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Water-logging and its' impacts on livelihood: A study from Jashore Sadar Upazila, Jashore, Bangladesh

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Abstract

Jashore, the south-western hub of Bangladesh has been facing elongated water-logging and remains inundated for longer period of time over the year. The objectives of this study were to assess the main causes of water-logging and impacts on livelihood using historical rainfall and SRTM DEM (Digital Elevation Model) data and loss of agriculture using Landsat Multi Temporal data and validate it with people's perception. A self-explorative semi structured questionnaire survey was performed with a total of 115 respondents were selected based on age (>50 years) and cultivable land (≥30 decimals) from 5 Unions (Chanchra, Diara, Ichhali, Noapara, Ramnagar) and Jashore Sadar Municipality under Jashore District. Rainfall data were placid from Bangladesh Meteorological Department (BMD) and analysed through SPSS and figures were produced with Arc GIS software. The study revealed that the main causes of water logging were lack of adequate drainage path (58%) which was validated through GIS analysis, followed by excessive monsoon rainfall (42%), rapid growth of urbanization (16%), increased sediment/siltation (12%) and controlled river water flow due to guards construction (8%), respectively. The results showed that almost 90% area of Jashore Sadar Upazila had ≥167mm rainfall and average monsoon rainfall were within 263 to 313mm. About 95.24% of male and 96.55% of female respondents' told about the scarcity of fresh water during water-logging period and lost their homestead vegetable garden (94%), followed by unable to farming domestic birds (78%) and animals (64%), respectively. The result concluded that 84% of the respondents' lost their agricultural crops and 52% respondents' family members migrated to meet their livelihood during the water logging period. Dredging of *Kobadak* River should be the solution to allow regular tides of the river at first stage and helped to runoff the excessive rain water in the study area.

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1. INTRODUCTION

The south western district Jashore has been experiencing severe water logging problems. Excessive rainfall, river flow changing, siltation deposits were the major reasons of water-logging here (Awal, 2014). Another vital reason is developing unplanned road network without considering stream order or surface runoff of heavy rainfall. Water-logging is alarming for the south-western people of Bangladesh. It has caused noteworthy movement bestowing public-spirited experiments in pure water supply, freshness, accommodation, availability of foods and occupation transforming. People of this region are bound to face this problem for 3-4 months every year and agricultural lands are hailed under losing valuable agricultural yields. Agricultural doings as well as socio-economic activities have principally been susceptible because of severe inundations (Adri and Islam, 2012; Adri and Islam, 2010). Male were forced to go away for weeks/months to manage livings due to loss of agricultural crops. Female took the full responsibility including collecting fresh water, cooking food, rearing aged and child members and also livestock. Social depression, migration, joblessness and various types of sicknesses have been enlarged in this zone (Awal, 2014; Salauddin and Ashikuzzaman, 2011; Neelormi et al., 2009; Ahmad and Ahmad, 2000). Various parts of Satkhira, Jashore and

Khulna Districts were the most inundated areas during monsoon period (Jakaria et al., 2016) and facing long time inundation every year (Gazi and Moniruzzaman, 2014; UNDP, 2011). Safe water scarcity and water-logging have been main problem in this region. Different natural hazards increase the water logging and change agricultural doings as well as socio-economic expansion (Gazi and Moniruzzaman, 2014; BCAS, 2010). Climate change may smoothen directly by cyclonic disaster and duration of inundation in the coastal belt of Bangladesh (Islan and Ahmed, 2004; Hasan and Islam, 2014). Sadar Upazila of Jashore District is facing regular water-logging and drainage problems due to river bed siltation and low capacity of drainage systems (Hasan and Islam, 2014). About 2% to 20% people of this district faced this problem round the year (Khadim et al., 2013). The sanitation system was totally collapsed during water-logging, flora and fauna has been degraded, damages/loss of agriculture crops have been another major disaster due to prolonged water-logging. The siltation system was disturbed that causes escalating the inundation situation (WARPO, 2005). This study aimed to assess the main causes of water-logging using historical rainfall and SRTM DEM (Digital Elevation Model) data; loss of agriculture using Landsat Multi Temporal data and validate with people's perception and to investigate the impacts on livelihood due to prolonged water-logging in Jashore Sadar Upazila.

