MONITORING DYNAMICS AND IMPACTS OF WATER-LOGGING IN BHUTIAR BEEL IN KHULNA DISTRICT OF BANGLADESH

A.Z.MD. Zahedul Islam[1], S. M. Humayun Kabir[2], Sukumar Dutta[3] and Md. Abu Taleb Pramanik[4]

[1]*Principal Scientific Officer, SPARRSO, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; Tel: 880-2-8124198; Fax: 880-2-8113080*
E-mail: ***azmd_zahed@yahoo.com***

[2]*Senior Scientific Officer, SPARRSO, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; Tel: 880-2-9124308; Fax: 880-2-8113080*
E-mail: ***boqul2001@yahoo.com***

[3]*Senior Engineer, SPARRSO, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; Tel: 880-2-8125272; Fax: 880-2-8113080*
E-mail: duttasukumar@yahoo.com

[4]*Scientific Officer, SPARRSO, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; Fax: 880-2-8113080*
E-mail: ***atpramanik@yahoo.com***

KEY WORDS: Water-logging, Disaster, Agriculture, Economic loss

ABSTRACT

Water-logging has become critical problem in some part of Bangladesh. It is a silent disaster and has not yet been drown due attention by the policy makers in the country. The present study was carried out in Bhutiar Beel where water-logging occurred about a decade ago. Multi-temporal satellite images were used to reveal the dynamics and impacts of water-logging in the study area based on RS and GIS techniques. The study incorporates field information to validate and to supplement the information derived from RS datasets. The study revealed the hazardous extent of water logging that damaged the entire agriculture cropping system in the study area. The economic losses due to the water-logging were estimated. This paper also discusses the social implications of the water-logging in the study area. Based on the methodology developed in the study, a national system for monitoring water-logging in the country is under way to be established in Bangladesh based on RS and GIS techniques.

1. INTRODUCTION

Water-logging is involved in the livelihood of the people of Bangladesh since quite a long time. However, since the last three decades it has been appearing as a serious problem in this country. The Bhutiar Beel situated in the Tarakhada upazila of Khulna districts is the recent example of water-logging in the country. The water-logging is a silent disaster as it does not devastate quickly and visibly that other disaster like flood, cyclone etc. does. So, it draws less attention of the disaster managers and policy makers though the nature of damage by water-logging is cumulative over the years and jeopardizes the life of the affected people permanently. Bangladesh, being a developing country and having large population, faces issues concerning food security critically. Reclamation of original landuse in the water-logged areas and then refreshing the landuse would contribute to the food security in the country. However, the reclamation procedures must be worked out very carefully so that sustainable improvement is achieved. This implies that the dynamics of water-logging is to be studied systematically along with all relevant drivers contributing to the occurrence of water-logging.

In majority of the cases, water-logging is created by human activities through infrastructure development; but multi-dimensional natural processes are also involved. Processes of water-logging occurred through natural processes is much difficult to understand than those occurred through human activities because of the long span of time elapsed for the natural processes to establish the association of occurring water-logging. However, for both cases, it is necessary to analyse multi-temporal spatial and other relevant data and information to reveal exact extent, causes and dynamics (Dwivedi et al, 2002) of water-logging and to infer measures to reclaim the original land use. Remote sensing can provide most appropriate spatial dataset for such analysis.

The present study was carried out in Bhutiar Beel situated in Tarakhada upazila of Khulna districts where water-logging occurred about a decade ago. The study area covers (figure 1) an area of about 8,648 hectare. The area is a

depressed land where water was accumulated as perennial water during monsoon before pre-water logging period (2000). The area was enriched with the Aman (summer rice) crop which was the main source of income of the families depended on the Beel. Boro crop (winter rice) was introduced in the study area since the last decade. Water-logging in the Bhutiar Beel has very severe and serious impact on the socio-economic condition and jeopardize the life of the depended people of the Beel.

