Final Report

of

Study on livelihood systems assessment, vulnerable groups profiling and livelihood adaptation to climate hazard and long term climate change in drought prone areas of NW Bangladesh

March 2006

Printing supported by:

Comprehensive Disaster Management Programme
Ministry of Disaster Management and Relief

UKaid from the British people
European Union
NORWEGIAN EMBASSY
SWEDEN
Australian AID
UNDP Empowered lives. Resilient nations.

Improved Adaptive Capacity to Climate Change for Sustainable Livelihood in the Agriculture Sector
Comprehensive Disaster Management Programme (CDMP) BGD/01/004/01/99 DP/9/1

Final Report

of

Study on livelihood systems assessment, vulnerable groups profiling and livelihood adaptation to climate hazard and long term climate change in drought prone areas of NW Bangladesh

March 2006

Submitted by

CEGIS

Center for Environmental and Geographic Information Services

Food and Agriculture Organization of the United Nations

Food and Agriculture Organization (FAO) of the United Nations
Department of Agricultural Extension, Bangladesh

Final Report

Study on livelihood systems assessment, vulnerable groups profiling and livelihood adaptation to climate hazard and long term climate change in drought prone areas of NW Bangladesh

Improved Adaptive Capacity to Climate Change for Sustainable Livelihood in the Agriculture Sector. [BGD/01/004/01/99 DP/9/1]

Comprehensive Disaster Management Programme (CDMP).

March 2006

Report prepared by:

Atiq Kainan Ahmed
and
Ehsan Hafiz Chowdhury

With overall technical guidance from:

Dr. Stephan Baas, SDAR, FAO, Rome Italy.

Submitted by

CEGIS Center for Environmental and Geographic Information Services
House 6, Road 23/C, Gulshan-1, Dhaka-1212, Bangladesh. Tel: 8817648-52, Fax: 880-2-8823128

and

Food and Agriculture Organization (FAO) of the United Nations

Study team

Principal contributors and report prepared by:

Atiq Kainan Ahmed (Livelihoods vulnerability specialist)
Ehsan Hafiz Chowdhury (Hydrologist and database expert)

Field research support by:

Sushanto Paul
Kazi Kamrull Hassan
Md. Akbar Ali
Md. Abdur Rashid
Md. Aminur Rahman Shah

For further information please contact:
Atiq Kainan Ahmed (Project Leader)
E-mail: aahmed@cegisbd.com

Acknowledgement

The present study on livelihoods adaptation was made possible with the kind funding of the United Nations Development Programme (UNDP) and Food and Agriculture Organization (FAO) of United Nations and under the overall association with Department of Agricultural Extension (DAE), Bangladesh.

The CEGIS study team is especially thankful to Dr. Stephan Baas, Lead Technical Advisor (Rural Institutions and Participation Service, SDAR, FAO, Rome) for his overall technical guidance and highly proactive initiatives. The final document and the development of the project outputs are direct results of his valuable insights received on a regular basis.

Collaboration with both central level and field officials of DAE was highly instrumental. In devising the study activities, contribution of Mr. Md. Shamsul Alam, National Sub-component Manager (NCM), and former NCM Mr. Giasuddin Ahmed, were decisive. In course of the study, the discussions with Mr Abdur Rashid Sikder and others DAE officials at central level were found insightful. In devising the fieldwork the useful contributions from the DAE field offices in four study upazilas and in district offices of Nawabganj and Naogaon was significant. The association with the responsible SAAOs in four upazilas was highly useful.

For management of project activities interactions with Dr. Mahmudul Islam (FAO-Bangladesh), Jurgens Ingmar (SDRN, FAO) and Mr. Abdul Mannan (BMDA and project) were useful.

The finalization of the study report has been benefited from the valuable comments and suggestions received from various agencies such as DAE, DOE (Climate Cell), SPARRSO, and others. The valuable comment received from Mr. Ralf Ernst on the draft report was gratefully acknowledged.

In developing the study, CEGIS team is also indebt to the local people of the study villages who participated in the community level workshops with great enthusiasm. The information, insight and knowledge received from them are the major source for overall structuring the study findings.

Useful participation of various line agency representatives in the upazila and district level workshops are also greatly acknowledged. In devising the two district workshops the collaboration with Asian Disaster Preparedness Center (ADPC), Thailand was found useful.

Finally, the comments and appreciations received in the central level validation meeting (held at DAE headquarters) from the various agency representatives, researchers and officials on the draft final report helped the in finalization of the report.

Table of Contents

List of Tables

List of Figures

Acronyms

ADM	Agricultural Disaster Management
ADPC	Asian Disaster Preparedness Center
B. Aman	Broadcast Aman
B. Aus	Broadcast Aus
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BDNAPA	Bangladesh National Adaptation Programmes of Action
BMD	Bangladesh Meteorological Department
BMDA	Barind Multipurpose Development Authority
BWDB	Bangladesh Water Development Board
CBO	Community Based Organization
CDMP	Comprehensive Disaster Management Programme
CEGIS	Center for Environmental and Geographic Information Services (earlier EGIS-II)
CFAB	Climate Forecast Application in Bangladesh
cm	Centimeter
DAE	Department of Agricultural Extension
DEM	Digital Elevation Model
DMB	Disaster Management Bureau
DoF	Department of Fisheries
DPHE	Department of Public Health Engineering
DRAS	Drought Assessment Framework
EGIS	Environment and GIS Support Project for Water Sector Planning (now CEGIS)
FAO	Food and Agriculture Organization of the United Nations
FAP	Flood Action Plan
FFWC	Flood Forecasting and Warning Center
GEF	Global Environment Facility
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectare
IRS	Indian Remote Sensing Satellite
ISPAN	Irrigation Support Project for Asia and the Near East
ITDG	Intermediate Technology Development Group
LANDSAT	Land Satellite

LDCs	Least Developed Countries
LGED	Local Government Engineering Department
LMP	Livelihood Monitoring Project (a CARE project)
LTC	Lead Technical Consultant
LTU	Lead Technical Unit
MDMR	Ministry of Disaster Management and Relief (now MoFDM)
MoA	Ministry of Agriculture
MOEF	Ministry of Environment and Forests
MoFDM	Ministry of Food and Disaster Management (earlier MDMR)
MoWR	Ministry of Water Resources
MPO	Master Plan Organization
NAPA	National Adaptation Programmes of Action
NCA	Net Cultivable Area
NCM	National Subcomponent Manager
NDMC	National Disaster Management Council
NGO	Non Government Organizations
NIR	Net Irrigation Requirement
NMIC	National Minor Irrigation Census
NPD	National Project Director
NWMPP	National Water Management Plan Project
NWRD	National Water Recourses Database
REB	Rural Electrical Board
RVCC	Reducing Vulnerability to Climate Change (A CARE-SIDA project)
SAAO	Sub Assistant Agriculture Officer (earlier called Block Supervisor)
SLF	Sustainable Livelihoods Framework
SOD	Standing Orders on Disaster
SRDI	Soil Research Development Institute
SSDP	Support to the Strengthening of Disaster Preparedness in Agricultural Sector
T-Aman	Transplanted Aman
TAR	Third Assessment Report
TNO	Thana Nirbahi Officer
UNFCCC	United Nations Framework Convention on Climate Change
UP	Union Parishad
WARPO	Water Resources Planning Organization

Executive Summary

Food and Agriculture Organization of the United Nations (FAO) is assisting the Government of Bangladesh and other key stakeholders in designing and promoting livelihood adaptation strategies in the agricultural sector, which is expected to help in making strategic actions to reduce vulnerability to climate change.

The present study (carried out by CEGIS in association with DAE) is an integral part of this FAO assistance to GoB and CDMP. Present study is composed of a livelihood systems assessment, vulnerable groups profiling and the studying of livelihood adaptation practices and technologies to climate hazard and long-term climate change in drought prone areas of NW Bangladesh. The study has been carried out in four selected upazilas of two districts – Nawabganj and Naogaon – of the northern Bangladesh.

Study objectives

The specific objectives and activities of the CEGIS study was to: a) assess local perceptions of climate hazard, past and present climate risk/ impact, b) study livelihood systems and establish livelihood profiles of the major vulnerable groups considering household categories, c) investigate about current and past adaptive responses and coping strategies of the vulnerable groups to risks in particular climate risk, d) review the mandates, actual roles and capacities of communities and local institutions/ organizations, e) and provide the physio-geographic environment and framework conditions of the study areas.

Physio-geographic environment of the study area

The study area is located in the northwestern part of the country under Naogaon and Chapai Nawabganj district mainly covering Barind Tract, Punarbhava floodplain and Ganges river flood plain area. Rainfall distribution of the study area shows that annual total rainfall is almost similar in nature and ranges between 1400-1500 mm and 80% of the rainfall occurs in monsoon. Water deficits occur during the dry months of the year, which is around 400-500 mm and surplus in the monsoon season. The trend of dryness is almost similar but wetness in the monsoon shows a little bit increasing trend. Change of temperature is high during the recent decades. The mean annual temperature is around 250 C and varies from 16-350 C. Mean annual humidity is around 72% and sunshine hour ranges 6.5-7 hrs in the study area.

During the dry season the surface water flow of the Mohananda and the Punarbhava rivers shows a decreasing trend. Major soils are Clay-Clayey loam and Loam with imperfectly drainage characteristics resembling very low infiltration rate. The depletion of groundwater table is remarkably high from early eighties and the irrigation coverage is increased at large scale from 1985 to onwards. Groundwater resources estimated by NWMP shows that the resources are constraint for irrigation from the shallow aquifer and irrigation development potential is only suitable from deep aquifer using DTW with full development level. The agricultural practices are mainly governed by climatic factors and the area is mainly severely drought prone due to low rainfall intensity and high temperature.

Local perceptions

The study found that the people hold various perceptions towards the current and past risks in the study area. People perceive that the current climate in the area has been behaving differently from the past years. The seasonal cycle (locally called *rhituchakra*) has changed, droughts became more frequent, pest and disease incidences increased, average temperature has increased in the summer while winter has shortened and the severity of some winter days increased. However, people found

difficulties in expressing the degree of changes. Local people in the study area have also perceived that their boro, aus and winter vegetable, fruits (several varieties of mangoes) production remained affected due to temporal variations in rainfall, temperature and drought occurrences.

Livelihood profiles

Adopting an innovating analytical Sustainable Livelihoods Framework (SLF) the study profiles the major livelihood groups in the area. It was observed that the livelihoods are severely affected by drought situation. The access to boro, aus and rabi remains largely dependent over the access and availability of the irrigation water. Failure in getting access to DTW water in the non-irrigated areas and the occurrence of several anthropogenic factors (e.g. electricity failure, high price of agricultural input) remains as the major form of vulnerability for the farmers. The wage labourers face unemployment and crises of failed migration. Petty traders find difficulties in getting buyers on a regular basis. In this thriving situation, the large businessmen and large (or rich) farmers were found vulnerable by a lesser degree. However, these groups are found vulnerable to the climatic hazards in a covariant (all in analogous condition) way but having access to the higher degree of assets other than the natural (mostly financial, social and physical) the group actually keep them out of severe vulnerabilities caused by climatic conditions.

Local adaptive practices

In this difficult climatic conditions, the study identified that there are some local adaptive practices existing in the study area. Four major types of adaptive practices: a) traditional responses (e.g. pond and *dighi* excavation, retention of rainwater in *khari* and canals, shedding, tillage, breaking top soil), b) state supported responses (e.g. DTW facilitated irrigation), c) alternative responses (e.g. adoption of mango farming, orchard developing), and d) some domestic responses (e.g. alternative livestock and poultry/birds rearing) are existing in the study area. The study found that the successes derive from these adaptive practices are of relative nature: some are promising, some brings a limited success and some have only a low efficacy in severe conditions of severe drought or in variable climatic conditions.

Institutional assessments

The study looked into the institutional domain under which these groups are trying to survive in. Several types of institutions: government and local government agencies, NGOs, social, informal and private institutions; and farmers/water user groups were found to be operating in the area. The institutional assessment found that ***the agencies operating in the study area have differences both in roles, capacities and how-hows to deal with climatic risks***. At the moment with their mandates in providing DTW irrigation BMDA is providing some support in their operated areas but ***is offering only a little to the areas where the ground water is not accessible***. The local level structure of ***union disaster management committee*** for disaster management was also found officially there but it emerged from the discussion with the local people that the access to these UDMCs and capacity of these institutional entity is very week. The involvement of NGOs in local disaster risk management is not quite deeper consider to any other disaster prone areas of the country. Lack of coordination among the NGOs and NGOs and with government remained as a critical institutional weakness as well.

Conclusions and recommendations

The present study found that both the ***climatic conditions*** and the ***anthropogenic factors*** are contributing towards the vulnerability of the life and livelihoods of the people. Climatic factors are creating the vulnerabilities but due to the anthropogenic capabilities (and the access to various forms of assets) livelihoods are becoming more vulnerable and leading towards disasters and losses. This is a dual effect of climatic and anthropogenic at the same time. With this realization from the empirical domain, the present study has put forward context-based recommendations.

