CTCN Technical Assistance to Bhutan

Reference Number: 2016000046

"Flood risk assessment for Dungsamchhu Basin in Samdrupjhonkar Municipality"

The team from Bhutan and AIT involved in the CTCN Technical Assistance

Deliverable 3: Flood vulnerability, hazard, and risk maps

CONTEXT

Bhutan has been grappling with flooding problems for years. A combination of steep topography and the projected increase in rainfall in the coming decades due to climate change poses major threats, particularly during the monsoon season. In addition to direct flood damages to life and property, these events also trigger subsequent hazards such as landslides. The Government of Bhutan has recognized the need to urgently manage the recurring flood problems in the country. As a result, it has approved a budget of Nu.728 million in the 11th Five Year Plan for flood protections works throughout the country, and established the Flood Engineering and Management Department (FEMD) to oversee all flood management works in the country. The newly established FEMD, however, lacks the technical capacity to carry out the flood risk assessment studies, which is crucial in developing flood management plans to mitigate the impacts of floods.

In May 2016, FEMD and the National Designated Entity (NDE) of Bhutan, the National Environment Commission Secretariat (NECS), submitted a request for CTCN assistance on "*Capacity development for preparing an integrated flood management plan for Dungsamchhu Basin in Samdrupjongkhar*". The request was accepted by the CTCN, and consortium partner Asian Institute of Technology (AIT) was engaged to provide technical support. After several rounds of interaction between AIT and FEMD, the scope of the technical assistance was defined specifically and deemed to focus on "*Flood Risk Assessment for Dungsamchhu Basin in Samdrupjhonkar District*". The objective of the technical assistance is to enhance the skills of the relevant engineers in FEMD and Samdrupjhonkar municipality to indigenously undertake flood risk assessment and to translate this assessment into flood adaptation interventions.

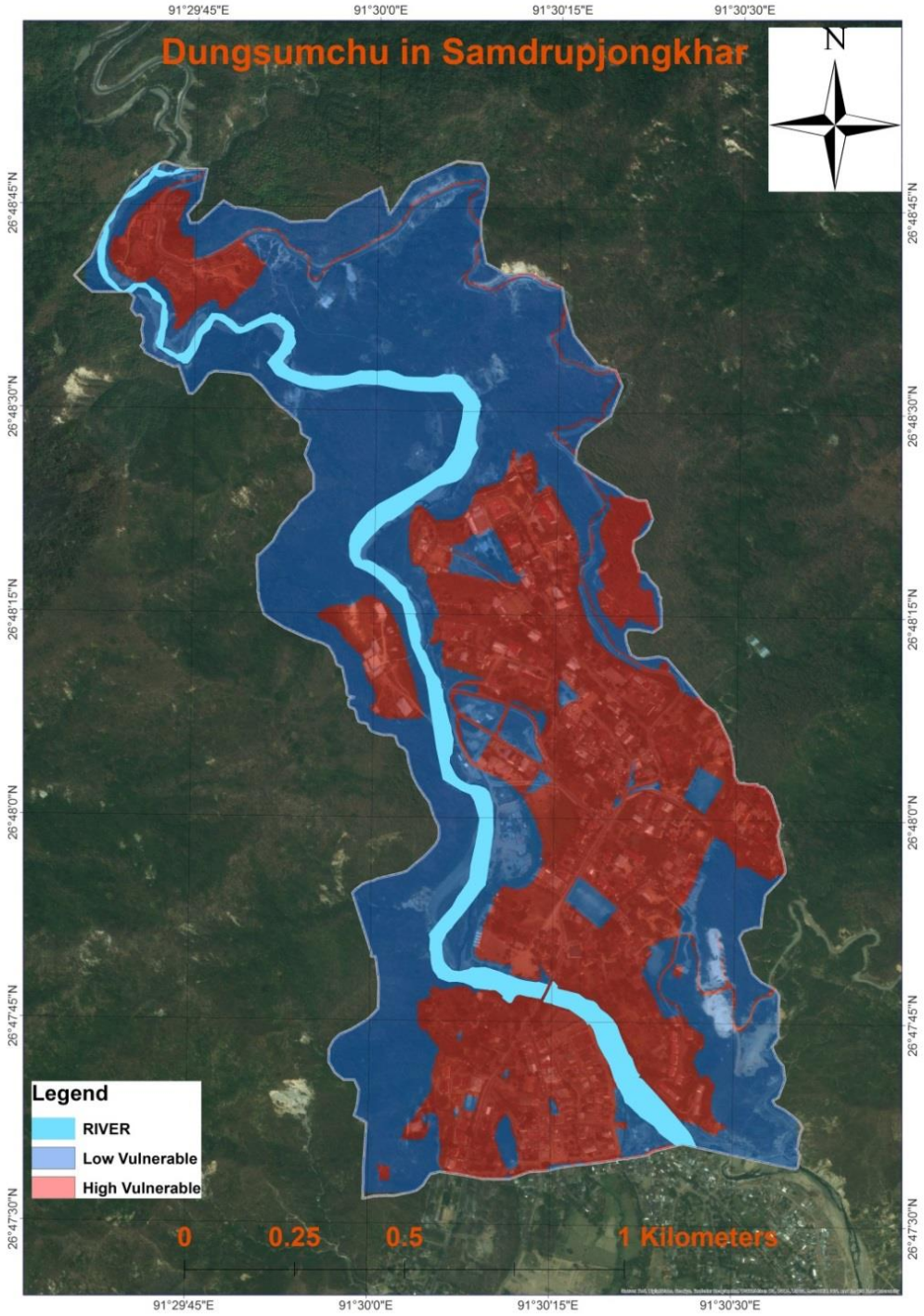
One of the activities under this technical assistance was to develop flood hazard and risk maps for the Samdrupjhonkar municipality. This document presents the maps developed by the FEMD engineers in consultation with experts from AIT.

