1. Housing and homestead
2. Crop production loss
3. Livestock death
4. Loss in productivity
5. Supply shortage and price of inputs
6. Limited access to market
7. Loss of income savings and employment

ADAPTATION:**Agricultural Adaptation in coastal zones:**

- Climate resilient rice varieties (Bina-8, BIRRI-40, 41, 47, 53, 54) and saline resilient non rice crop varieties (Mug bean-BM 08, Maize, Mustard, Cowpea, Tomato) should be cultivated.
- Some agricultural adaptation technologies such as raised bed, floating vegetables, hydroponic fodder cultivation, mulching, water storage in crop fields, ditch and dyke method in farming, mound plantation, agro-forestry, drip irrigation, non-traditional crop varieties should be practices.

Aquaculture based adaptation

- Crab fattening
- Mono-sex tilapia farming
- Fish culture with repeated stocking and repeated harvesting
- Cage aquaculture
- Shrimp farming
- Sea bass farming
- Some aquaculture technologies such as closed system bagda farming, golda mono farming, mono-sex tilapia farming in pond, pangas farming, carp poly ulture, cage culture in open water, carp brood development, mola with carp culture, sing magur koi demonstration may be extension.

Water based adaptation

- Rain water harvesting
- Pond sand filter
- Desalinization for drinking water
- Piped watering system

Disaster related adaptation

- Houses on raised plinths
- Settlement on raised lands
- Mud wall housing
- Cyclone resistant housing
- Reinforcement of coastal fishing of boats

Coping practices among women;

- Predicting and preparing for disaster
- Protecting houses and homesteads
- Storing essential items
- Teaching children

SUMMARY AND RECOMMENDATIONS

The major objectives of present research were to identify the elements of mitigating climate change disasters, find out risk factors relating to Agro-Ecological Zones of diversified cropping pattern and AEZ productivity and identify the agribusiness factors needed for recommended crop diversification programs. The major findings of the studies are presented here along with the summary and recommendations.

From the findings it may be finally recommended that

- Nationwide programs should be conducted to increase the awareness of the people about the elements of climate change.
- The disaster management programs should be drawn from the grass root levels where the event is happening.
- Teachers should given more importance in implementing disaster programs.
- Government Officers were found to be reluctant to deal with the negative impacts of climate changes.
- The gender issues must be taken in to account while planning disaster mitigation programs.
- The gained information from the study can be used as one factor for determining coastal agricultural policy of Bangladesh.

- Government should emphasize introducing climate resilient agricultural practices that ensure productivity and employment.
- Crop and livelihood diversification system should be introduced to reduce yields gap.
- Policy and institutional framework are needed for sustainable natural resource management and conservation to support agricultural growth in the coastal areas of Bangladesh.
- Rain water may be stored in the saline areas to minimize the salinity effect during the dry season.
- Local weather forecasting should be developed.
- Coastal people should be trained up on Climate Risk Assessment (CRA) and prepare Climate Resilient Management Plan (CRMP).
- Government should formulate a project to raise awareness and to promote the feasibility of integrated agricultural system in the coastal areas to ensure the sustainability of coastal agriculture.

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