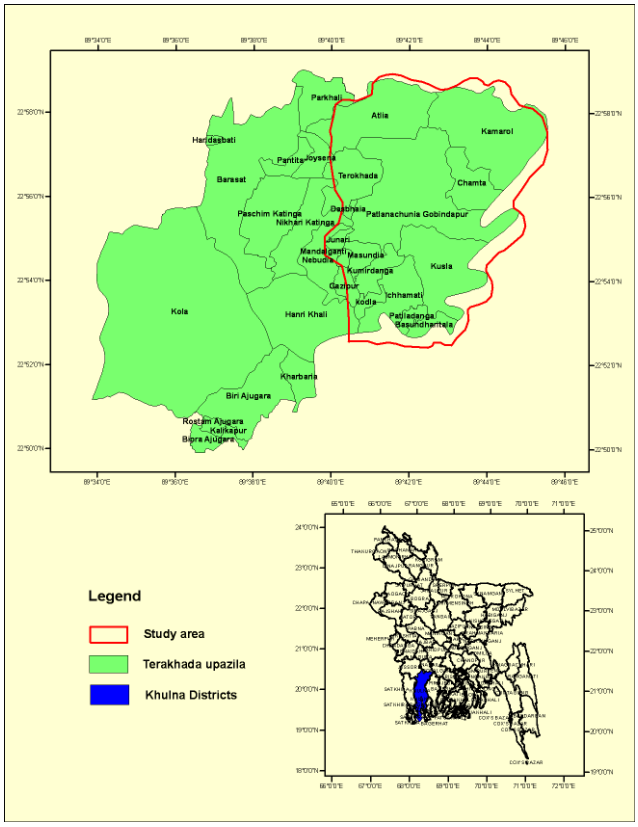

Figure 1. The study area is shown in red polygon.

Table 1. Satellite data used in the study

Dataset Name	Date of Images	Satellite/ Sensor
1990	04/11/89, 07/01/1990, 02/04/1992	Landsat TM.
2001	25/10/2000, 29/01/2001, 19/04/2001	
2009	29/09/2009, 19/01/2009, 24/03/2009	
	20/09/2009	RADARSAT
Other	24/03/2003, 29/03/2005	Landsat TM.

2. OBJECTIVES OF THE STUDY

The ultimate objective of the study was to reveal the dynamics and impacts of water-logging in the study area. In pursuance of this objective the following main tasks were carried out:

a. Identification and estimation of water-logged area in time domain.
b. Estimation of the damage caused by water-logging.

3. METHODOLOGY AND DATA

Integrated technology of RS-GIS-GPS and Ground Truth Validation & Verification (GTVV) have been used for the study. Standard procedures of geo-referencing, digital classification and refinement and GIS analysis were carried out based on ERDAS Imagine and ArcGIS software. Spatial information needed for the study was derived from multi-temporal satellite images. The RS data were grouped as sets shown below in table 1. The 1990 dataset represents pre-water logging condition and the 2001 and 2009 datasets represent the post-water logging condition. The datasets were selected to infer the multi-temporal and seasonal dynamics of water-logging as well as to estimate the impacts of water-logging on agricultural sector in the study area.

4. RESULTS AND DISCUSSIONS

4.1 Dynamics of Water-Logging

Figure 2 shows the expansion of water-logging in Bhutiar Beel in dry season (March-April) from 1992 to 2009 and table 2 presents the statistical information on the dynamics of water-logging. The water that was contained in Bhutiar Beel in different seasons in 1990 (dataset name) was its normal (perennial) water existed in the deeper part of the Beel. Only 20 hectare area was covered by water in the deepest part of the Beel in the dry season of 1992 which was about 0.23 % of the total study area. This clearly indicates that in 1992 there was no water-logging in the Beel. It is seen (table 2) that, with respect to 1990, the areas of water in all of the seasons were increased in 2001 and were continued to increase up to 2009. This indicates the occurrence of water-logging in the Beel during this period. From filed collected information it is supported that water-logging started in the Beel around the year 2000. In the wet season of 2001, 49% of the area under study became inundated and logged which came down to 19% in the dry season. In the wet season of 2009, water-logged area in the Beel reached to 52% of the total study area which came down to 32% in the dry season. The increase of water-logging in the wet season from 49% in 2001 to 52% in 2009 indicates that the Beel was saturated with water-logging condition in 2009. This is also supported by field collected information. In the dry season, the amounts of water-logged areas were reduced comparing to the wet season areas due to natural seepage and use of the water for

irrigation of Boro crop cultivation. The actual condition of water-logging in Bhutiar Beel is shown partly in figure 3 which presents a photograph taken in May of 2009.