2. STUDY AREA

Jashore Sadar Upazila consists of 435.22 sq. kilometre (Banglapedia, 2012) located between 23°04' - 23°20'N latitudes and 89°06' - 89°25'E longitudes (LGED, 2019). The total number of populations is 742,898 (BBS, 2015). Most of the areas are poorly drained with 1980 mm annual average rainfall but June to October covered its 80% (Hasan and Islam, 2014). The study area covered were 5 Unions; Chanchra, Diara, Ichhali, Noapara, Ramnagar and Jashore Sadar Municipality under Jashore District (Figure 1).

3. METHODOLOGY

This research was conducted with questionnaire survey using purposive sampling technique. All the secondary data which help the research with provable best output was collected from Bangladesh Meteorological Department (BMD), Bangladesh Agricultural Research Council (BARC) and prepared with MS Excel program and use Geo Statistical Wizard technique for preparing rainfall maps of study area. Digitized detail road shape of study area was obtained from Local Government Engineering Department (LGED) Digital Road Map, Google Earth Pro and Open Street Map. Finally Stream order flow was created from SRTM DEM data (Figure 3).

3.1 Data collection

A total of 115 samples (18 from each union and 25 from municipality) were purposively selected based on above 50 years old and more than 30 decimals cultivable agricultural land by semi-structured self-exploratory questionnaire survey. Primary data were collected from September-November, 2017. A Participatory Rural Appraisal (PRA) was conducted with the help of local individuals of the study area. Secondary data were collected from BMD and BARC. The collected data were tabulated and summarized and analysed through SPSS (version 20.0) and maps were produced with Arc GIS (version 10.6).

3.2 GIS analysis of rainfall data

Examination of the distribution of rainfall data shows that data is not normally distributed. For data correction and closest to the normal QQ Plot curve and present in Arc GIS following with this step: From Geostatistical Wizard select the method Kriging/CoKriging as Geostatistical Methods and input the rainfall dataset. Select Ordinary as Kriging Type and in Dataset menu select Third Order Polynomial will be fitted in Order of trend removal because U-shaped curve (Representation Strong Trend) was detected in Trend Analysis. Semivariogram/Covariance Model was to setup the model parameters in which true values of anisotropy, search direction and all line were considered. The types of values (i.e. true and false) used to adjust the directional influences of autocorrelation in the output. The search direction angle was fixed at 352.8° which represents in the Semivariogram curve (Figure 2).

4. RESULTS

4.1 Causes of water-logging

Excessive rainfall and lack of surface runoff may be the reason for increased flood and inundation situation in Jashore but the real scenario is more intricate and initiated by the collaboration of different determinants. Heavy rainfall (92.5%) and low plain land (53.13%) were the key determinants of flood/water logging in Sunamganj region (Khan et al., 2021). The result revealed that 58% respondents agreed with the main cause was lack of adequate drainage path, followed by excessive monsoon rainfall (42%), rapid growth of urbanization (16%), increased sediment/siltation (12%) and controlled river water flow due to embankments (8%) (Table 1). Figure 4 represented two variables where first one was unplanned roads and second one was stream flow direction. The road networks impacted on surface flow tension was major issues for water-logging in Jashore Sadar Upazila. These unplanned roads position were fettering the surface water flow to lead water-logging, those were represented through zoom maps of Icchali, Noapara and Diara Unions of the

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study area. Water-logging become common issue in these three unions of Jashore Sadar Upazila due to unplanned roads which was clearly visible from the map (Figure 4). So, people's perception, lack of adequate drainage path (58%) and GIS analysis also represented the same scenario in study area.

