NATIONWIDE RIVERINE FLOOD RISK ASSESSMENT IN BANGLADESH BY USING INUNDATION MODELLING WITH GIS AND REMOTE SENSING TECHNIQUES.

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1. INTRODUCTION:

Even though flood frequency and damages are increasing in Bangladesh, there is no recent or improved nation-wide flood hazard map. Present flood inundation map is produced based on old topography (50 years ago), showing a general overview of a flood situation with a coarse resolution of about 1 km (FFWC Report, 2012). This map does not allow us to identify most flood prone and hazard areas on local scale. In addition, there is a need to use remote sensing techniques to solve the particular issues of transboundary rivers as most of the major rivers' upstream areas are outside Bangladesh.

2. OBJECTIVE:

The main objectives of this study are: 1) to develop nationwide flood hazard assessment by using the GIS-based flood inundation depth (FID) model with simulated daily river discharge from the global BTOP model, 2) to identify potential flood areas, and 3) to assess flood risk from remote sensing data and survey data within the most affected areas.

3. STUDY AREA:

The target area was the entire Bangladesh, where monsoon riverine floods are dominant and frequent and more than 80% of the total population lives. The country is situated in the downstream portions of three large river basins, named Brahmaputra, Ganges and Meghna of areas of about 10^6 sq km, $5.5*10^6$ sq km and $0.85*10^6$ sq km. There are presently 73 flood monitoring stations nationwide. During the last 25 years, 4 mega floods (1988, 1998, 2004 and 2007) hit Bangladesh, among which the1998 flood was the most severe (100-year return period), and caused many causalities and economic losses. Then, we particularly focused on one specific area in the target country, i.e., Serajgonj district (as shown in Figure 1) for risk assessment.

4. DATA AND METHODOLOGY:

The first step of this study was the preparation of inundation maps using the daily river discharge obtained from the global BTOP model (Block wise use of TOPMODEL, originally developed by Takeuchi et al. 1999) with 20 km cell size. The daily river discharge was simulated from 1951 to 2007 using the input precipitation from the grid-based APHRODITE (Yatagai et al. 2012) Monsoon Asia (version V1003R1) with potential evapotranspiration estimated by the Shuttleworth-Wallace model using climate forcing data CRU TS3.1 and a monthly normalized different vegetation index, (Gusyev et al. 2013). The river length, elevation and riverbed slope throughout transition of stream network scales with 12 different scales ranging from 90m to 20 km meshes based on a simple scaling algorithm using HYDROSHEDS (Lehner et. al., 2008). The simulated discharge from the BTOP model was calibrated by using observed river discharge data at gauging stations of the three major rivers. The Flood Inundation Depth (FID) Model (a topography-based model originally developed by Kwak et. al. 2012) was used where a simple algorithm of the Digital Elevation Model (DEM) and H_{max} of each individual cell in the study area were used to calculate the difference value in each cell in order to get Inundation Depth. H_{max} was set as the maximum river water depth of 50-year return period flood. HYDROSHEDS 3s (90 m resolution) DEM data was used in this study. Finally, after calculation of FID in each cell, inundation map was produced by using GIS mapping in hazard areas.
The second step was the risk assessment of a specific area within the nationwide inundation area. In this case, the selected area was Serajgonj district (as shown in Figure 1).

Keywords: Flood Hazard Map, BTOP model, FID, APHRODITE, Flood Risk Assessment.
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This area is one of the most vulnerable parts to flood damages. Risk assessment of this area was performed considering household losses/damage and affected people by using population data gathered from LANDSCAN and statistical information. Finally, the risk assessment was verified by using MODIS (nationwide case) and ALOS images (specific area case).

5. RESULTS AND DISCUSSIONS:

The final output of this study is the nationwide flood inundation map and flood risk map of the specific area. Analyzing the observed inundation duration and peak inundation depth (Figure 1) during the 1998 flood, we can get the approximate locations of the most affected areas during a major flood event.

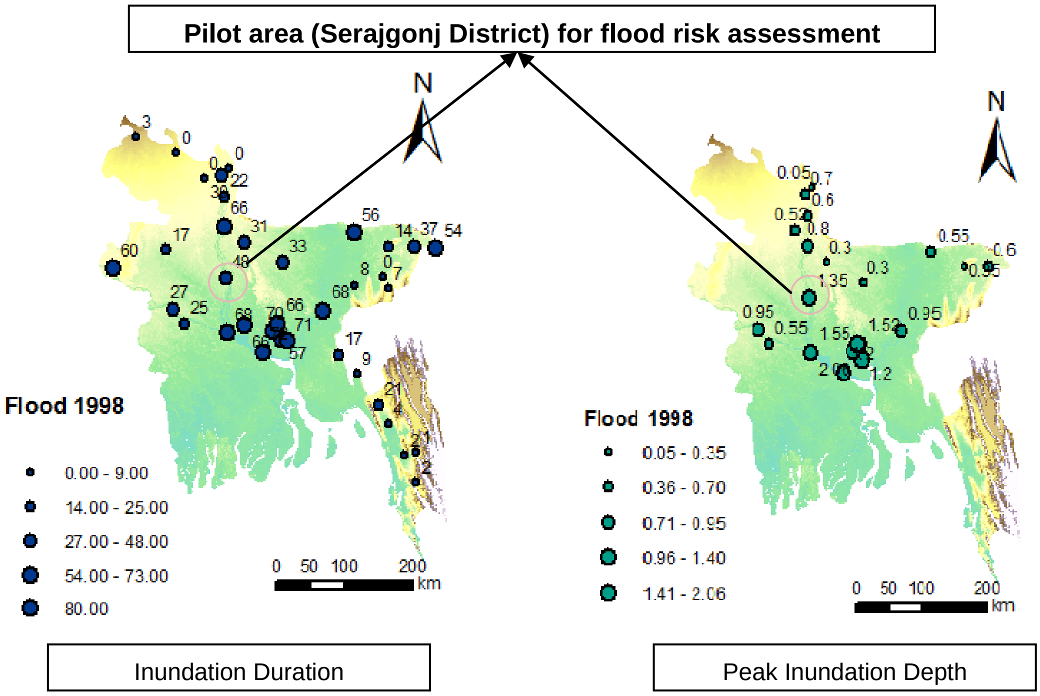

Figure 1: Peak inundation duration in days (left) and peak inundation depth in meters (right) during 1998 flood.

In the specific area, 48-day inundation and 1.35-meter peak inundation depth were recorded in the 1998 Flood. Figure 1 shows calculated inundation duration and inundation depth plotted over the study area and scenario of the specific area during 1998 flood. This is a novel approach of the Bangladesh Flood Inundation Mapping, where a point-based observation system is transferred to the inundation area using FID model although the area needs to be identified more accurately. The results of this study will have a great impact in flood management specially reducing flood damages in Bangladesh. Structural countermeasures as well as early warning systems regarding flood disaster management in most affected areas can be improved based on the result of this study. Also flood risk information can be provided more efficiently to the affected people as well as policy makers, researchers, mass media, etc.

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