The study recommends ***multiple pathways to improve adaptive responses that would comprise of both short-term and long-term adaptive measures***. Such multiple pathways could comprise of: a) treatment of the climatic risks through physical adaptive measures if possible (such as planned physical water resources management), b) the adjustment/alteration of agricultural practices (e.g. setting up adequate cropping pattern and selection of tolerant crops); c) the creation of alternative livelihoods opportunities for future other than traditional crops, and d) awareness raising and skill development.

The ***challenge would be to find out the right combination and integrating*** among these varied adaptation options that would be required for respective "geo-physical settings" and "livelihoods systems". Setting and selecting these livelihood options are about stretching the limits of the local adaptive responses as well as the innovation, experiences, technologies appropriate to the livelihoods-culture and environment of the respective areas.

In this respect, both ***long-term and short-term measures for adaptation both are needed.*** But, for both the contexts: a) ***linkages between climate change adaptation and the mainstream development*** needs to be established, b) development of an ***enabling institutional environment*** is required for climate change adaptation where the institutional coordination and collaboration between right kind of institutions and policies is needed.

1 Introduction

1.1 Background

Bangladesh, due to its geo-physical position and socio-economical context, is prone to several types of recurrent natural disasters. Especially the northwest regions are drought prone. Droughts are associated with either the late arrival or an early withdrawal of monsoon rains. Drought adversely affects all the three paddy varieties (Boro, Aus and Aman), which accounts for more than 80% of the total cultivated land of the country and cause damage to jute, the country's main cash crop.

Droughts in March-April prevent land preparation and ploughing activities from being completed on time, delaying the broadcast of Aman and the planting of Aus and jute. Droughts in May and June destroy broadcast Aman, Aus, and jute plants. Inadequate rain in August delay transplantation of Aman in highland areas, while drought in September and October reduce yields of both broadcast and transplanted Aman and delay the sowing of pulses and potatoes. Boro, wheat and other crops grown in the dry season are also periodically affected by drought.

Increasing climate uncertainties are an additional threat in disaster prone environment and one of the major risk factor for risk averseness. Intensity and variability of climatic hazards are expected to steadily increase in the near future due impacts of climate change.

The high exposure to hazard risks forces farmers to depend on low inputs and low risk technologies. Non-adaptation of new technologies to drive maximum gains during favorable seasons delays recovery from natural disasters.

In order to increase resilience at all levels, from the national to community level and to reduce damage and losses from natural disasters and the impacts of climate change, the Government of Bangladesh has launched the Comprehensive Disaster Management Programme (CDMP), which started field implementation in 2004. The CDMP among other thrusts is also addressing the risk associated with the climate variability and change, including livelihood adaptation to climate change. Component 4b of the CDMP seeks as its title says, "to establish an integrated approach to managing climate risks at the national and local level".

Within this framework, the Food and Agriculture Organization of the United Nations (FAO) is assisting the Government of Bangladesh and other key stakeholders in designing and promoting livelihood adaptation strategies in the agricultural sector, which is expected to help in devising strategies to reduce vulnerability to climate change, particularly amongst women and poor communities who have the lowest capacity to adapt. The FAO contribution has been defined as sub-component 4 of component 4b.

The present study (carried out by CEGIS in association with DAE) is an integral part of this FAO assistance to GoB and CDMP. This study relates especially to the second output of the above.

The CEGIS study is composed of a livelihood systems assessment, vulnerable groups profiling and the studying of livelihood adaptation practices and technologies to climate hazard and long-term climate change in drought prone areas of NW Bangladesh.

The study has been carried out in four selected upazilas of two districts – Nawabganj and Naogaon – of the northern Bangladesh (see Figure 1-1).

1.2 Objectives of the CEGIS study

The major objectives of the study is to answer three basic questions:

- ◊ Where does a society stand today with respect to vulnerability to climate risks?
- ◊ What factors determine its current vulnerability?
- ◊ How successful are its efforts to adapt to current and possible future climate risks?

The specific objectives and activities of the CEGIS study was to:

- ◊ Assess local perceptions of climate hazard, past and present climate risk/ impact.
- ◊ Study livelihood systems and establish livelihood profiles of the major vulnerable groups considering household categories (Landless, marginal, small, medium, large) their subgroups (if any) in 12 villages, a non-vulnerable group should also be profiled.
- ◊ Investigate about current and past (30 years) adaptive responses and coping strategies of the vulnerable groups to risks in particular climate risk.
- ◊ Review the mandates, actual roles and capacities of communities and local institutions/ organizations (including local government agencies and self-help groups) in disaster prevention preparedness, as well as the service they offer and resources they can plan with.
- ◊ Describe the physio-geographic environment and framework conditions of the study areas.

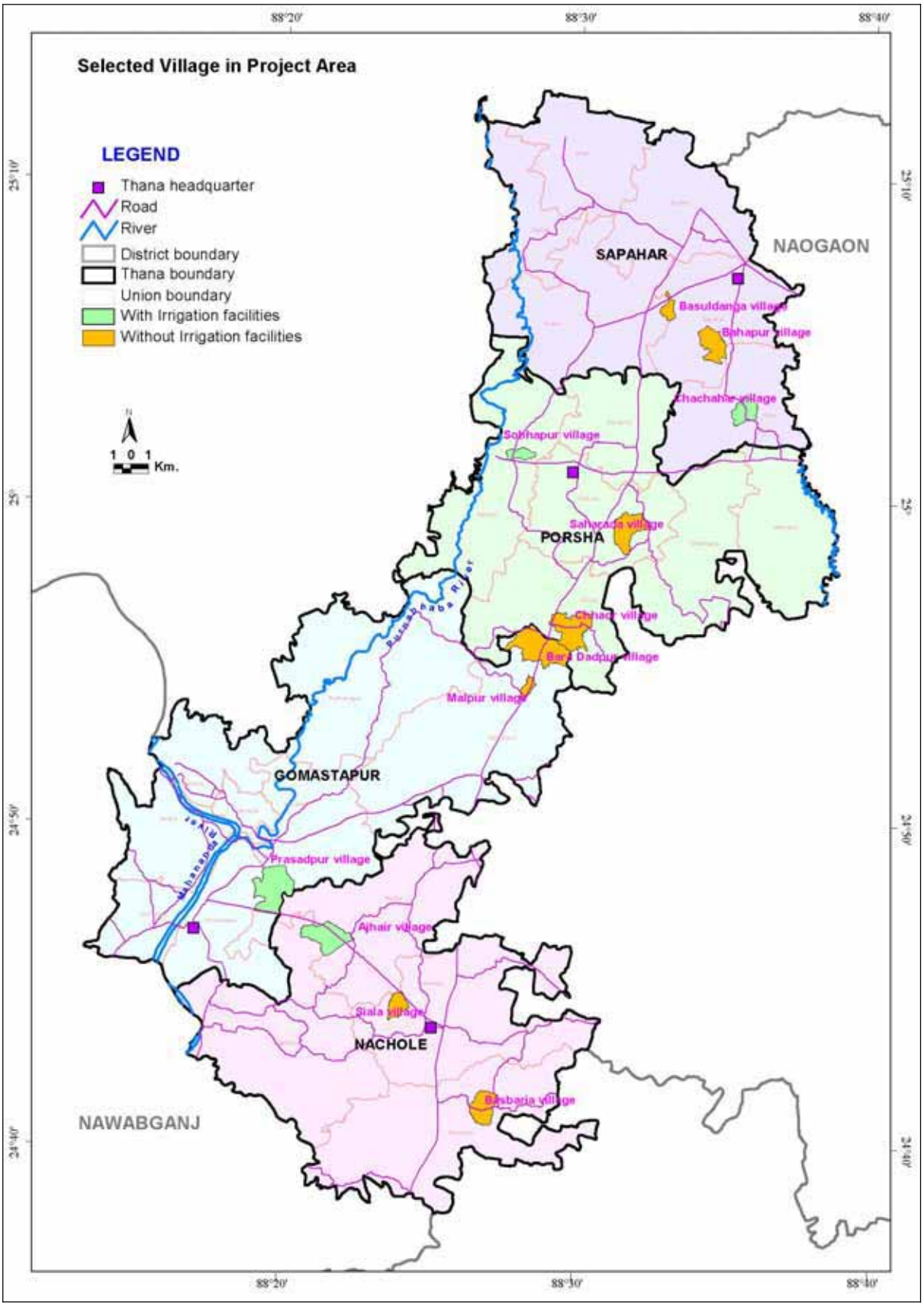


Figure 1-1. Pilot study area is shown in the map

2 Methodology

2.1 Sequential devising of the methodological measures

The study has developed under three phases (shown in figure 2-1). Vulnerability and Adaptation (V&A) profiling of the major vulnerable livelihood groups have been developed under several layers of methodological measures/ initiatives and in four sequential phases. In each phase, respective outputs have contributed towards the overall composition of the vulnerability and adaptation profiling.

Firstly: Review of secondary information and description of geophysical features of the study area.

Secondly: Reconnaissance field visit, elaboration of the methodology for the investigation and implementation.

Thirdly: Field assessment (comprising of PRA/RRA sessions, upazila and district workshops and key informant interviews), and

Fourthly: Analysis and document of the findings.

The activities of each phase are diagrammatically shown in the figure below.

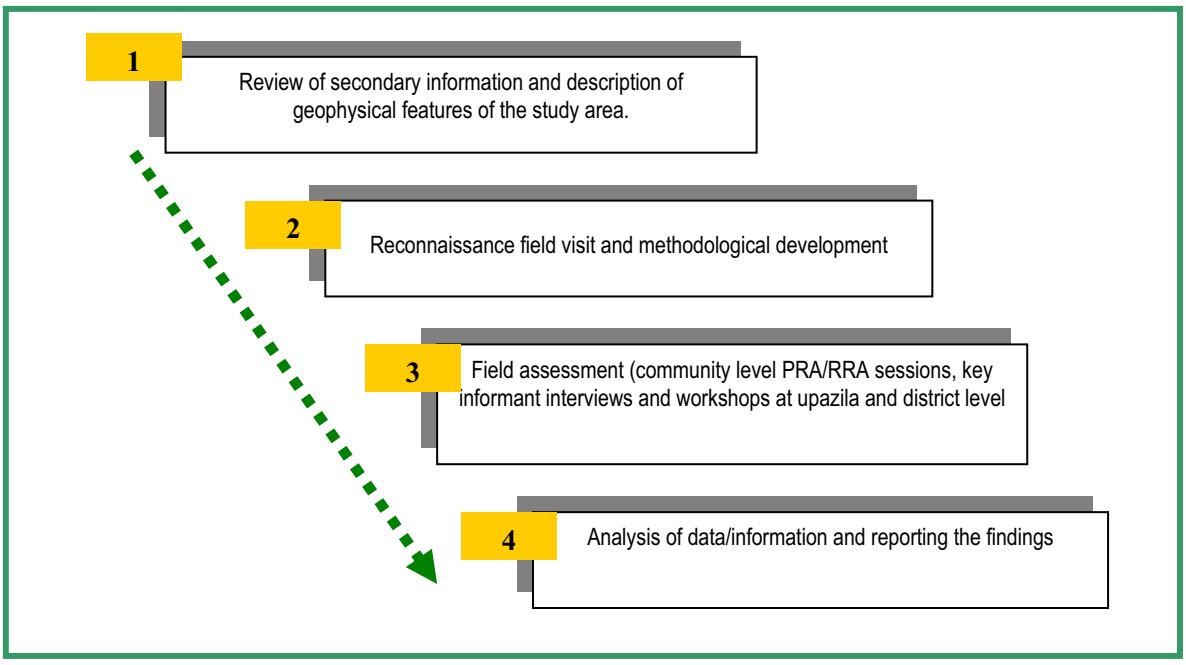


Figure 2-1. Sequential progression of four phases of the study

2.2 "Nature" and "representativeness" of the study

Focusing on the study objectives and the major study questions, the present study primarily devised with both quantitative and qualitative nature of investigation. Primarily in devising the physio-geographic features of the study area, the study developed a quantitative account and made use of existing secondary sources of available data.

In identification of the major vulnerable livelihood groups the secondary statistics from standard national statistics were used as well.

The vulnerable livelihoods profiling exercise (also some least vulnerable groups to see contrasts) on the other hand were devised largely following the innovative analytical framework of "Sustainable Livelihoods Framework (SLF)" from which rich qualitative understanding of the local realities have been developed. In these exercise, the major intention was to identify and understand the qualitative enriched intrinsic characteristics of the local livelihoods, their vulnerabilities and their adaptive strategies. A more detailed profiling of the agriculturally based livelihood systems was clearly outlined for practical implications.

In developing such profiles of the livelihood systems, climatic vulnerabilities, adaptive practices and institutional domains the question of 'representativeness' was addressed through **"multi-layer-multi-stakeholder validation and triangulation"**. In addressing the representativeness of the study findings, a ***"gradual up scaling method"*** based on various levels of validation (from individual to community and from upazila/district to national level) and ***"triangulation of multiple methodological techniques"*** of information collection -- such as PRAs, Key Informant Interviews, Community Sessions, matrix administration etc. -- have been conscious adopted as opposed to any strictly quantitative procedures of statistical representativeness.