DEVELOPMENT OF THE MAPS

- The maps were developed by FEMD engineers who had attended the training workshop in Bangkok, which was the second activity of the Technical Assistance.
- They were remotely mentored by three experts from AIT through Skype calls, and emails.
- Based on the advice provided by the AIT experts, the team from FEMD was successfully able to develop a first draft of the maps within 2 months of starting the work.
- These were reviewed by the AIT experts once, who provided comments and suggestions to fine-tune the outputs.

- After receiving comments from the AIT experts, the FEMD finalized the maps within a month.

FLOOD VULNERABILITY MAP

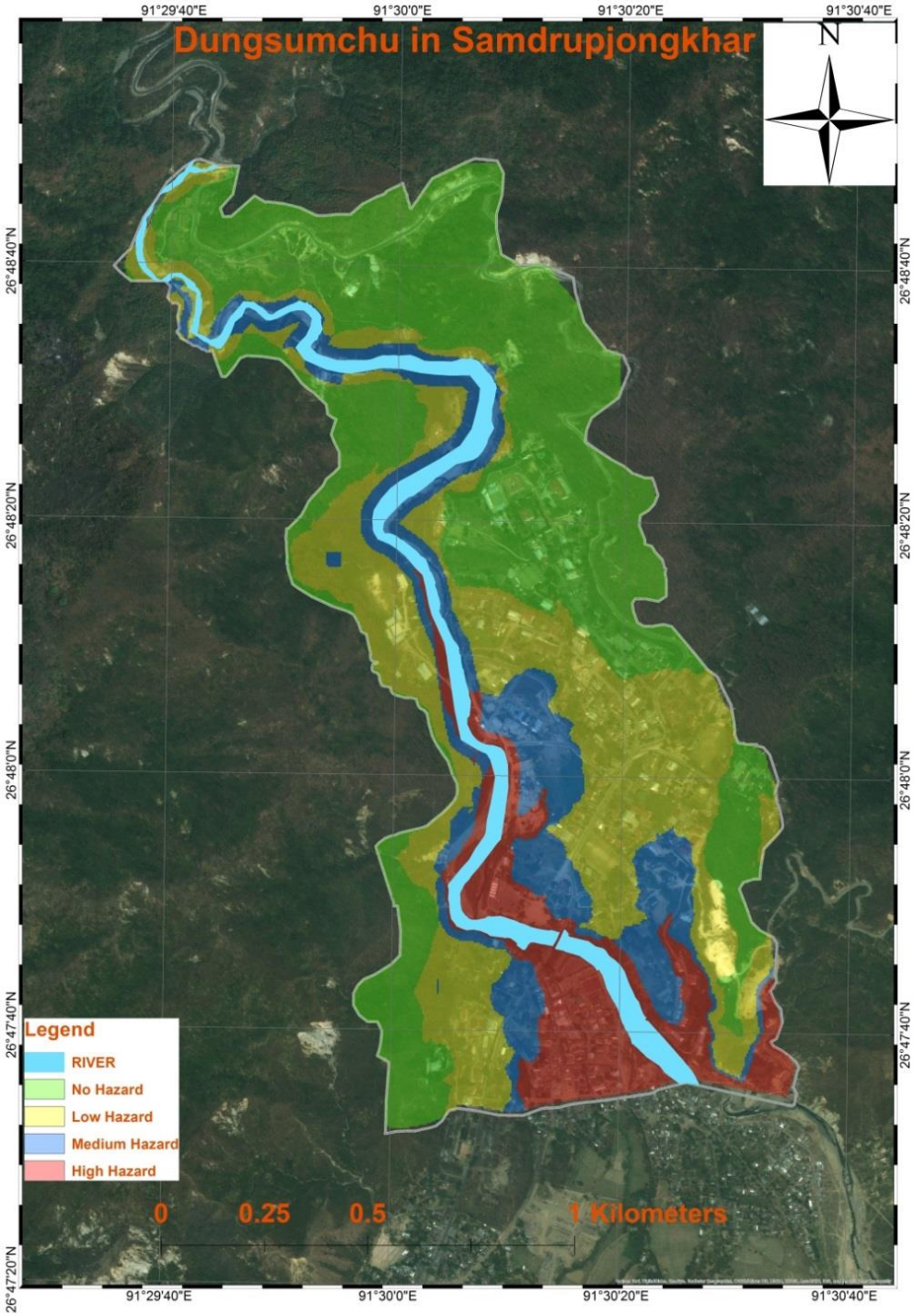


The flood vulnerability map was developed primarily via a vulnerability assessment that was carried out in the area of interest. A specifically designed questionnaire

was used to perform the vulnerability assessment. The steps used to analyze the survey questionnaires for vulnerability assessment included (1) Variable selection (to identify only those variables for which enough and consistent responses were received from respondents); (2) Variable classification and scoring (to classify and quantify the variables into four vulnerability indices, i.e. social, economic, physical and exposure); (3) Regional division (to decide the spatial scale of analysis). In this case it was decided to carry out the assessment at household level, and the land area was divided into 'developed' and 'underdeveloped'; (4) Vulnerability index calculation (which was calculated for the different indices using standard formulae); (5) Weighting and ranking variables (to capture the effects of individual variables on the overall vulnerability).

Because of the small geographic area of analysis, the land usage was divided into two categories—developed, and undeveloped. To prepare the flood vulnerability map, the raster base map for Samdrupjongkhar municipality was reclassified 12 times using the reclassify tools under spatial analyst of GIS, based on the ranking given for each vulnerability indices in the two land use categories. Because the area is only divided into undeveloped and developed area, the vulnerability map prepared using the GIS shows only two scorings with values of 199.92 and 116.62. Areas with values equal to 116.62 were considered having low vulnerability and those with 199.92 were considered having high vulnerability. Ábout 2.69% of buildings out of 817 are located in less vulnerable area and remaining 97.31% are located in high vulnerable area based on the vulnerability map.