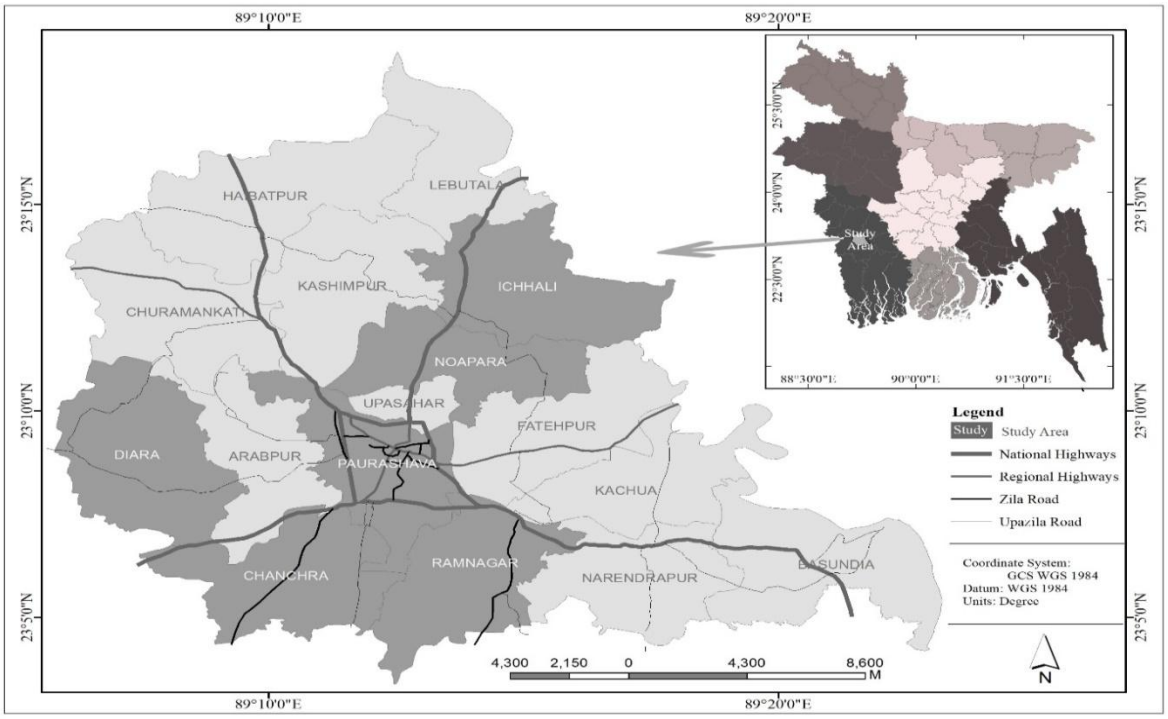

Figure 1: Location of the study area

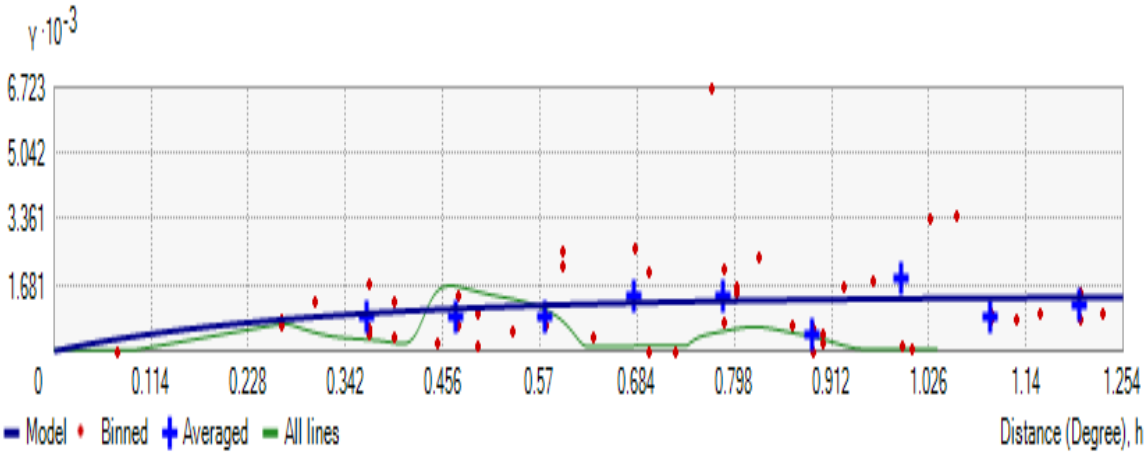

Figure 2: Semivariogram curve