4.2 Impacts on Agriculture

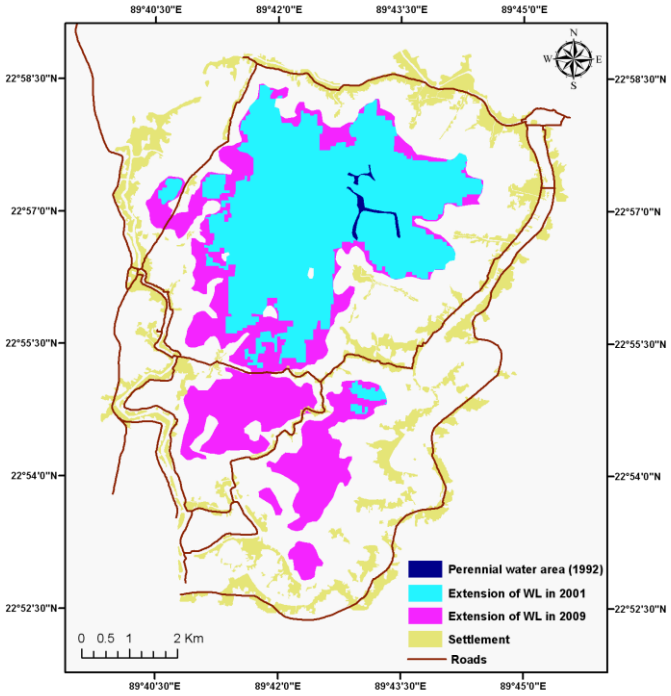

Figure 2. Extension of water-logging in Bhutiar Beel in dry season (March-April) from 1992 to 2009.

The water-logging in the Beel has damaged the entire agricultural cropping system including the two major cropping seasons - Aman (summer rice) and Boro (winter rice). Figure 4 shows the Aman crop areas cultivated and water-logged in 2009. Figure 5 shows the same for Boro crop areas. Table 3 presents the damage by water-logging in agricultural sector. The Aman area lost in 2009 due to water-logging was 3544 hectare (87 % of the total cultivable Aman area) which amounts to 7641 metric tons of Aman paddy, and economic loss calculated was Taka 15,68,66,938.00. Loss of Boro area in 2009 was 3073 hectare (73 % of the total cultivable Boro area) amounting to 7641 metric tons of Boro paddy and economic loss was Taka 24,20,69,230. Total economic loss in agriculture in 2009 was Taka 39,89,36,000 (5,540,778 USD).

4.3. Socio-Economic Impacts

Based on field collected data, it is seen that in Bhutiar Beel 11,467 families were water-logged and lost the whole of their cultivable lands in the Beel and have become landless, poor, marginalized and destitute. They also lost their jobs as well as wage-earning support to maintain livelihood. These families have been forced to shift their profession and most of them have migrated to urban areas in search of jobs. Some of the poor families have undertaken the hard jobs of van and rickshaw pulling, fishing and day labouring. The women have managed to work as garment-workers.

Table 2. Extension of water-logging in Bhutiar Beel

Year	Wet Season (Sept-Oct)		Dry Season (March-April)		Remarks
	Total water area in hectare	% of total study area	Total water area in hectare	% of total study area	
1990	932	11	20	0.23	Perennial water
2001	4248	49	1690	19	Water-logged
2009	4509	52	2790	32	Water-logged

Figure 3. Photograph taken on May 2009 showing the actual condition of water-logging in the study area.

CONCLUSIONS

The study successfully derived the required thematic information from multi-temporal satellite images and incorporated it with the field collected data for inferring the dynamics and impacts of water-logging in the study area. 52 % of the study area was water-logged in 2009 which has been identified as the saturation level. Due to this water-logging, 87 % and 73 % of the total cultivable lands of the Aman and Boro crops respectively were lost in 2009 that accounted for a total economic loss of Taka 39,89,36,000 (5,540,778 USD) in 2009. The affects of

water-logging was cumulative since its inception around the year 2000 which has damaged the entire agricultural cropping system and has jeopardized the life of the people in the study area.