In the following section (also outlined in the Table 2-1), the study methodology is outlined by detailing out the methodological measures that were applied in different phases.

Table 2-1. The methodological measure, issues, tools and sources

SL	Objectives	Analytical Issues	Methods/tools used	Sources
1	**Physical** descriptions and of secondary review	- Geographical locations - Humidity - Temperature - Rainfall - Rainfall surplus-deficit - ET - Ground water - Land physiography - Soils - Drainage class - Water bodies - Agriculture landuse - Major crops	- Secondary review - GIS based analysis	- BMDA, DAE, NWRD, BWDB, SRDI, and so forth.
2	Assess local **perceptions** of climate hazard, past and present climate risk/ impact.	- Local perceptions on climatic hazards - Local perceptions on impacts of various climatic risks/ hazards in the present situation	- Community level PRA sessions - Interviews	- Primary field data.
3	Study livelihood systems and establish **livelihood profiles** of the major vulnerable groups considering household categories (Land less, marginal, small, medium, large) their subgroups (if any) in 12 villages, a non-vulnerable group should also be profiled.	- Hazard characterization - Composition of livelihoods activities - Vulnerability factors - Temporal connotation of vulnerabilities - Impact of drought on livelihood activities - Local knowledge - Drought hazard management measures	- Community level PRA sessions - Interviews - Upazila level workshops	- Primary field data.

SL	Objectives	Analytical Issues	Methods/tools used	Sources
4	Investigate about **current and past (30 years) adaptive responses and coping strategies** of the vulnerable groups to risks in particular climate risk.	- Various types of adaptive practices and responses existing in the study area.	- Community level PRA sessions - Interviews - Upazila level workshops	- Primary field data.
5	Review the mandates, actual roles and capacities of communities and local **institutions/ organizations** (including local government agencies and self-help groups) in disaster prevention preparedness, as well as the service they offer and resources they can plan with.	- Following the existing methodologies developed in various earlier studies with FAO.	- Interviews - Upazila level workshops - District workshops	- Primary field data.

2.3 Review of secondary information

The study activities have started with the review of secondary information. The secondary review of the study was carried out looking at the various sources of information relating to three major domains.

- ◊ Geo-physical features of the study area [major sources are: NWRD, SRDI, DAE, BMDA and so forth];
- ◊ Relevant climate change adaptation related guidelines [e.g. guidelines on APF, NAPA etc.];
- ◊ Relevant climate change and adaptation related publications in Bangladesh;
- ◊ Existing project/study publications for Livelihoods and institutional profiling [e.g. National Water Management Plan (2005), CEGIS-SSDP (2005) study, CEGIS-FAO (2004), CARE (2002 and 2004) and so forth.];
- ◊ And other relevant literature and secondary sources of information.

2.4 Reconnaissance field visit

The study field activities have started with a reconnaissance field visit to the study upazilas. From 11-14 July, 2005 CEGIS study team has visited all the study upazilas and all then prospective study villages. Some the major outcomes of the study were as follows:

- ◊ Visit all four upazila field locations for observation of the field situation.
- ◊ Visit all 12 villages of the study area for finalizing village selection.
- ◊ Introductory discussion with the all four upazila and district DAE offices.
- ◊ Identification/selection of the study villages.
- ◊ Raw field findings for developing context based methodology and field instruments/protocols.
- ◊ Identify locations of the field sessions and workshops.
- ◊ Discussion with the community people and some key informants.
- ◊ Identification of the major vulnerable groups in the community.

2.5 Development of the detailed workplan

Follow up to the reconnaissance field visit the study team members have developed a detailed work-plan and forwarded to FAO and DAE for suggestion and clearance. The detailed work-plan then updated and the field activities have been planned with National Subcomponent Manager and other officials for organizing the field sessions and workshops accordingly.

2.6 Identification of the major vulnerable livelihood groups

An exercise of identification of the major livelihood groups has been performed by the CEGIS study team during the reconnaissance field visit (11-14 July, 2005). The major livelihood groups emerged in the study area are as follows:

- Farmer (small/marginal/large)
- Wage labourers
- Petty traders/businessmen
- Fishers (very few in numbers and primarily seasonal)
- Large businessmen (can be considered as least vulnerable)

From this initial identification of the livelihood groups existing in the study villages major livelihood groups and vulnerable groups have been selected. Detailed discussion on the selection process and relevant statistics are outlined in the Chapter 5 of the report.

2.7 Selection of the study villages

The twelve study villages have been pre-selected by the project and finalized to include in the study during reconnaissance stage. The villages are selected from all four study upazilas. From each upazilas both the irrigated and non-irrigated areas are considered. In each upazila two villages have been selected from the non-irrigated areas of the upazila and an irrigated village has been selected. The names of the villages and their categories are shown in the Table 2-2.

Table 2-2. Selected study villages by category

Sl. no.	Village	Union	Upazila	District	Category
1	Basuldanga	Sapahar	Sapahar	Naogaon	Non irrigated area
2	Bahapur	Sapahar	Sapahar	Naogaon	Non irrigated area
3	Chachahar	Tilna	Sapahar	Naogaon	Irrigated area
4	Sobhapur	Nithpur	Porsha	Naogaon	Irrigated area
5	Saharada	Tentulia	Porsha	Naogaon	Non irrigated area
6	Chhaor	Chhaor	Porsha	Naogaon	Non irrigated area
7	Bara Dadpur	Parbatipur	Gomastapur	Nawabganj	Non irrigated area
8	Malpur	Parbatipur	Gomastapur	Nawabganj	Non irrigated area
9	Prasadpur	Rohanpur	Gomastapur	Nawabganj	Irrigated area
10	Ajhair	Kasba	Nachole	Nawabganj	Non irrigated area
11	Shibpur/Siala	Nachole	Nachole	Nawabganj	Irrigated area
12	Bakail/Basbaria	Nizampur	Nachole	Nawabganj	Non irrigated area

2.8 Vulnerable group profiling and institutional analysis

The vulnerable group profiling and institutional analysis in this study has been developed focusing the study objectives. The methodological measures for the present has been developed both: a) taking experiences from the already established methodologies that are applied in the context of Bangladesh (e.g. CEGIS May 2004, CEGIS-DAE-FAO May 2005), and b) trying out innovative vulnerable group profiling approach to develop climate change specific vulnerability analysis that are useful for assessing climatic hazards and adaptive practices/responses at a local level.

Under the present study the **vulnerable group profiling** has been instrumented through:

a) Carrying out community level PRA/RRA sessions;

b) Carrying out upazila/district level workshops;

c) Key informant interviews; and

d) Community level observations and visual depiction through photography.

The **institutional analysis** was developed through:

a) Reviewing of relevant documents, policies and publications;

b) Carrying out community level PRA/RRA sessions;

c) Carrying out upazila/district level workshops;

d) Carrying out open discussions with relevant institutional professionals and local knowledgeable persons, and

e) Field observations by the researchers.

2.8.1 Community sessions

In each community session, discussions have been held with major livelihood groups in the community. Representatives of the various livelihood groups were present in the community level PRA/RRA sessions. In these sessions, intensive discussions were generated on the pre-devised matrices (see in the annex section for details) were filled out by the facilitators.

CEGIS team comprising experienced participatory appraisal facilitators have facilitated the discussion. These community sessions assessments were carried out adopting participatory approach and methods. This allowed participation of the vulnerable groups and inclusion of their respective community perspectives in a more pro-active interface. The primary focus was on the qualitative data but was converted to the matrices that ultimately allowed quantitative figures as well. The field team prior carrying out the field assessments have been trained in house by the study lead anthropologist on administering participatory tools and techniques in the field work.

In each of these sessions, a dedicated “note-taker” has been appointed for detailed documentation. In each community sessions a cross section of approximately twenty participants have participated. The community sessions were held at selected village locations.

2.8.2 Upazila and district workshops

In the upazila and district level sessions focus has been dual. In the upazila level workshops upazila level line agency professionals were present in the workshops. On the other hand in the district workshops district level officials of relevance participated. Some representatives from the upazila offices of respective districts have also participated in the district workshops.

Both the livelihoods and institutional issues along with adaptation issues (with possibilities) have been discussed in detail in these formal workshops. In the upazila workshops both matrices and the discussions were inspired. These sessions also remained participatory in nature.

Two district workshops were carried out in the study after completion of the four upazila level workshops. Taking a gradual scalling up approach the community and upazila level session findings were shared in these district workshops. Additional needed data and information have also been collected in these district workshops following "Delphi method" (through cards). At district level, more policy level issues have been collected to develop greater understanding of the vulnerability and the adaptation of the respective districts of the study area.

2.8.3 Key informant interviews

Additional to the community sessions and upazila level workshops, key informant interviews were carried out with various relevant people and professionals. Interviews were usually carried out in a "one to one" mode, "one to many mode" and in many cases with more "elderly informants/members of the community" as well. Some interviews were carried out with female members as well. Usually, after each community sessions researchers sat with respective key informants for such interviews in a more suitable locations preferred by the informants. Key informant interviews were carried out with relevant: a) institutional (i.e. agency) resource professionals, b) local knowledgeable people, c) livelihood group members; d) female members, and e) other associated people. Approximately over thirty such key informant interview sessions were carried out sporadically in four upazilas of the study area.

2.9 Arrangements and implementation of the phases

2.9.1 Organizing sessions and workshops with DAE offices

Prior collection of information from the field, the team members went to the field location again on 5 July, 2005 for organizing the community level field sessions and upazila workshops with the local upazila DAE offices and particularly with the respective SAAOs (earlier known as Block Supervisors) of the study area. The CEGIS field team has taken a formal "letter of invitation" from the National Subcomponent Manager requesting to participate in the participatory field information collection workshops and sessions. The respective SAAOs have been provided with a fixed amount of honorarium for their respective days of services in organizing the field activities and facilitating roles. This allowed the SAAOs the necessary field movements that were needed to organized the field activities with the CEGIS team.

2.9.2 Community level sessions and upazila workshops

The field information/data collection activities in terms of three following methodological measures have been carried out from 10 to 15 July, 2005. During this time CEGIS team carried out following number of activities:

- ◊ 12 community level session

The field activities, the CEGIS field team worked in three groups where each team comprised of following members:

- ◊ A facilitator from CEGIS,
- ◊ A note-taker from CEGIS,
- ◊ Respective SAAO,
- ◊ Community representative(s) for the workshop, and
- ◊ Observer/monitor (CEGIS/FAO/DAE).

A total of 406 participants attended the community sessions and upazila sessions. The details of the field sessions and workshops are shown in the following Table. The gray shaded rows are used for demarcation of upazila and district workshops that are of more formal nature.

Table 2-3. Details of the field sessions and workshops by dates

Date	Type of Session/ workshops	Venue	Name of Professionals			Number of participants
			CEGIS	DAE	MONITORS	
10 July, 2005 (Sunday)	Community session (Malpur)	Mulpur bazaar, Gomastapur	Md. Akbar Ali & Kazi Kamrul Hassan	Md. Mainul Haque (SAAO)	Atiq Kainan Ahmed (CEGIS)	44
	Community session (Prasadpur)	Prasadpur UP member's house, Gomastapur	Md.Aminur Rahman Shah & Susanto Paul	Md. Rabiul Islam (SAAO)	Depandra Mohon Saha (UAO, Gomastapur)	25
	Community session (Bardadpur)	Bardadpur School, Gomastapur	Md. Abdur Rashid & Bhudeb Sarkar	Md. Ashan Habib (SAAO)	Atiq Kainan Ahmed (CEGIS)	25
11 July, 2005 (Monday)	Community session (Basbaria)	Basbaria School, Nachole	Md. Akbar Ali & Susanto Paul	Md. Golam Murtoja (SAAO)	Atiq Kainan Ahmed (CEGIS)	25
	Community session (Sialia)	Community Location, Nachole	Bhudab Sarkar & Abdur Rashid	MD. Aminl Islam (SAAO)	Atiq Kainan Ahmed (CEGIS)	24
	Community session (Ajhair)	Community Location, Nachole	Md.Aminur Rahman Shah &Kazi Kamrul Hassan	Md. Motiur Rahman (SAAO)	Abdul Mannan (FAO) and Atiq Kainan Ahmed (CEGIS)	22
12 July, 2005 (Tuesday)	Community session (Basuldanga)	Basuldanga,School Sapahar	Md. Akbar Ali & Kazi Kamrul Hasan	Ranjit kumar Shingha (SAAO)	A.B.M. Mustafizur Rahman (UAO, Sapahar, DAE), Abdul Mannan (FAO), and Atiq Kainan Ahmed (CEGIS)	39
	Community session (Bahapur)	Bahapur School Sapahar	Md.Aminur Rahman Shah & Abdur Rashid	Denischandra Sarkar (SAAO)	Abdul Mannan (FAO) A.B.M. Mustafizur Rahman (UAO, Sapahar, DAE) and Atiq Kainan Ahmed (CEGIS)	25