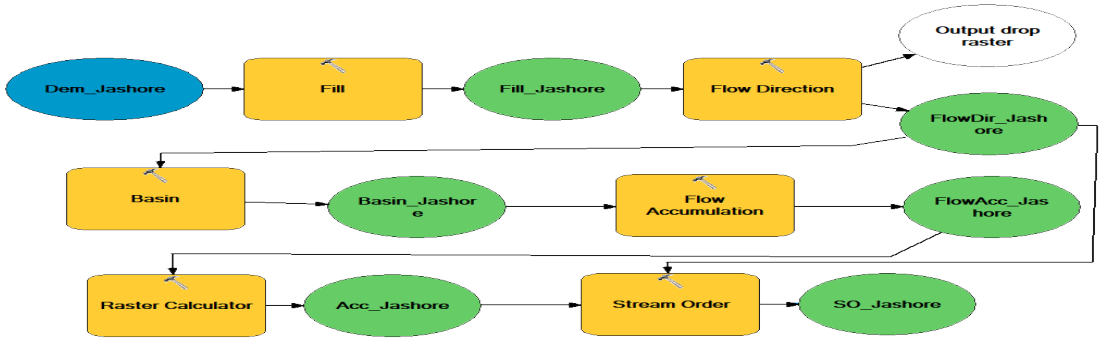

Figure 3: Model for finding the flow of stream

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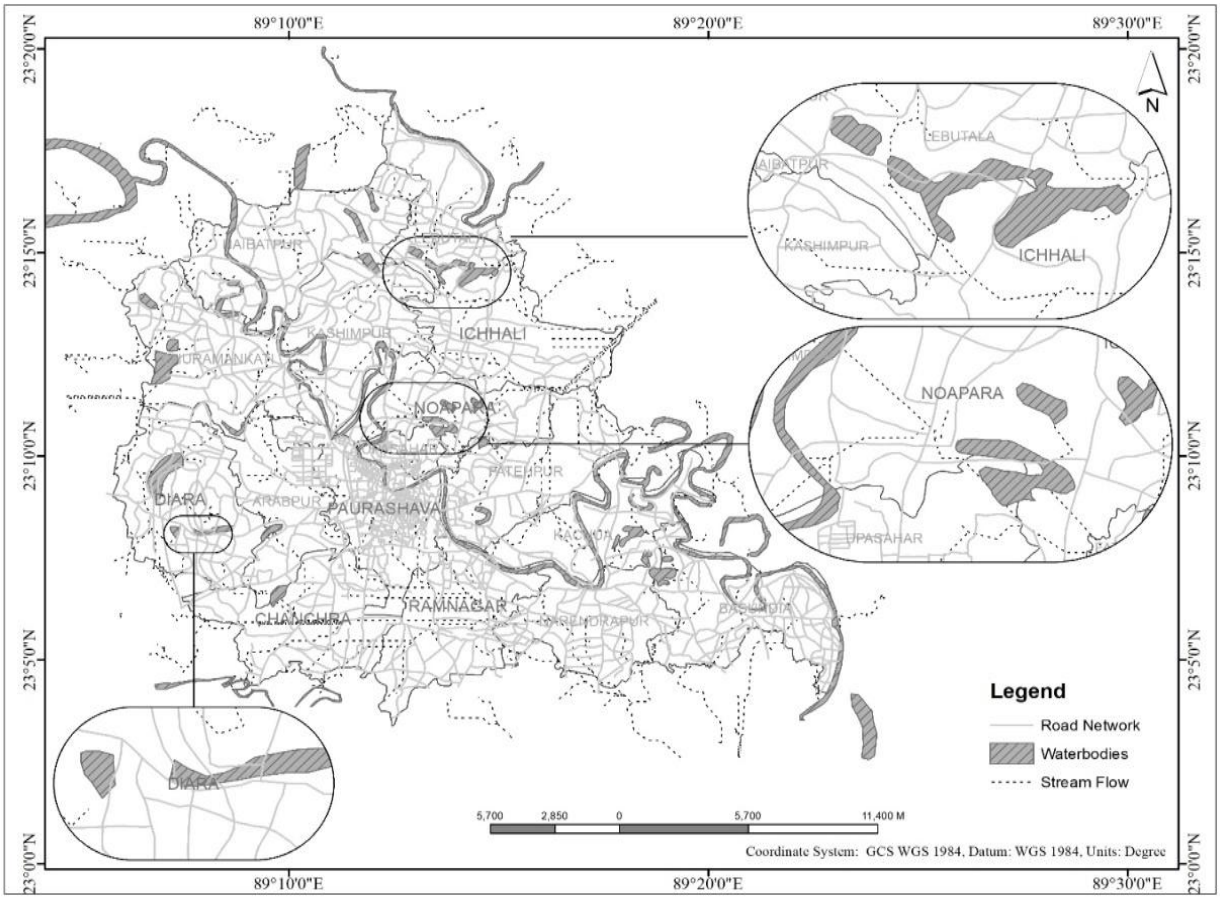

