Government of Nepal
Ministry of Energy, Water Resources and Irrigation
Water Resources Research and Development Centre
Pulchowk, Lalitpur

WRRDC RESEARCH LETTER

Issue: 20
May 2022

Flood Hazard Mapping and Vulnerability Analysis of Building structures at Chame and Taal Gaon area, Manang District

Background

Nepal is at high risk from hydro-metrological and geophysical hazards. Different parts of the country get flooded every year during monsoon. Flood inundation causes significant damages to life and property in Nepal, annually. Almost 300 people are killed annually by floods in Nepal on average (Shen and Hwang 2019). The monsoon of 2021 also caused severe flooding in Manang. The Marsyangdi River received more than double the average yearly rainfall of 300 mm. The floods caused most of the damage in Taal and Dharapani area. It also disconnected access to the district headquarter of Chame. The flood and landslides destroyed 56 houses and damaged more than 200 houses; leaving hundreds of people displaced.

Flood hazard mapping and vulnerability analysis can be an effective tool in reducing flood damages. Most of the previous studies are done at basin scale and use limited topographic survey data. This study aims to provide a detailed flood inundation analysis at settlement scale with detailed aerial survey, hydrologic and hydraulic modeling and vulnerability analysis of buildings.

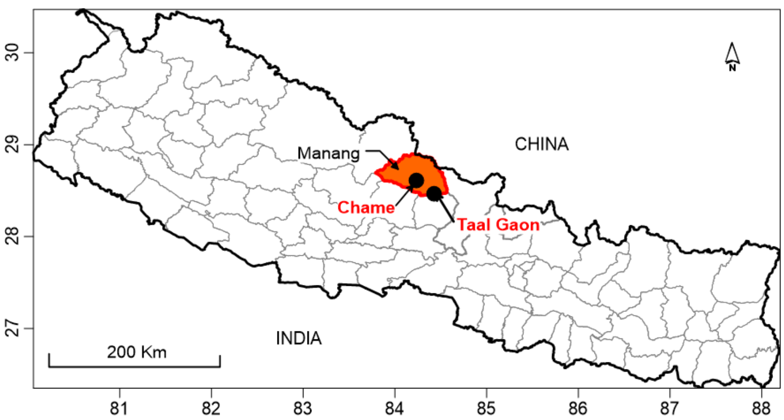

Figure1: Location map of study area

Figure2: Damaged buildings

Objective

The objective of the project is to prepare settlement scale flood hazard map and perform vulnerability analysis of building structures at Chame and Taal Gaon area of Manang District. The specific objectives include i) aerial survey ii) hydrologic and hydraulic modeling iv) flood risk area and flood depth mapping v) development of depth damage and vulnerability curves for buildings vi) buildings vulnerability mapping vi) provide suitable recommendation for protection of settlement.

Methodology

The study team initially performed desk study to collect site information, hydrological and meteorological data, aerial survey planning and field visit preparation. Aerial survey of Chame and Taal Gaon was done during field visit and data for damaged buildings from past floods were also collected. A Digital Elevation Model (DEM), ortho-photos and building footprints were created from aerial survey. The hydro-meterological data was collected and used to develop hydrologic model in HEC-HMS. The model was calibrated from 2012 to 2014 and validated for 2014 to 2016. An open channel hydraulic model was developed in HEC-RAS. Flood inundation maps and depths were created for four different return periods. The maps were used to define risk levels for different structures that lie in the floodplain. The data collected from field survey was used to develop vulnerability functions (depth damage curves) using nonlinear regression analysis using exponential functions. The curves were further used to assign probability of damage to buildings that lie the floodplain; based on depth of flood for individual buildings.

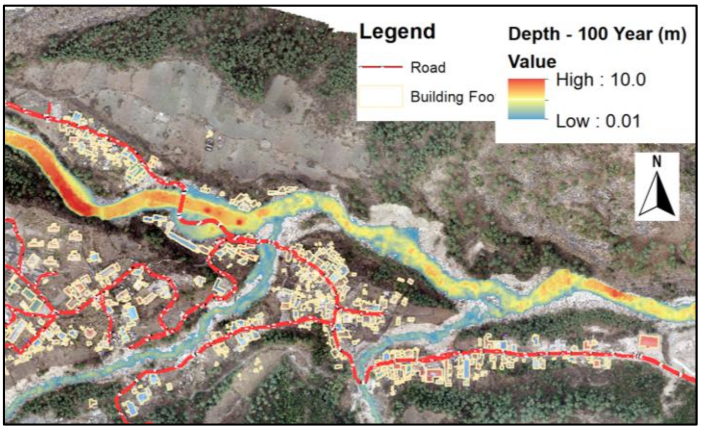

Figure 3: Flood depth map of Chame (100 Yr return period)