Date	Type of Session/ workshops	Venue	Name of Professionals			Number of participants
			CEGIS	DAE	MONITORS	
	Community session (Chachahar)	Chachahar Madrasha, Sapahar	Susanto Paul & Bhudab Sarkar	Saydur Rahman (SAAO)	A.B.M. Mustafizur Rahman (UAO, Sapahar, DAE), Abdul Mannan (FAO), and Atiq Kainan Ahmed (CEGIS)	23
13 July, 2005 (Wednesday)	Community session (Sobhapur)	Community Location, Porsha	Md.Aminur Rahman Shah & Kazi Kamrul.	Md. Mahatab Uddin (SAAO)	UAO, DAE (Porsha)	25
	Upazila level Workshop (Gomastapur)	Upazila Parishad Hall Room Upazila: Gomastapur District: Nawabganj	Susanto Paul & Bhudev Sarkar	All respective SAAOs.	Depandra Mohon Saha (UAO), Abdul Mannan (FAO), and Atiq Kainan Ahmed (CEGIS)	29
	Upazila level Workshop (Nachole)	Upazila Parishad Hall Room Upazila: Nachole District: Nawabganj	Md. Akbar Ali & Abdur Rashid	All respective SAAOs.	UNO (Nachole), Md. Mizanur Rahman (UAO, DAE), and Abdul Mannan (FAO),	16
14 July, 2005 (Thursday)	Upazila level Workshop (Porsha)	Upazila Parishad Hall Room Upazila: Porsha District: Naogaon	Susanto Paul & Md.Aminur Rahman Shah	All respective SAAOs.	Md. Rafiqul Islam (UAO, Porsha), Abdul Mannan (FAO), and Atiq Kainan Ahmed (CEGIS).	22
	Upazila level Workshop (Sapahar)	Upazila Parishad Hall Room Upazila: Sapahar District: Naogaon	Abdur Rashid & Kazi Kamrul Hassan	All respective SAAOs.	TNO (Sapahar) A.B.M. Mustafizur Rahman (UAO, DAE, Porsha).	17
	Community session (Saharanda)	Community Location, Porsha	Md. Akbar Ali & Bhudeb Sarkar	Md. Joynal Abedin (SAAO)	-	25
15 July, 2005 (Friday)	Community session (Chhaor)	Community Location, Porsha	Md. Akbar Ali Kazi Kamrul Hassan	Md. Ganioul Islam (SAAO)	-	20
Total no. of participants in the community sessions and upazila workshops =						**406**

Source: CEGIS study database (2005).

2.9.3 District level workshops and central validation meeting

The CEGIS team jointly with ADPC has organized two district workshops where the team presented field findings according to the study objectives for validation and also collected some additional data for further analysis.

A central level validation meeting was also held at DAE headquarters where a cross section of fifteen agency representatives, researchers and central officials participated and validated the study findings at a central level. The draft final report was also circulated to various groups for comments and the comments were incorporated in the final (present) document.

Table 2-4. Dates, venue and participation related information of the district workshops

Date	Districts	Venue	Name of Professionals			Number of participants
			CEGIS	DAE	MONITORS	
16 August, 2005 (Tuesday)	Nowabganj	RHRI Hall Room, Chapai Nawabganj.	Atiq Kainan Ahmed, Ehsan Hafiz Chowdhury, Akbar Ali and Sushanto (CEGIS). Dr. Silvaraju (ADPC)	NPD, DD-DAE Chapai Nowabganj, all respective UAOs and SAAOs.	Mr. Tariqul Islam (UNDP) and Dr Mahmudul Islam (FAO).	42
17 August, 2005 (Wednesday)	Naogaon	DD-DAE office Hall Room, Naogaon.	Atiq Kainan Ahmed, Ehsan Hafiz Chowdhury, Akbar Ali and Sushanto (CEGIS). Dr Silvaraju (ADPC)	NPD, DD-DAE Naogaon, all respective UAOs and SAAOs.	Mr. Tariqul Islam (UNDP) and Dr Mahmudul Islam (FAO).	38
Total participants in two district workshops =						**80**

Source: CEGIS study database (2005).

2.10 Analysis of information

The information collected through the workshops and the review of secondary data was analyzed by the research team. Standard analytical process for analyzing qualitative and quantitative data/ information was developed.

In developing the data analysis for qualitative raw data, standard spreadsheet analysis and GIS based technologies based on ARCGIS were used. The analysis of descriptive statistical figures was also developed with spreadsheets. Several types of prioritization and rankings were also performed using such software.

In order to develop qualitative analysis and synergies several standard applied anthropological methods were used. Standard code based methods, use of Microsoft access and compilation of field regular notes were generated to develop comparative analysis and primary accounts.

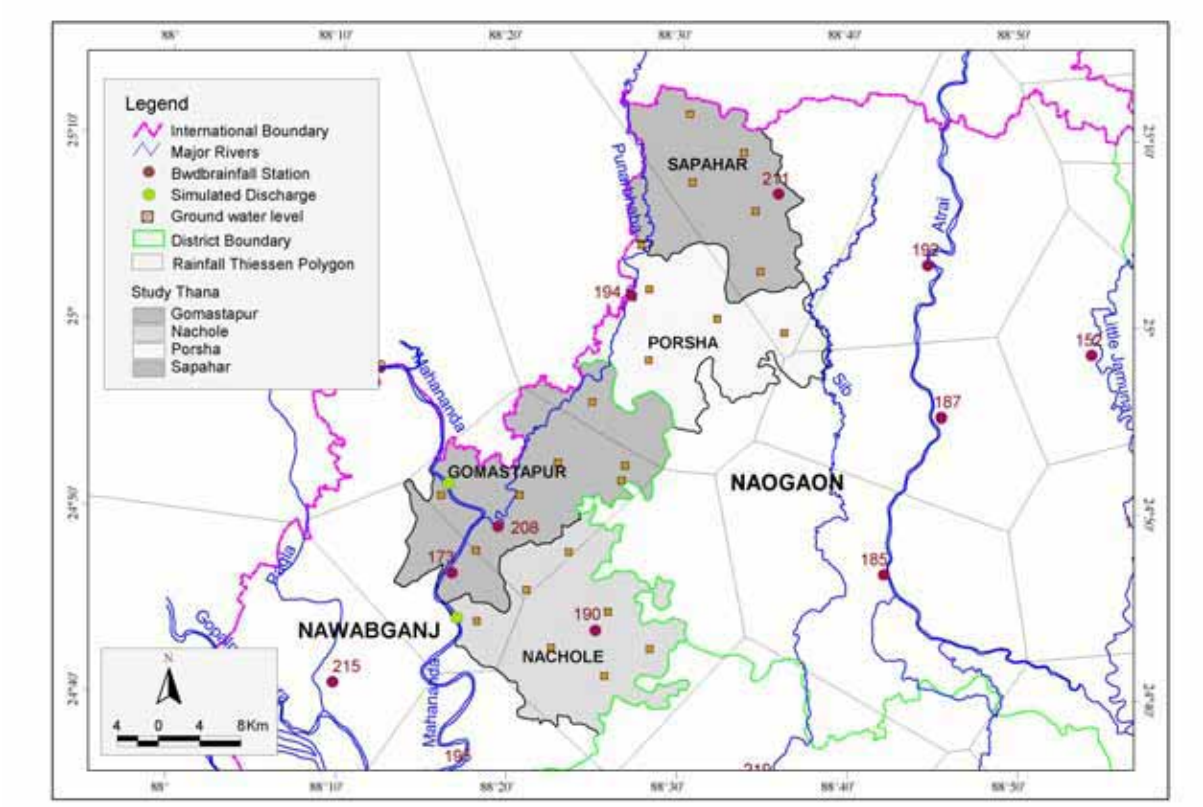
In order to reach adequate understanding of the local patterns of practices a strong concentration on the visual applications were used. A collection and preservation procedure of regular field photographs with thematic connotations has been adopted. This allowed presenting the findings in more visual manner of the local contexts and meanings.

3 Physio-geographic environment and framework conditions

3.1 Geographical Locations

The study area is situated in the Northwestern region of the country at 88°10'-88°40'longitude and 24°40'-25°10'latitude. It covers the part of Naogaon and Chapai-Nawabganj districts of the region. The study areas are mainly bounded by the *Punarbhava* and *Mohananda* river in the west and *Sib-Barnai* river in the eastern side of Porsha upazila. The location map of the study area is shown in the figure below.

Figure 3-1. Location map of the study area



3.2 Data collection and secondary review

To analyze the physio-geographic nature of the study area, different secondary data and information is collected. The National Water Resources Database (NWRD) is mainly used for different types of spatial and temporal data layers. NWRD holds information from different agencies, those who are involved in the collection of primary data. Primary data is analyzed for the present study to look in to the different physical properties along with hydro-meteorological parameters. Different model results are used from the secondary sources for describing the hydrological characteristics of the area. Mainly ground water resources and surface water flow information are reviewed from Groundwater model results of WARPO and MIKE11 model results of NWMP. The drought severity in the areas is also investigated using the Drought Assessment framework (DRAS) for T Aman crop during the Kharif season on average year condition.

The table below describes the data and information gathered from the agencies along with the period of data availability. Figure 3-1 shows the location of hydro-meteorological stations used for analysis and representation of other geophysical features of the study area.

Table 3-1. Data interpreted for describing the geo-physical characteristics of the study area

Data Layer	Data Source	Period of data	Parameter Observed	Station Investigated
Meteorological parameters	BMD	1960-2002	Temperature, Wind speed, Humidity, Sunshine	Dinajpur, Rajshahi
Rainfall	BWDB	1960-2000	Rainfall Pattern	Gomastapur, Mohadevpur, Nachole, Nazirpur, Chapai-Nawanganj, Rohanpur, Sapahar
Groundwater	BWDB/ WARPO	1960-2001	Groundwater Depth	NAO046, NAO051, NAO501, NAO502, NAO505, NAW002, NAW004, NAW005, NAW006, NAW007, NAW008, NAW011, NAW508, NAW509
Lithology	BWDB	-	Subsurface geology	GL7037007, GL7037002, GL7056011, GL7056015, GL7056014, GL7056012, GL6479003, GL6479006, GL6479004, GL6486001, GL6486007, GL6486005
Surface water	BWDB/ NWMP	1965-2003	Surface water flow	Rohanpur, Mohananda

3.3 Topography

The general topography of the study area is ranges from 15 to 50 meter Pwd (Figure 3-2). The Barind area is mainly high comparatively than the other part of the flood plains. The western side of the study area is composed of flood plain soil, which is depressed area and inundates from average year flooding due to spillage of riverbanks.

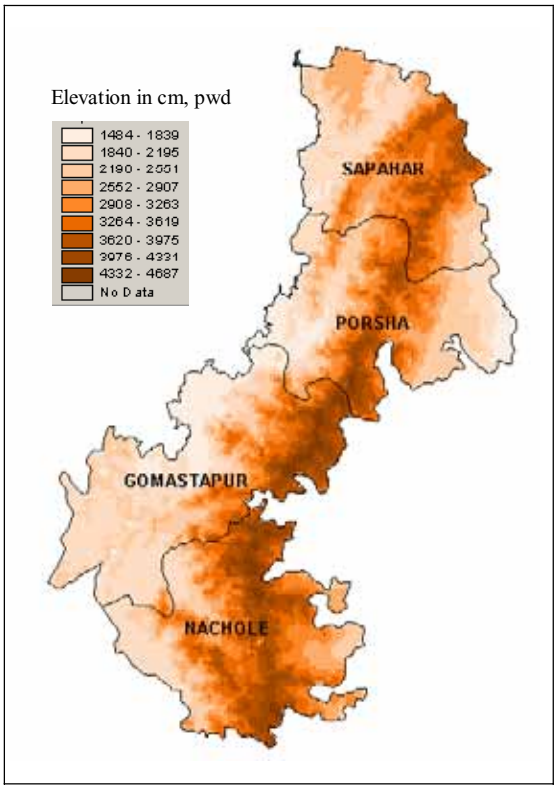


Figure 3-2. General Topography (DEM)

3.4 General Physiography

The study area is mainly constituted by four major physiograpy. These are High Barind Tract, Level Barind Tract, Lower Punarbhava Floodplain and High Ganges River Floodplain. High and Level Barind Tract covers most of the study area (75%), mainly in the central part of the upazilas. Lower Punarbhava Floodplain covers only 12% of the study area in the western side and High Ganges River Floodplain covers 13% in the Gomastapur and Nachole upazila. Figure 3-3 shows the major physiography of the study area.

3.4.1 Nachole Upazila

The area is constituted by two major physiography: Barind Tract and Ganges River Floodplain. The Ganges floodplain soil is on the western side of the upazila covering 9% and the 91% of the area is occupied by Barind soil. Generally High Barind area is not flooded in the rainy season, but Level Barind area is subjected to inundation upto 90 cm and stayed a maximum of 1-2 months under water during monsoon season. The Ganges floodplain mainly covers highland and some beel areas. The beel areas are generally inundated from slight to moderate depth during the monsoon.