Figure 4: Unplanned road as the obstacles of water flow during heavy rainfall

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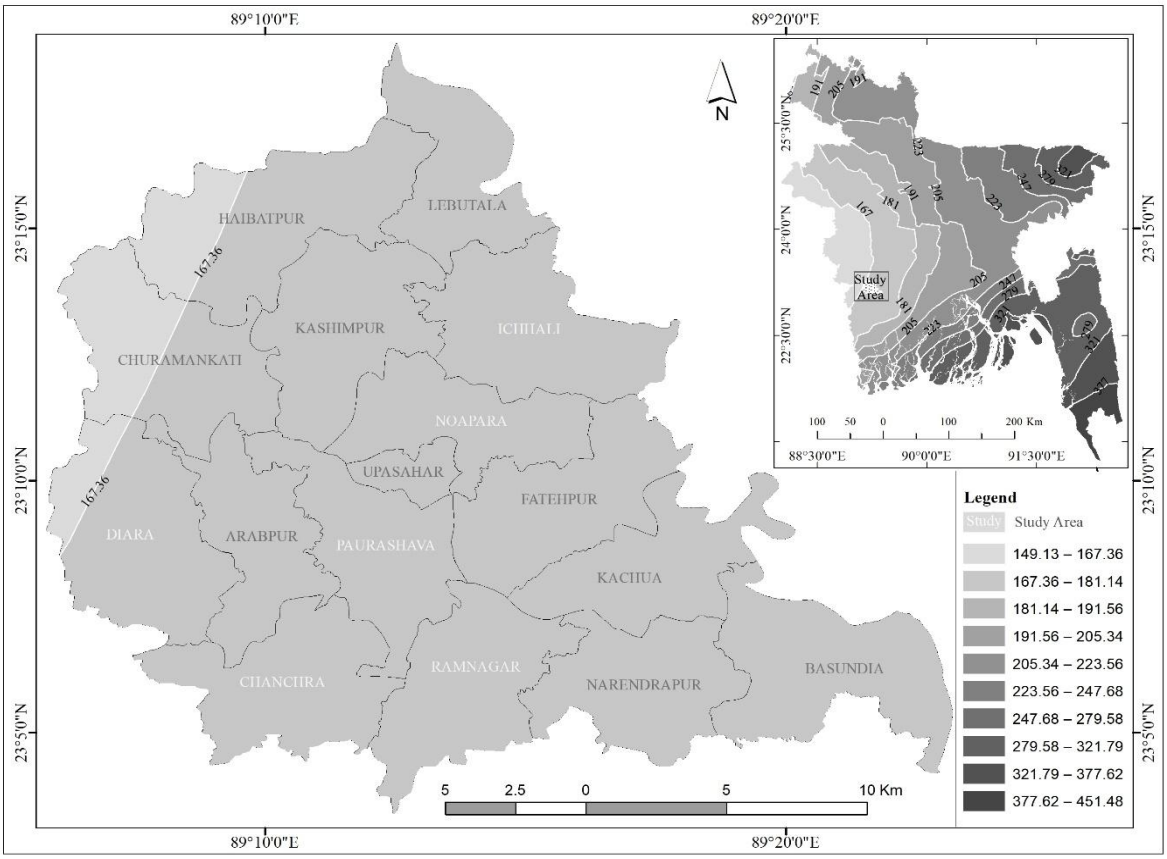