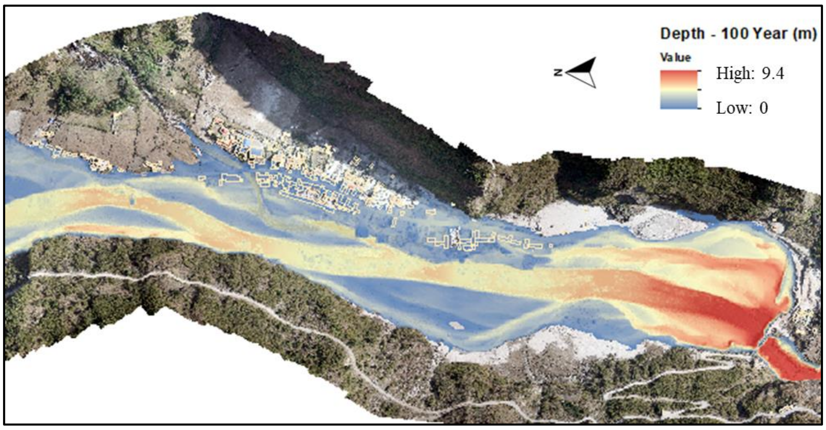

Figure 4: Flood depth map of Taal Gaon (100 Yr return period)

Results

The flood inundation maps give a clear picture of very high risk, high risk, medium risk and low risk areas. Taal Gaon area is highly prone to flood damages with 73 buildings in very high risk areas. Depth damage curve is plotted using nonlinear regression model with coefficient of determination (R^2) values of 0.77. From the vulnerability curve, at 4 m of depth, 100% of the building will have probability of getting minor, major and severely damage. Whereas, 75.4% of the building have chances of damage beyond repair and 44% of the building has probability of being completely damaged.

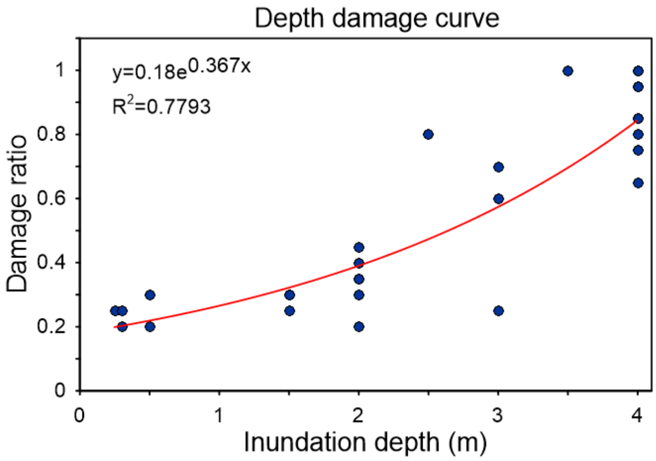

Figure 5: Depth Damage Curve – Masonry Building

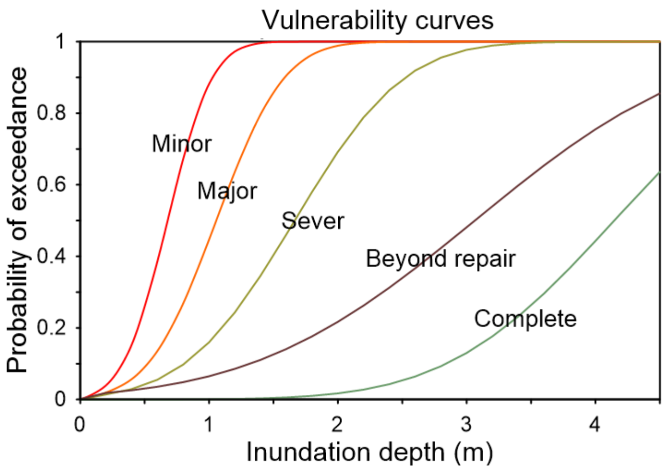

Figure 6: Vulnerability Curve for Masonry Buildings

Conclusions

A detailed hydrologic and hydraulic analysis was performed using precise drone survey data. The hydrologic study provides a clear idea of flood risk areas and structures at risk. The depth damage curves for masonry structures is helpful in estimating vulnerability of structures for different depths of flood. This study can be further used to raise awareness regarding flood hazards and risks. It can also be helpful in mitigating loss and damages from flood hazard in the future.

Reference

Shen, G. and Hwang, S.N., 2019. Spatial–Temporal snapshots of global natural disaster impacts Revealed from EM-DAT for 1900-2015. Geomatics, Natural Hazards and Risk.

FOR FURTHER INFORMATION:
Government of Nepal
Ministry of Energy, Water Resources and Irrigation

Water Resources Research and Development Centre

Dr. Ananta Man Singh Pradhan, Sr.Div. Engineering Geologist, ananta.pradhan@nepal.gov.np
Mahesh Khanal, Information Officer, mahesh.khanal@nepal.gov.np
Website: www.wrrdc.gov.np

Citation: Pradhan, A.M.S., Bista, A., Maharjan, M., Maharjan, B., Gadtaula, M. 2022. Flood Hazard Mapping and Vulnerability Analysis of Building structures at Chame and Taal Gaon area, Manang District, WRRDC Research Letter, Issue no: 20, May 2022, pp. 1-2.