3.4.2 Gomastapur Upazila

Gomastapur upazila is mainly constituted by four physiography. These are Barind Tract, New and Old Ganges Floodplain and Punarbhava floodplain. Around 47% of the Upazila covers the Barind area. It is generally 2 to 5 meter higher and older deposit than the floodplain soil. These areas are normally free from floods except some lower patches inundated to shallow depth. New Ganges floodplain (2.8%) is almost flat in nature with some highland. Highland is not flooded during the monsoon. Old Ganges floodplain (26.1%) is consisting of medium high to high land and Beel area. Punarbhava floodplain (13.4%) is on the northwestern side of the upazila and comprises of flat and deep Beel areas. The Beels are connected with the river and the area is flooded moderate to deeply during monsoon season.

3.4.3 Porsha Upazila

Porsha upazila is mainly comprised of two major physiography: Barind Tract and Punarbhava Floodplain. Around 75% of the land is constituted by Barind soil and the rest is by the deposit of Punarbhava floodplain soil. The Barind Tract is generally 2 to 4 meter high than the floodplain, which is again divided into two types of land: High Barind and Level Barind Tract. High Barind area is not normally flooded but Level Barind area flooded upto 90 cm of depth and inundated from 1 to 2 months time in an average monsoon season. The Punarbhava floodplain is almost flat land. A large number of Beels and water bodies are found in the area, which is generally flooded from shallow to deep during the monsoon season.

3.4.4 Sapahar Upazila

The upazila is mainly covered by two major physiograpy: Barind and Teesta Floodplain. The Barind area covers 74.6% of the upazila. It is mainly consists of wide flat terrace and valley areas. Barind area is generally 1 to 2 meter higher than the floodplain and relatively older deposits. Normally valley separates the trace areas, which helps in draining out the water naturally. High terrace and valley areas are free from flooding but lower areas are subjected to flooding in the monsoon season. Teesta floodplain (15.4%) is mainly constituted by Highland and Beel area. High lands are not flooded, but low land and Beel areas are flooded during the monsoon season.

3.5 Soils

The major soils of the study upazilas are Clay-Clayey loam and Loam soils. Clay-Clayey loam-Loam soil (98%) dominates the area with a small portion of Sandy loam (2%) soils. The top and sub soil is generally Clay to Loam and substratum is dominantly Clay soil. Table 3-2 shows the drainage characteristics of the study area. The internal drainage characteristic of the soil is generally imperfectly drained i.e. water seepage from the soils at a slower rate and normally water does not stand on the surface for more than 15 days, but sopping wet in the rainy season. Surface water drains out during the month of mid September to October, and land is paced for cultivation for Rabi crops. The general characteristics of the soils in the selected upazilas are shown in Tabular format in Annex

A. It describes the soil characteristics by series depicting the geo-physical parameters by land types and soil depth.

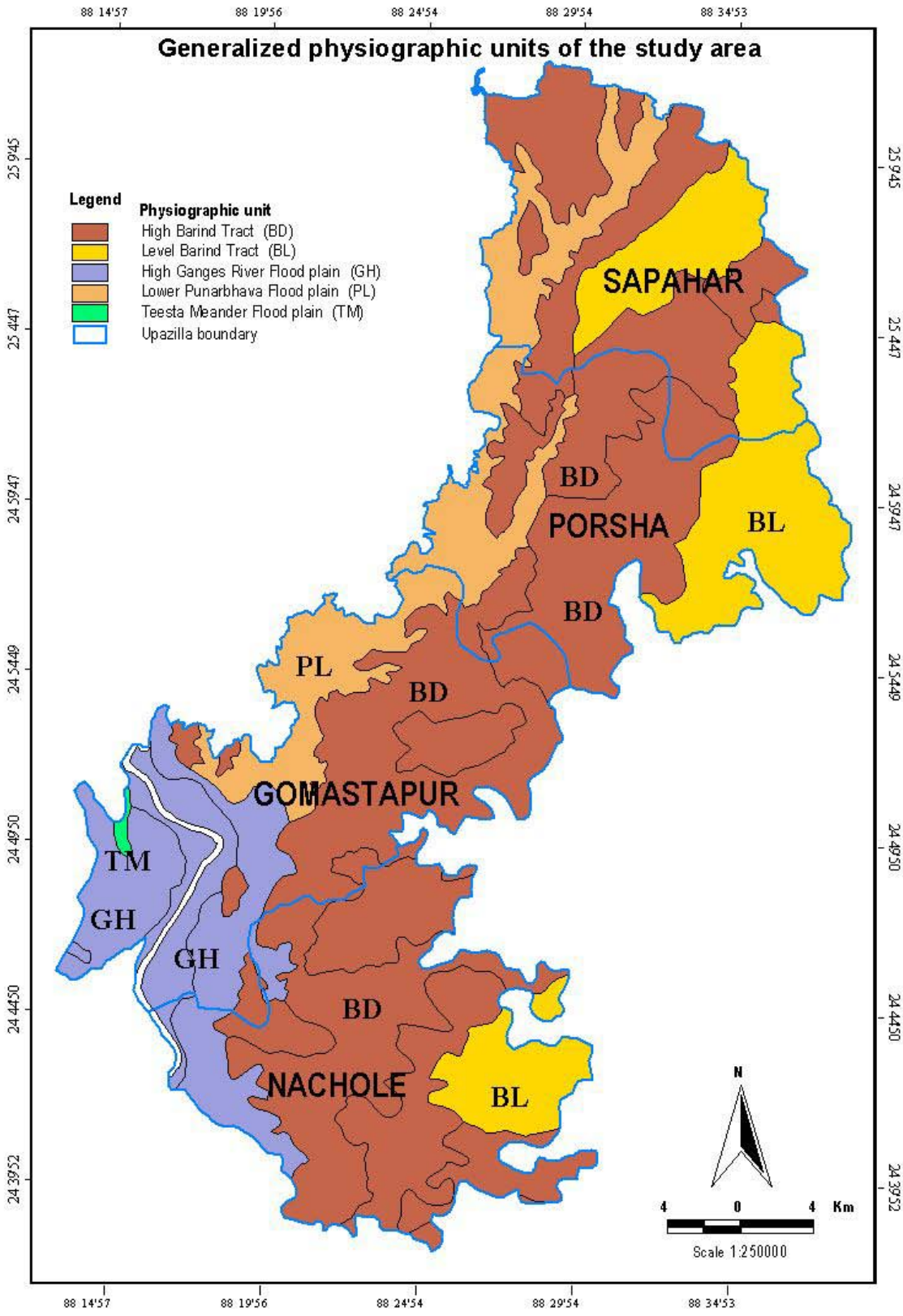


Figure 3-3. Major physiography of the study area

Table 3-2. Drainage classification of the study area in percentage

Upazila	Drainage Class		Surface drainage				
	IPD	POD	VER	NOR	ERL	LAT	VLT
Nachole	92	8	89	1	5	5	-
Gomastapur	71	29	65	2	12	16	5
Porsha	83	17	81	-	2	3	14
Shapahar	83	17	82	-	1	3	14

IPD=Imperfectly drained, POD=Poorly drained, VER=Very early, NOR=Normal, ERL=Early, LAT=Late, VLT=Very late

3.6 Lithology

Subsurface lithology is the prime parameter to delineate extent and thickness of aquifer. A number of borelog information is available in the study areas, which are drilled by BWDB, BADC and BMDA. The logs cover a depth ranges from 40m to 300m in different location. Most of the borelogs identified in the Porsha and Saphar upazila shows that the properties of upper layer is of plastic clay upto 30m and in the lower part it is consists of coarse to fine sand. Plastic clay are sedimentary in origin. Old rivers and streams washed kaolinite (formed from decomposed granite) from its parent rock. As the streams flowed from upland areas the kaolinite mixed with other clay minerals, sands, gravels and vegetation before settling in low-lying basins to form overlaying seams of plastic clay.

Brown clay with silt is observed in the Gomastapur and Nachole upazila mainly in the upper layer and medium to coarse sand is found in the lower part. Topsoil of the area is mainly composed of clay material indicating low percolation rate as well as low moisture holding capacity. Recharge characteristics is also poor in the study area due to slow percolation rate from soils. Some of the borelogs of the study area is presented in Annex A.

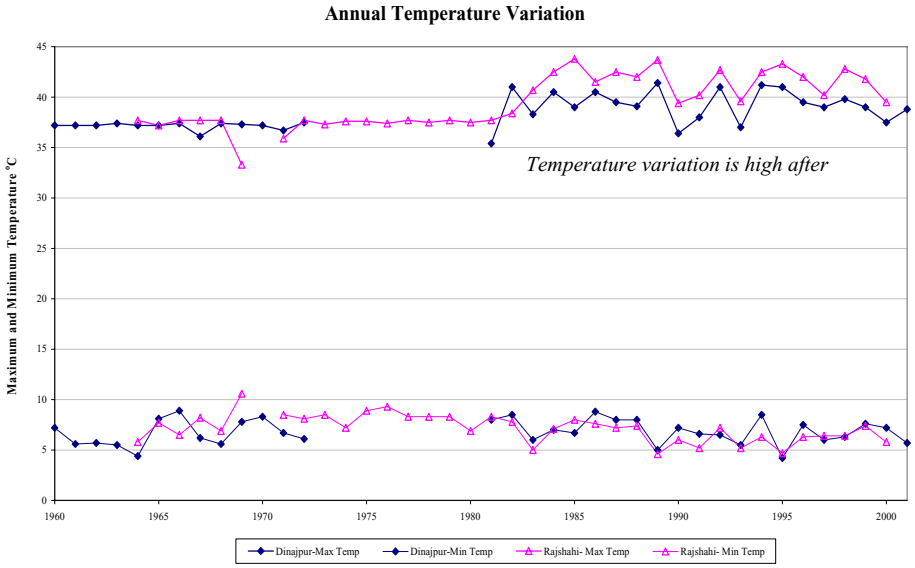
3.7 Climatic Parameters

Climatic parameters are investigated in the study using the temporal data from BWDB and BMD. Rainfall distribution along with its pattern is shown from long time series data of 1960-2000. Climatic factor such as humidity, sunshine, wind speed and temperature data is analyzed using the time series data and trend is generated. The stations are selected on the basis of Theissen polygon method using GIS application.

There is little variation of climatic parameters in the study area. The climatic parameters of the study area are presented in the Table in Annex A. The mean annual total rainfall varies from 1400- 1500mm in the study area. But the dry season rainfall is only 18%-22% of the mean annual rainfall. Annual total evapo-transpiration in the study area varies from 1245-1350 mm.

The mean annual temperature is around 250 C and mean minimum and maximum temperature varies from 16-350 C. High temperature is generally observed in the month of April and May and lowest in the month of January. The recorded maximum highest temperature is observed as high as 440 C and as low as 40 C. Trend of temperature shows that the high temperature is increasing in the recent decades. The rate of change of temperature is almost same upto 1982 and after that the temperature variation is very high as shown in Figure 3-4.

Figure 3-4. Annual temperature variation in the study upazilas



Mean humidity is around 72% and sunshine hour ranges 6.5-7 hrs in the study area. Mean wind speed is around 90kpd and high wind speed (155kpd) is observed in the month of May and June.

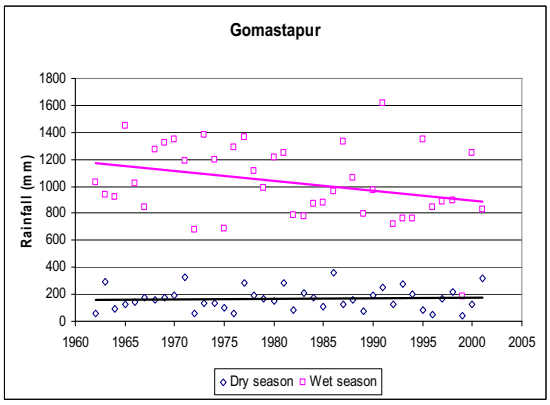
3.8 Rainfall Pattern/Trend

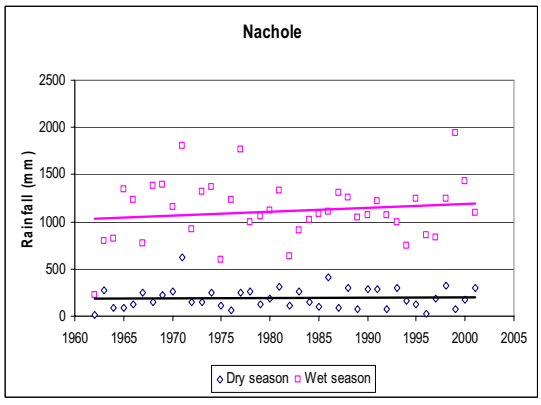
Rainfall distribution of the study area shows that annual total rainfall in the study area is almost similar in nature and long-term trend is not prominent. The long-term rainfall distribution and trends is shown in Figure 3-3 to 3-5.