The study is the first of its kind in Bangladesh based on RS/GIS techniques. The methodology used in the study was validated through field information. The success of the study has opened the door to establish a National Water-Logging Monitoring System (NWLMS) in the country based on RS/GIS techniques to keep vigilance over the situation in the existing water-logged areas as well as potential areas of water-logging. One of the main objectives of the NWLMS is to detect the occurrence of water-logging at its initial stage so that the remedial measure can be undertaken with much less cost and efforts.

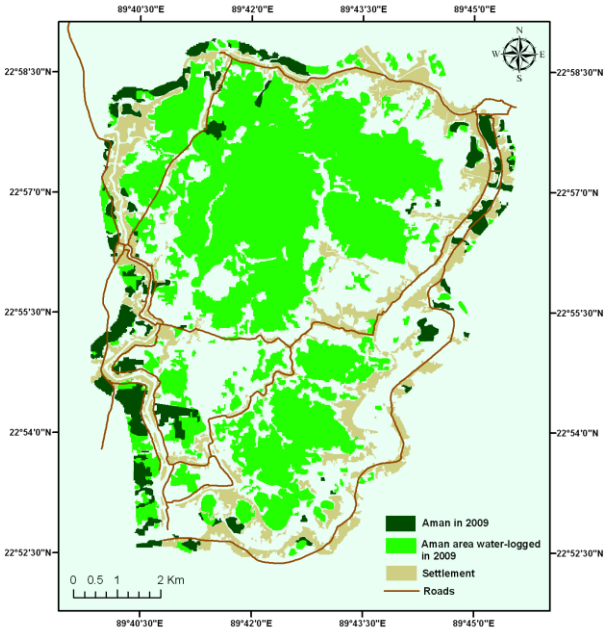

Figure 4. Cultivated & water-logged areas of Aman crop in 2009.

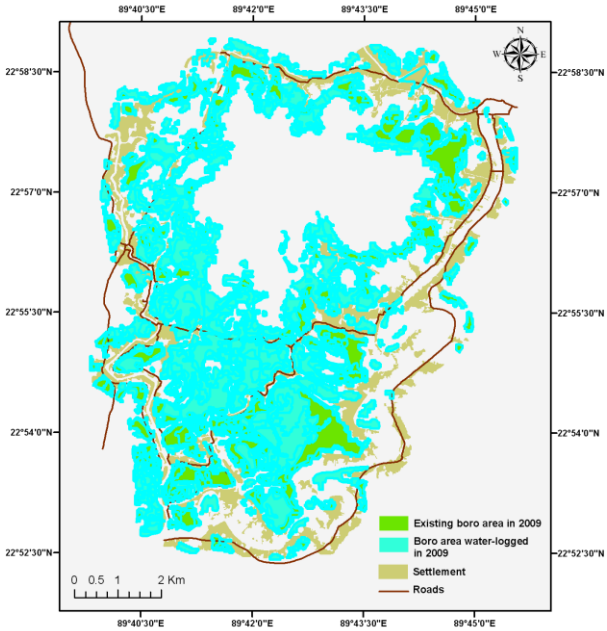

Figure 5. Cultivated & water-logged areas of Boro crop in 2009.

Table 3. Damages by water-logging in agriculture sector

Item	Aman crop	Boro crop
Total cultivable land in the study area (hectare)	4085	4204
Cultivated land in 2009 (hectare)	541	1131
Cultivable land lost in 2009 due to water-logging (hectare)	3544	3073
% of cultivable land lost in 2009	87	73
Loss of production in 2009 (MT)	7641	11791
Economic loss in 2009 (Taka)	15,68,66,938/-	24,20,69,230/-
Total economic loss in agriculture in 2009 (Taka)	39,89,36,000/- (5,540,778 USD)	

References:

Dwivedi, R. S., Sreeniva, K., 2002. The vegetation and water-logging dynamics as derived from space-borne multi-spectral and multi-temporal data. In: International Journal of Remote Sensing, Vol. 23, Issue 14.