Figure 5: Monthly average rainfall of Jashore from 1948 to 2018

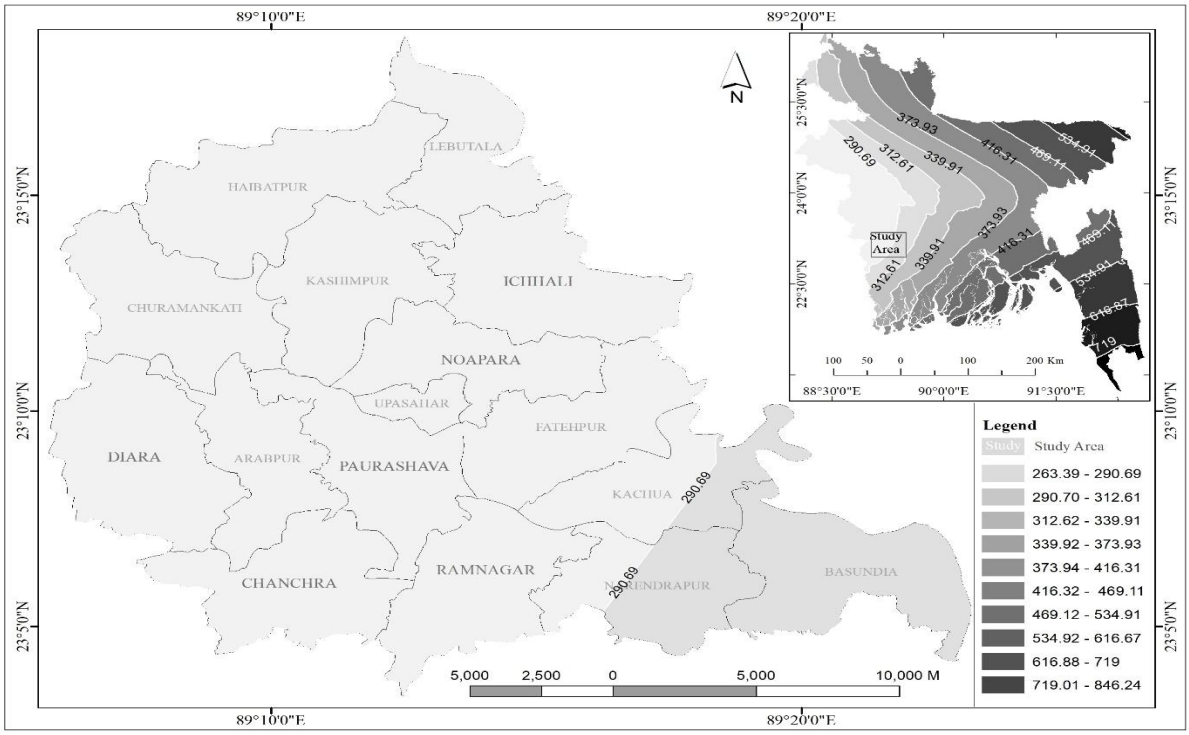

Figure 6: Monsoon average rainfall from 1948 to 2018

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4.2 Rainfall scenario of adjacent area

The Himalayan downpour occurs in the south of Bangladesh exclusively in the coastal areas. Figure 5 represents yearly average rainfalls of Jashore Sadar Upazil lies within 149 to 181 mm where only small parts of Haibatpur, Churamankati and Diara Unions have lower rainfall. Almost 90% of Jashore Sadar Upazila has 167 mm or more rainfall. Figure 6 represents average monsoon rainfall of the study area lies within 263 to 313 mm. Narendrapur, Kachua, Basundia Unions have 291 to 313 mm monsoon rainfall and rest part have lower rainfall. The differences between yearly average to monsoon average were almost 73%.