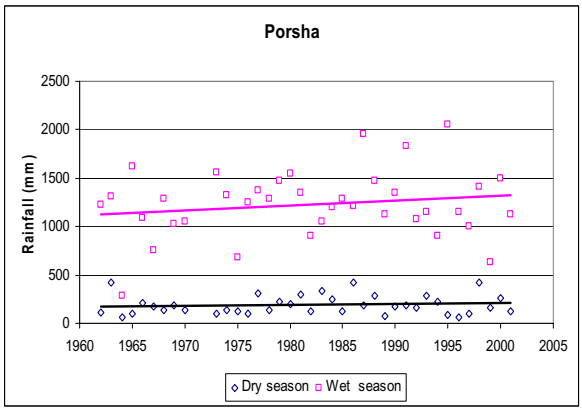
In all the selected upazilas, the monsoon rainfall shows an increasing trend except Gomastapur. In Gomastapur the trend of rainfall is little bit low. The dry season rainfall is almost similar and no prominent change is observed. The distribution of non-rainy days over the year is not also visible prominently, but the amount and distribution of rainfall is changing over the years.

Table 3-3 shows the amount of annual total rainfall in different months of the year.

Figure 3-3 to 3-5. Rainfall trend in the study upazilas







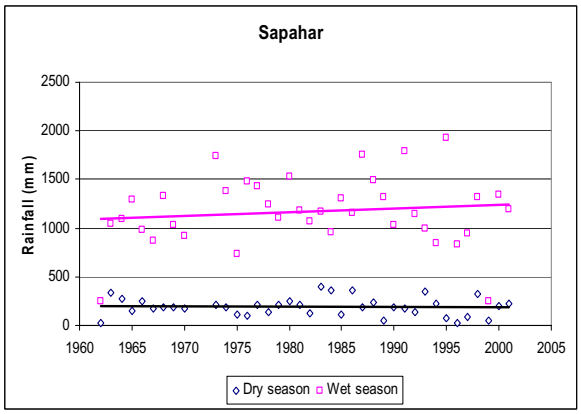
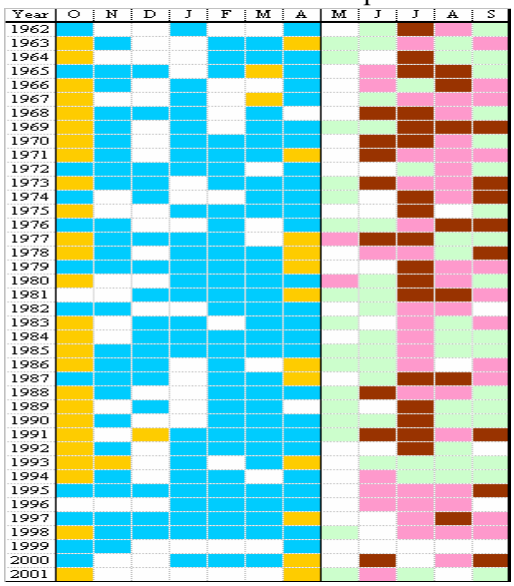
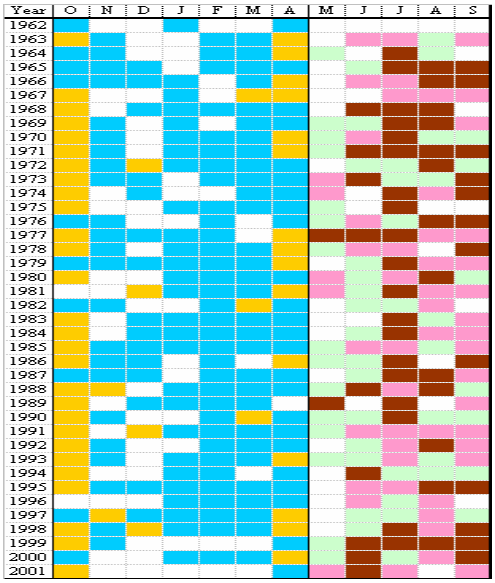


Table 3-3. Monthly total rainfall and its distribution in the study upazila

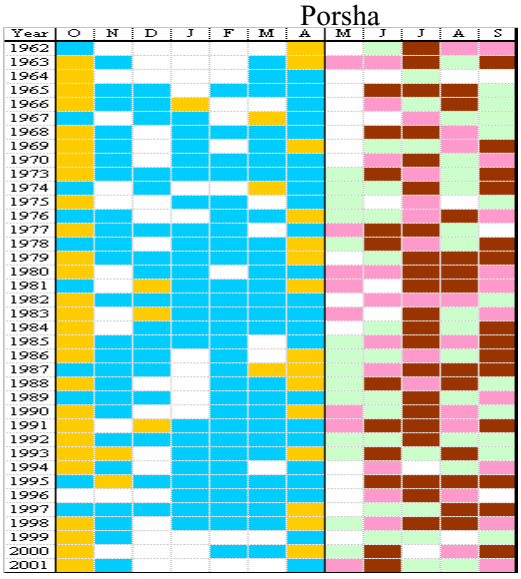
Gomastapur



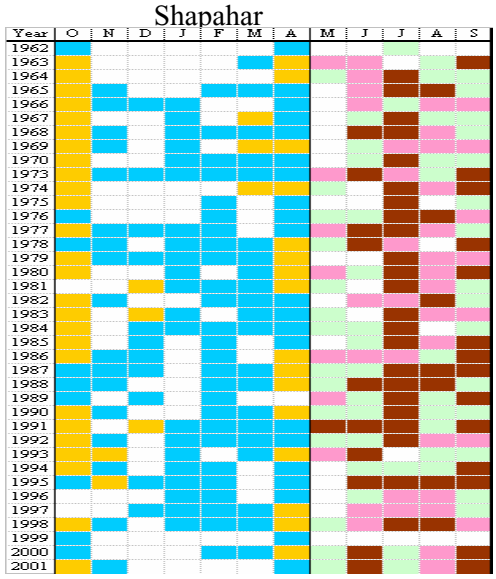
Nachole



Porsha



Shapahar



Legend:

Dry season		Monsoon season	
	Zero rainfall		< 100 mm
	< 50 mm		100 - 200 mm
	> 50 mm		200 - 300 mm
			> 300 mm

3.9 Rainfall Excess-Deficit

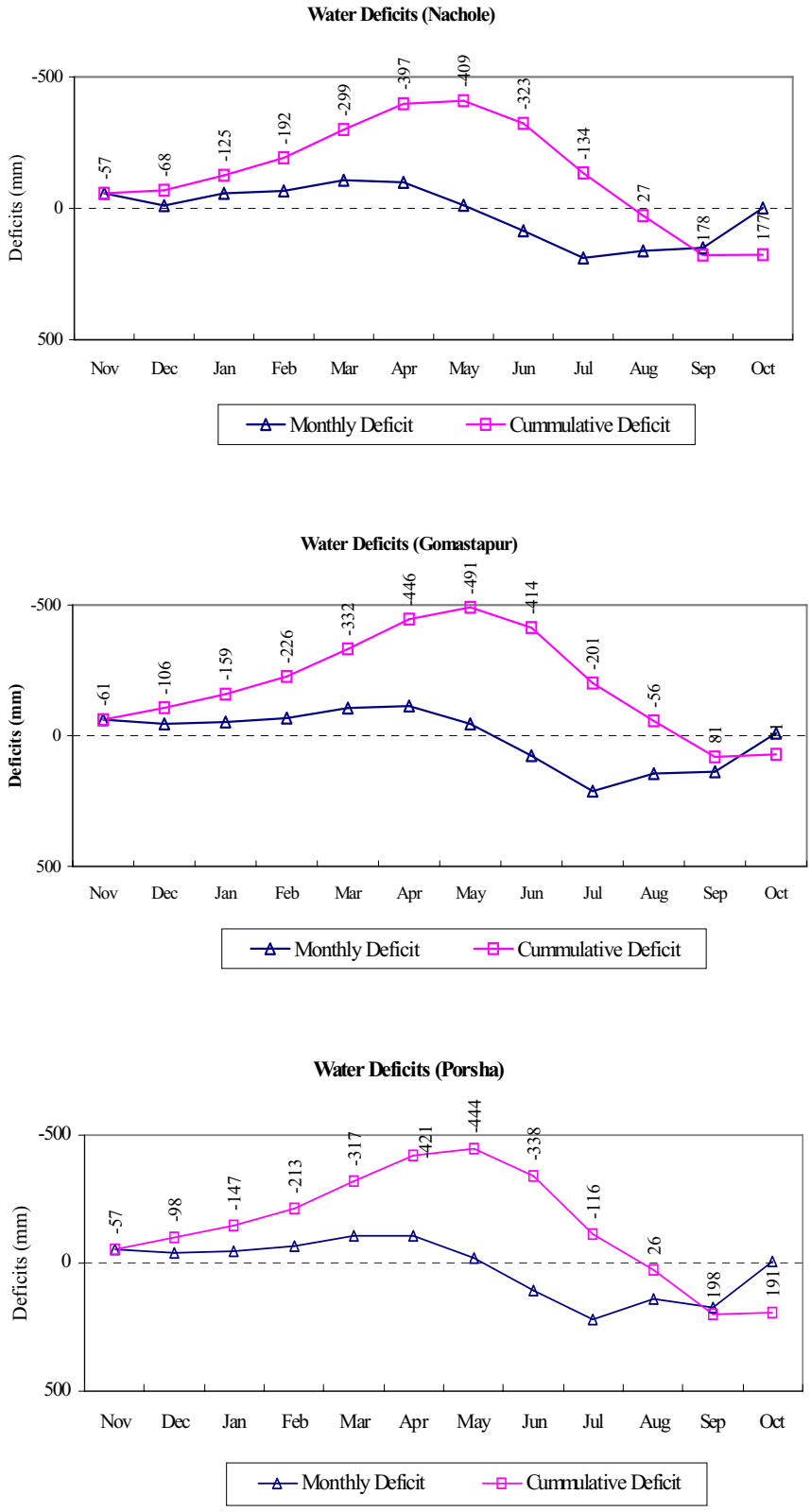
Rainfall plays an important role in mitigating the drought if it is distributed uniformly over the season. The rainfall excess and deficit could be helpful to look at the position of drought susceptibility in the study area. The difference between mean seasonal and dependable rainfall shows the variation between the expected and mean values. Table 3-4 shows the agriculture crop water demand (ET) and total rainfall distribution in the study areas for two different seasons. It shows that the water deficit exists in the dry months of the year, as the demand is higher than the total rainfall. During dry season, the rainfall meets only 50% of the ET requirement in the study area.

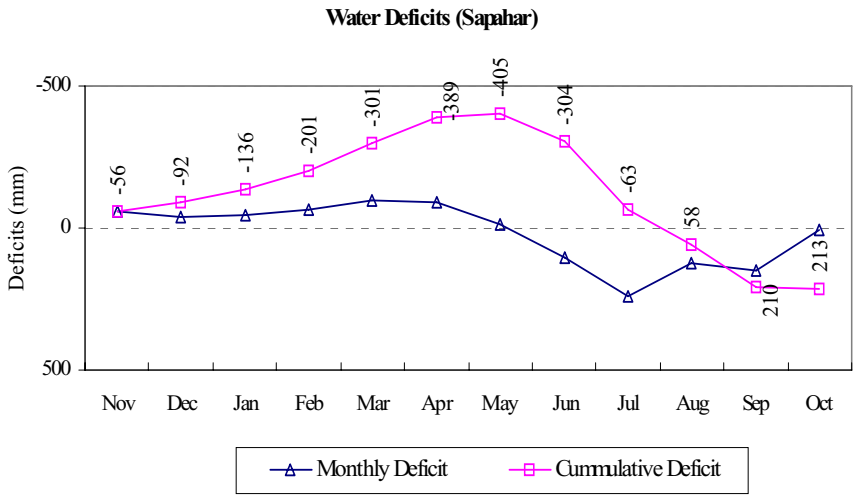
Table 3-4 . Seasonal balance of rainfall excess and deficit (mm)

Season	Parameter	Nachole	Gomastapur	Porsha	Sapahar
Monsoon season (June - October)	Rain (R)	1174	1150	1213	1176
	80% Dependable Rain (DR)	607	494	630	599
	ETo	588	588	578	558
	R - ETo	586	562	636	618
	DR - ETo	19	**-94**	52	41
Dry season (November - May)	Rain (R)	349	267	289	282
	80% Dependable Rain (DR)	57	53	74	58
	ETo	757	757	733	687
	R - ETo	**-409**	**-491**	**-444**	**-405**
	DR - ETo	**-700**	**-705**	**-660**	**-630**

During monsoon, the available rainfall may fulfill the crop water demand but during the dry season deficit is large to meet the demand. The demand is creeping during the dry months of the year and maximizes in May (Figure 3-6). The figures show that the dry season deficit is very high where as during the wet season, surplus rainfall is observed in all the four study areas. So to meet the crop water demand for the study area alternative sources are needed to investigate.

Figure 3-6. Water Deficits in the study area (Annual mean rainfall and ET condition)





3.10 Flooding and Surface water flow

As the study area covers mostly high land to medium high land, it is non-flooded during the average flood year. All the upazilas have large percentage of non-flooded areas except the Gomastapur upazila. Low-lying areas of the Gomastapur upazila are generally flooded from the Punarbhava and Mohananda river each year. Different areas are flooded with different degrees of inundation. Table 3-5 below shows the depth of inundation in the study upazilas. Around 5%-20% area goes under 90 cm to 180 cm of flooding and 80% of the area is non-flooded during average monsoon season. The area elevation curve generated for each upazila from the Digital Elevation Model (DEM) shows similar land type pattern.