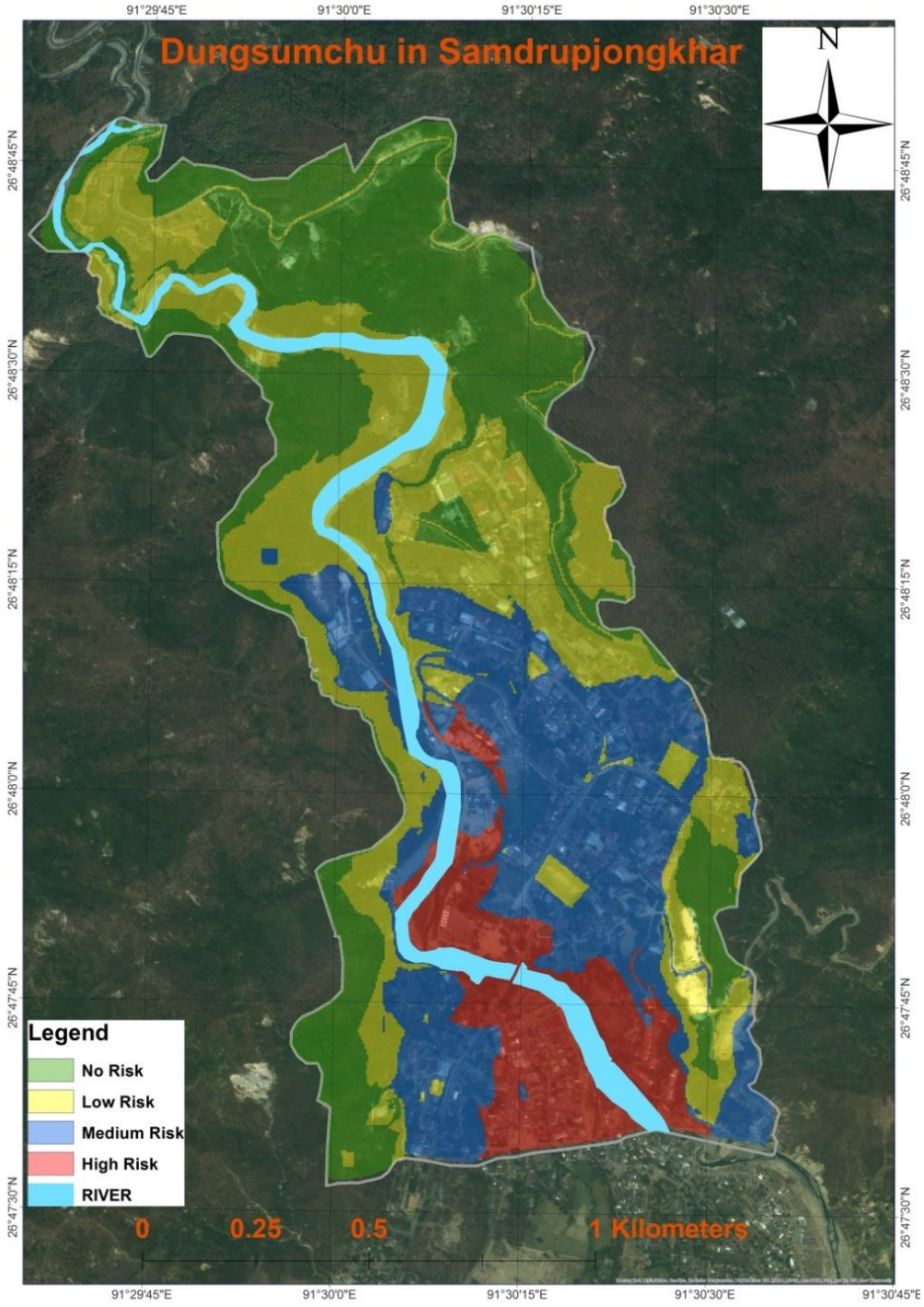
FLOOD HAZARD MAP



The flood hazard map was generated from Digital Elevation Model (DEM) of 4-meter resolution; and a river buffer map. A buffer is a naturally vegetated area along a river or stream corridor. The river buffer was calculated using Euclidean distance in the spatial analyst tools in GIS. The other variables used were flood depth, flood

duration, velocity, rainfall, elevation, soil and distance from the river. The flood hazard map was prepared based on the given weights for river buffer and elevation using raster calculator in GIS. A weight of 75 was given to the elevation data and 25 was given to the river buffer, to reflect their significance in the hazard analysis. Both the maps were then overlaid to prepare flood hazard map for Dungsamchhu using the relevant equations in raster calculator. The hazard map prepared using GIS was categorized into 4 classes using natural breaks in the symbology, with same distance between each class. The highest hazard value class was taken as high hazard, the second as medium hazard, the third as low hazard and the lowest as no hazard. Around 23% of buildings out of 817 are located in high hazard zone. Only about 21% of the buildings are located in no hazard zone.

FLOOD RISK MAP



The Hazard Map and Vulnerability Map were overlaid using raster calculator in spatial analyst tool of GIS to produce Flood Risk map. An equal weightage was given to both hazard and vulnerability. The risk map prepared using the GIS was classified into 4 classes using natural breaks in the symbology with same distance between each class. The highest risk value class has been taken as high risk, the

second as medium risk, the third as low risk and the lowest as no risk. Around 31% of the buildings out of 817 are located in high risk zone. Only about 1% of the buildings are located in no risk zone.