4.3 Water level scenario of adjacent river

Topographically, Bangladesh is a low-lying deltaic country divided into plain lands and tertiary hilly regions mainly. The plain land was formed by siltation/sedimentation of different larger rivers or their distributaries and its area is more than 90% of total Bangladesh. The plains are <10m above the sea level, declining to the coastal south. *Kabodak* River was the main drainage path from the study area which was a branch out from Bhairab River. A protract flooding was triumphed the *Kobodak* river in September-October in 2011 (BWDB, 2012), thus this area was flooded for prolong period. In 2011, water level exceeded the danger level continuously 89 days (BWDB, 2012). The situation stood up due to the reduced drainage system and extreme precipitation in the study area (Gazi and Moniruzzaman, 2014).

4.4 Scarcity of fresh water

Water-logging often submerged the local tube-wells and latrines making safe drinking water scarce. Arsenic had another major problem in this region. Table 2 shows about 95.24% of male and 96.55% of female talked about the scarcity of fresh water during water-logging period. Thus, people were facing severe problem doing their household chores.

Nirupoma (a woman of 50 years old) is a victim of water-logging with six family members. She said, it is almost impossible to live in water-logging area because there are no ways to earn money. The agricultural land is totally submerged with water. The lifestyle is much expensive during the water logging period than general time. My husband goes too far away (another district) to earn money.

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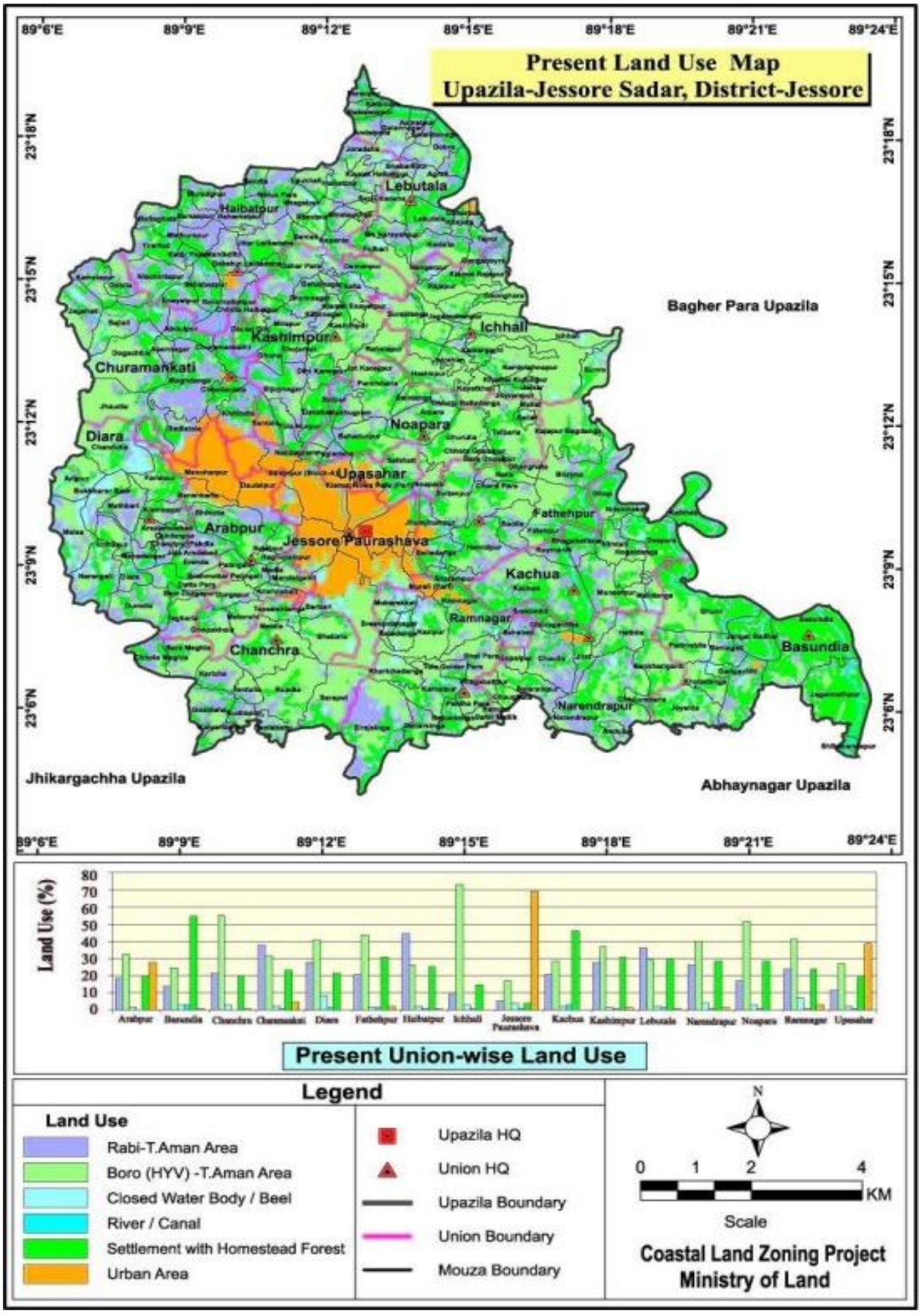