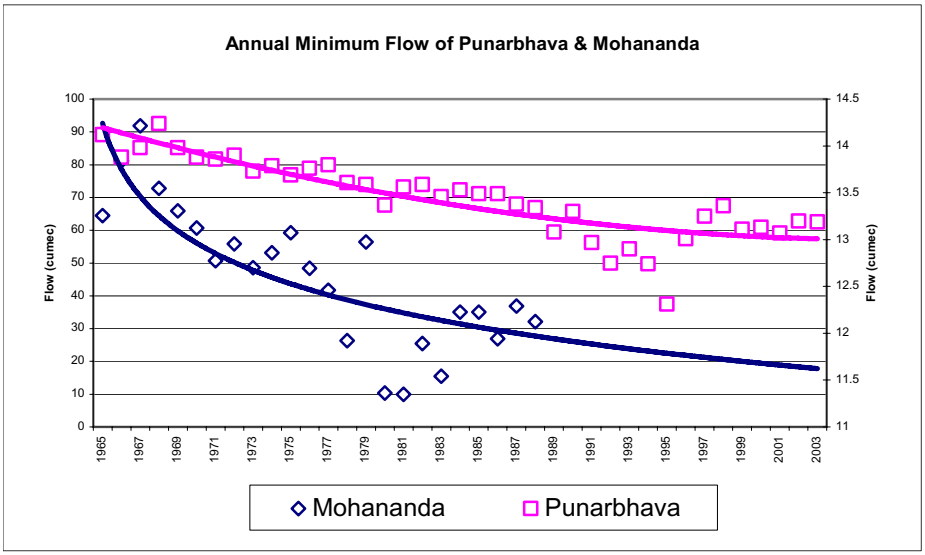
Table 3-5. Flooding situation in average year condition

Upazila	Non-flooded area (%)	Flooded area (%)			
	F0 < 0.3 m	F1 0.3 – 0.9 m	F2 0.9 – 1.8 m	F3 1.8 – 3.0 m	F4 > 3.0 m
Sapahar	81.7	6.9	10.5	0.9	-
Porsha	81.0	2.0	3.0	14.0	-
Gomastapur	65.0	12.0	6.0	12.0	5.0
Nachole	89.0	6.4	3.2	1.4	-

Source: SRDI

The main surface water sources of the study areas are Mohanada and Punarbhava river. The monsoon flow volume of the two rivers is sufficient enough to mitigate the agricultural demand of crops. But during dry season, the flow reduces appreciably and it is difficult to mitigate the potential suitable areas with the available resources. The long-term annual minimum flow describe that the volume of water in the rivers is reduced alarmingly over the years.

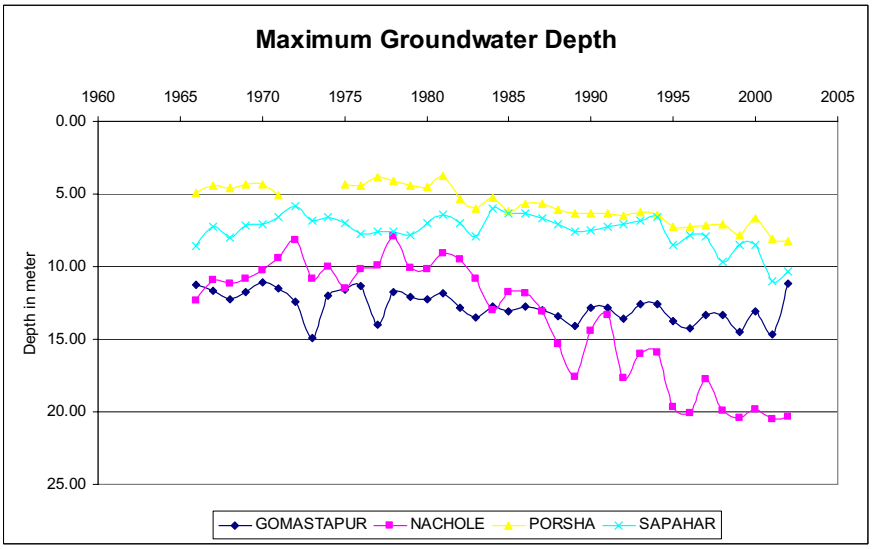
Figure 3-7. Minimum river flow of Mohananda and Punarbhava river



3.11 Groundwater situation and resources

Groundwater level data is analyzed to assess the groundwater situation during different months of the year. Data has been analyzed from 1960 to 2000. The depletion of groundwater table in the study area shows a remarkable draw down from early eighties. The groundwater table hydrograph is drawn from a selected number of wells in the study area. The mean ground water table in Nachole area shows that it was within 3 to 10 meter from the surface during 1980's. Groundwater is depleted more than 8 meters during the last ten years and recent trend shows the rate of depletion is much more prominent. During the dry season the ground water table depleted down to 14-20m in Nachole and Gomastapur upazila, whereas in Porsha and Sapahar upazila, the ground water table is within 6-10m.

Figure 3-8. Groundwater depth from surface of the study area



Groundwater resources estimated by NWMP shows that the resources are constraint for irrigation from the upper aquifer layer. Assuming 50% irrigation development potential, the most of the area will go under deep irrigation system. Only low lying areas of Porsha upazila can be under irrigation facilities from the DSSTW within 9 meter of the ground. But under full irrigation development

condition, the groundwater table will go further deep and DTW irrigation system is required, as the ground water will be depleted below suction limit of DSSTW and other modes.

Table 3-6. Groundwater development potential by irrigation mode

Upazila	50% Development Level					100% Development Level				
	ET-ER	F0	F1	F2	F3	ET-ER	F0	F1	F2	F3
Sapahar	119	DTW	DTW	DTW	DTW	476	DTW	DTW	DTW	DTW
Porsha	117	DTW	DTW	DSSTW	DSSTW	410	DTW	DTW	DTW	DTW
Gomastapur	189	DTW	DTW	DTW	DTW	528	DTW	DTW	DTW	DTW
Nachole	205	DTW	DTW	DTW	DSSTW	486	DTW	DTW	DTW	DTW

Source: NWMPP, 2001

(ET-ER) - Groundwater demand for irrigation in mm/unit of gross area

DP4 – Groundwater model simulation with different deep percolation rates for different types of soils. DP4 has been adopted in recognition of residual uncertainties in the parameter reconstruction.

3.12 Groundwater Development

Irrigation development in the selected upazilas show that the both surface and groundwater irrigation practices increased appreciably from 1980's to onward. The temporal analysis of National Minor Irrigation Census (NMIC) irrigation census data depicts that the irrigation coverage is increased at large scale from 1985. This is due to the initiation of extensive groundwater development by BMDA in the region. Figure 3-8 shows the trend of groundwater development of the study areas. Irrigation practices in the Porsha upazila are highest and in Nachole upazila is the lowest. Depletion of groundwater table in Porsha upazila is within the suction limit of STW/DSSTW whereas in the Nachole upazila, the groundwater depletion is more than 20 meters from the ground, which is beyond DSSTW suction limits (Figure 3-9).

Figure 3-9. Groundwater development in the selected upazilas

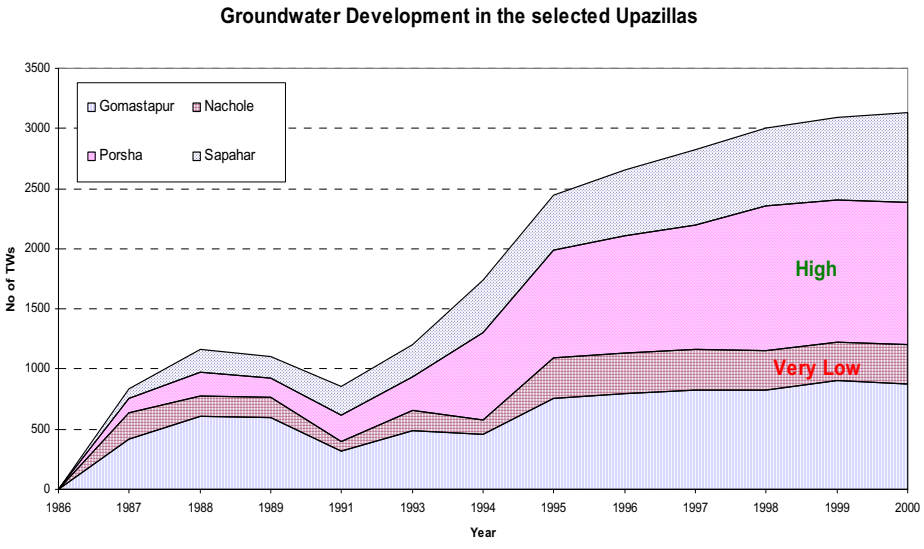
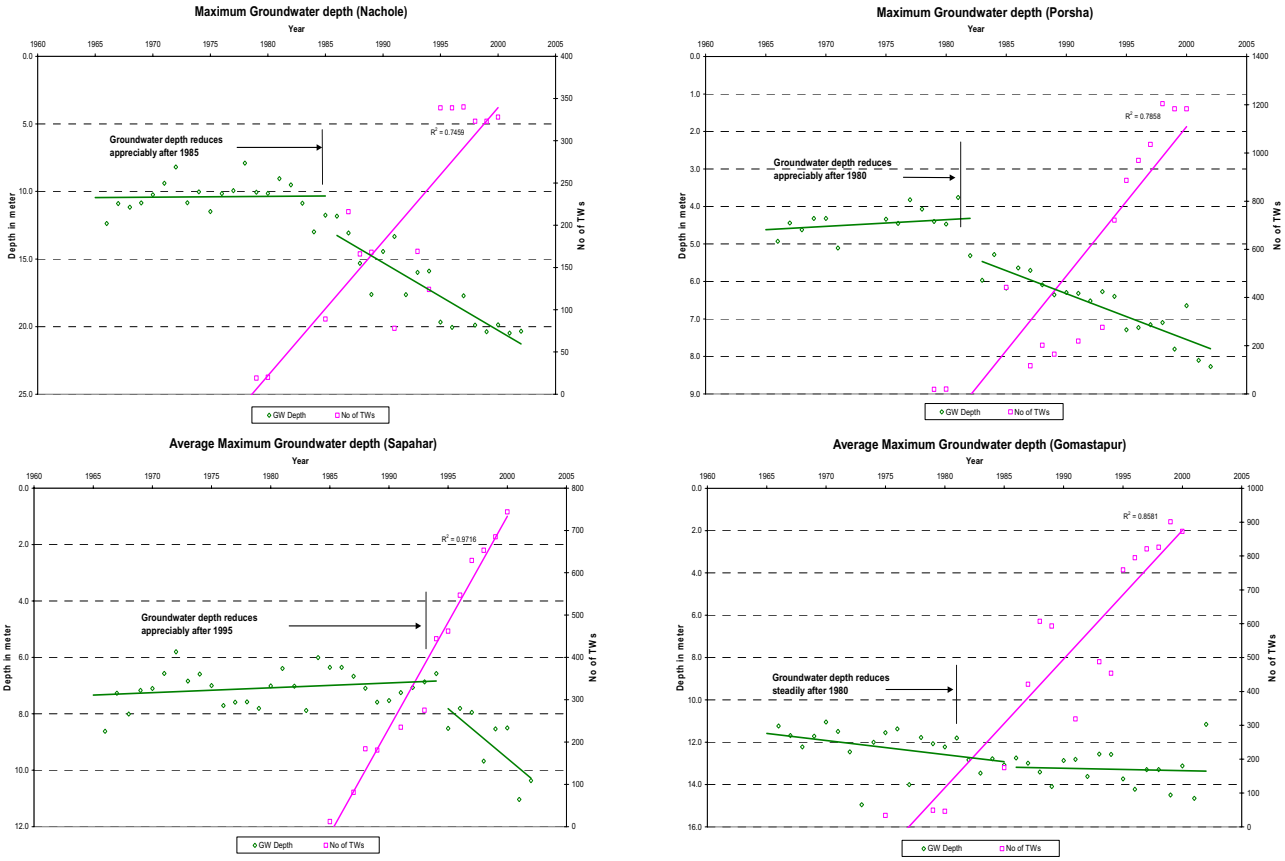


Figure 3-10. Groundwater depletion and irrigation development trend in the selected upazila



3.13 Water Bodies

A number of perennial water bodies are observed in the study area, which is used as an alternative source of irrigation water during the dry periods. Beels are large water bodies, which are generally connected to the rivers during monsoon seasons. Stored water in the *beels* is used for irrigation in almost all the upazilas. Even in the rabi season, the *beel* area goes under cultivation.

Table 3-7. Surface water bodies in the study area[1]

Type of Water Bodies	Number	Area (ha)	Uses for Irrigation (%)	Cultivated crop at Rabi Season (%)
Nachole: Beel	13	300	30	70
Dighi	19	25	50	-
Gomastapur: Beel	19	588.94	100	95
Dighi	2106	522.9	80	10
Porsha: Beel	11	60.19	30	100
Dighi	5	22.67	20	-
Sapahar: Beel	1	400	50	75
Dighi	1200	350	75	-

Source: DAE, 2004.

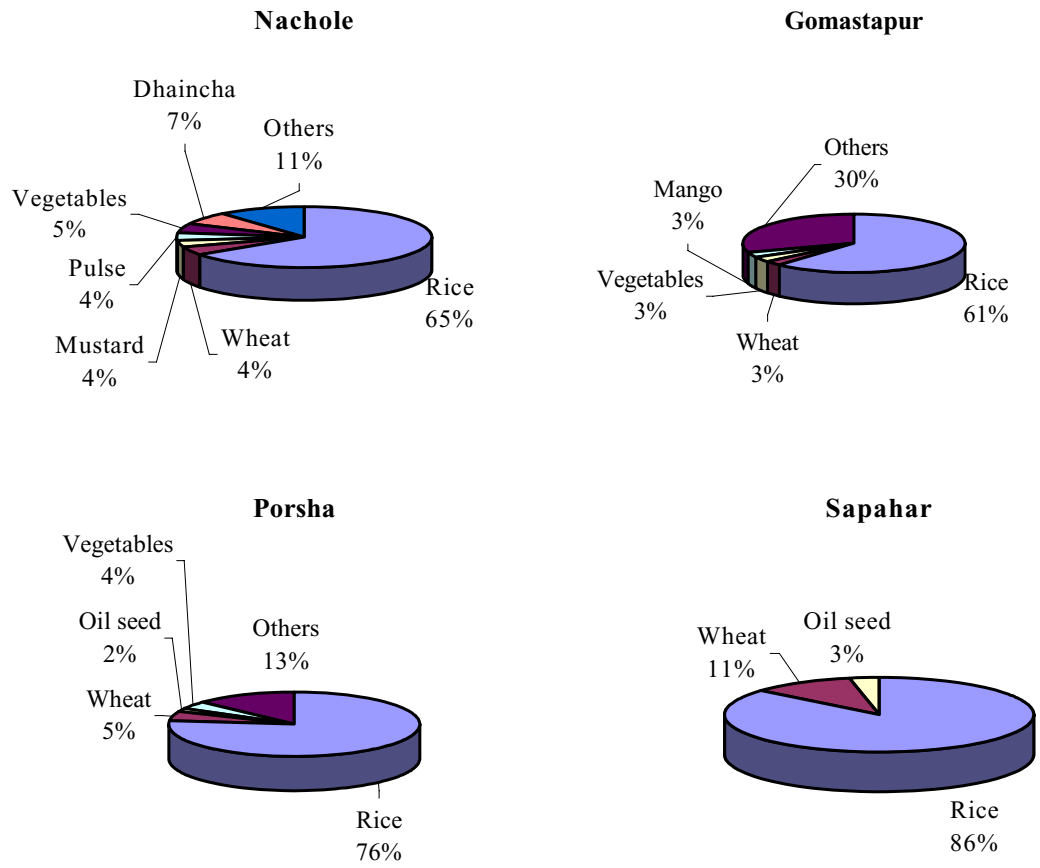
[1] The data on the water bodies have been collected from DAE. There are scopes of collecting further detailed data from Department of Fisheries, BMDA and other relevant sources.

3.14 Agriculture Land use

The agricultural practices are mainly governed by hydro-meteorological characteristics of the area. The selected upazilas are mainly drought prone due to low rainfall intensity than the other parts of the country. Different types of crops are practiced depending on the suitability of the land and availability of irrigation facilities.

The agriculture practices compromises mainly three seasons in an annual crop calendar. Rabi (November – February), Kharif-I (March – June) and Kharif-II (July – October). During Karif –I season Transplanted Aus is the main crop in the area and significant amount of land left as fallow due to unfavorable distribution of rainfall. Farmers prepare their seed bed near the pond side with the help of surface water. If timely rainfall occurs, farmers transplanted the T. Aus crop in the field, otherwise the land remains fallow. Kharif-II season is dominantly a rainfed T Aman is practice as a major crop and covered 70- 90% the area. Mainly drought occurred during transplantation, flowering and grain development stage of T Aman crop. During Rabi season, a small amount of land is irrigated with high yielding Boro where ground water irrigation facilities is available and 10-15% of cropped area covered by wheat, mustard, pulses and other types of vegetables where surface water is available. The pie chart in Figure 3-11 shows the present agriculture practices in the study area where major portion is covered by rice crops.

Figure 3-11. Present agricultural land use of the selected study area



In the study area, permanent fallow land is very high especially in the Sapahar and Gomastapur upazila due to suitability of land. In Sapahar upazila around 30% of the NCA is currently fallow.

Single cropped area is about 66% in Porsha and 46% in the Sapahar upazila. Double cropped area is high (62%) in the Gomastapur upazila and triple cropped area is very high in the Nachole upazila. The variability of cropped area coverage in the study upazilas is due to the existing irrigation facilities in place. The average cropping intensity in Nochole and Gomastapur upazila is about 205% and 192%, which is greater than the average cropping intensity (177%) of Bangladesh (BBS 2000-01). Cropping intensity in Porsha and Sapahar upazila is less than the national average values as shown in Table 3-8.

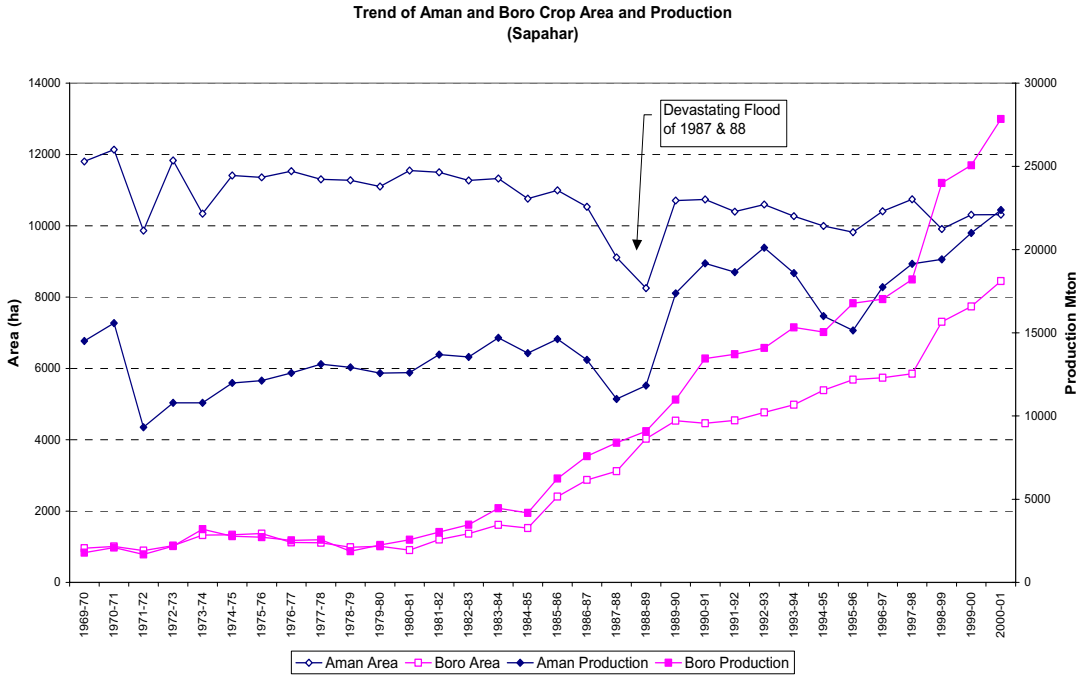
The trend of Aman and Boro crop is shown in this report compiling the area and production from the district level BBS census. Since upazila level information is not available, district level data has been used and prorated to derive the trend at upazila level. The trend shows that the area of Boro cultivation is increasing for all the study upazilas, but the Aman cultivation is almost stagnant over 30 years time. Figure 3-12 shows a sample upazila with the trends of major rice crop production.

Table 3-8. Agricultural land use of the selected study area

Land use	Nachole		Gomastapur		Porsha		Sapahar	
	Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA
Permanent Fallow Land	1182	-	4602	-	2912	-	3500	-
Current Fallow	100	0.38	85	0.31	492	2.09	5655	30.26
Net Cultivable Area (NCA)	26270	-	27125	-	23530	-	18685	-
Single crop	6896	26.25	6172	22.75	15618	66.37	8710	46.61
Double crop	11203	42.65	17000	62.67	6412	27.25	6783	36.30
Triple crop	8171	31.10	3953	14.57	1500	6.37	3192	17.08
Total crop land	53815	-	52031	-	32942	-	31852	-
Cropping Intensity (%)	205	-	192	-	140	-	170	-

Source: DAE annual report 2004.

Figure 3-12. Growth of area and production of major rice crops



3.15 Drought map

The DRAS model is utilized in identifying and classifying the drought severity that takes place for T. Aman crop. T. Aman crop is grown in the monsoon season (July to October) when the rainfall is high. Inadequate rainfall during the flowering stage of the crop is a primary factor governing the yield of crop. Farmers generally depend on rainfall for T Aman production and any delayed rainfall intensity puts the crop in a stress condition. This ultimately reduces the yield level of the crop. On the basis of the yield reduction of the crop, the drought classification has been made. In average year condition, the drought severity has been observed for the selected study areas. The map below (Figure 3-13) shows that the drought severity is high in Gomastapur upazila mainly in Ganges flood plain soil and moderate in the level Barind area. But Sever drought has been observed in the major part of the other three upazilas where 30-40% of the yield reduction is expected in an average year condition.

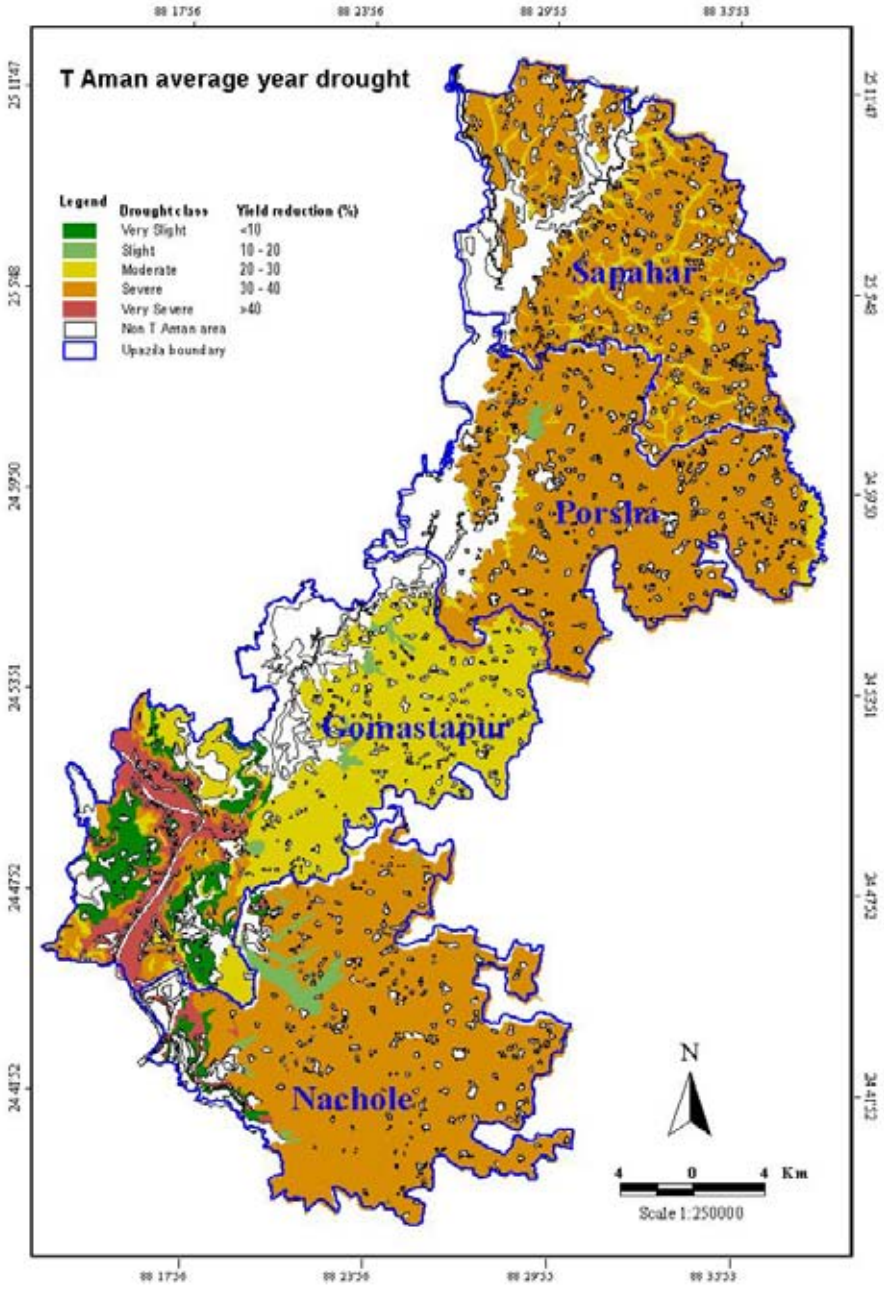


Figure 3-13. Output of drought mapping exercise through DRAS