Figure 7: Union wise land use with agriculture map of Jashore Sadar Upazila, Bangladesh Source: https://www.thebangladesh.net/upazilas-of-Jashore/Jashore-sadar-upazila.html#land-use-mouza-map (Access on 10 March 2018).

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Table 1: People's perception of water-logging in the study area

Causes of water logging	Percentage
Excessive monsoon rainfall	42
Lack of adequate drainage path	58
Rapid growth of urbanization	16
Increased sediment/siltation	12
Controlled river water flow	08

Table 2: Perception about scarcity of fresh water

Scarcity of fresh water	Male (%)	Female (%)
Yes	95.24	96.55
No	5.76	3.45

Table 3: Opinion about biodiversity loss

Types of flora and fauna	Loss (%)
Domestic animals	68
Domestic birds	78
Wild animals and birds	34
Homestead vegetable garden	94
Trees	42

Table 4: Opinion about loss of agricultural crops

Respondents' perception	Loss of crops (%)
Yes	84
No	16

Table 5: Migration status of family members

Respondents' perception	Migration status (%)
Yes	52
No	48

4.5 Loss of biodiversity

The researchers adopted clear idea about the biodiversity position of the surveyed area (Table 3), that 94% respondents lost their homestead vegetable garden during water logged period and they were bound to buy vegetable from market for consumption, thus the prices increased rapidly during that time. The study showed that 78% and 68% respondents were unable to farm domestic birds (poultry, pigeon, etc.) and animals (cow, goat, etc.), respectively. The study also revealed wild animals and birds were dead (34%).

4.6 Loss of agricultural crops

Figure 7 indicates that major portion of land (of all 16 unions) was used for agriculture purposes. The result showed that 50% respondents' (Salam et al., 2019), 82.5% respondents' (Khan et al., 2021) in contrast with 84% of the respondents' lost their agricultural crops (Table 4) and 52% respondents' family members migrated to earn money (Table 5) during the inundation period in the study area. For this, the people of this area were deprived from cash crops and food grains during water stagnant period.

5. CONCLUSION

Water-logging affects local biodiversity, which subsequently changes the lives and livelihoods of the people because there's a close interaction between peoples' welfare and environment. Analysis of the causes and impacts of water-logging problem in the study area suggest strong recommendations to reach a long-term solution to get rid of water inundation, such as drainage system should be developed, dredging of *Kobadak* River and sewerage line must be clear, thus the rain water will be passed thoroughly.

AUTHOR CONTRIBUTIONS

Conceptualization, M.S.K. and M.A.H.; methodology, M.S.K.; software, MAH; writing—original draft preparation, M.S.K.; writing—review and editing, M.S.K. and M.A.H. The researchers read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by authors.

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