ASSESSMENT OF FLOOD PHYSICAL VULNERABILITY IN RISPANA RAO CATCHMENT, DEHRADUN CITY, UTTARAKHAND, INDIA

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Abstract
In urban area flood is the most frequent hazard which destroys human lives directly and indirectly. It occurs when rapid accumulation and release of runoff water flows from up streams to down streams because of heavy rainfall. The geography of Dehradun demonstrated that it is situated at an altitude of 3350 meters and it is at the focal point of Doon Valley, farming part of Garhwal Himalayas. Extending from 29 °58' N and 31°2' N latitude and 77° 34' E and 78° 18'E longitudes. The aim of this study is to identify the physical vulnerability of buildings content and losses in residential area. With the help of questionnaires and base map prepared by ArcGIS software using satellite image Cartosat 1 with 2.5meter spatial resolution were used for this investigation. The primary data were collected through questionnaires, digital camera and GPS were used for field photography and for demarcating the coordinates. The aim of the field study is to collect data of the elements at risk. The study area is highly prone to natural hazards like earth quake, landslide and flood. Dehradun experiences heavy rainfall during monsoon season (from June to September). The study is carried out along the river side encroached by the migrated labourer class mostly from the outside of the regions.

Keywords: *Flood, Vulnerability.*

Introduction

In urban area flood is the most frequent hazard which destroys human lives directly and indirectly. It occurs when rapid accumulation and release of runoff water flows from up streams to down streams because of heavy rainfall. Landslide and flood become the main cause of destroying the human and animal lives in Uttarakhand. Anthropogenic interferences, rapid and unplanned developmental activities are mainly responsible for these disasters. Flood might be considered as one of the hazards making most impact on human beings (Ward 1978; UNDOR 1978 and Blaikie et al; 1994).

Owing to ever increasing pressure of population the urban sprawl is rapidly expanding especially in developing countries. The price of land is going high and is resultant in the form of converting the vegetated cover, agriculture land and wetland into built-up area and platforms for human activities. In developing countries people used to migrate for employment from rural to urban foci. They used to build their houses either in river bed, fringe areas or also in hazardous zones. The general mass living in flood prone areas mostly are poor i.e., below poverty level and they cannot afford to buy legal houses, and often illegally occupy the waste and barren land along the river bed.

Flooding is the serious problem in the area under reference. This comes along the Rispana River and drains in the south eastern part of Dehradun. The river remains dry throughout the year except in monsoon season (from June to September). The area is mainly inhabitat by migrated people, came from eastern Uttar Pradesh and Bihar. During the field investigation the researchers found that owing to illiteracy and poor economic conditions they prefer to live in such area. There is a significant increase in vulnerability of land and buildings due to

the uncontrolled growth of the city and the occurrence of flood is increasing year after year. The impact and consequences of the flood are quite severe. It causes damage to the buildings and houses (Jhuggi-Jhopadi) partially or entirely. The goods and belongings of daily uses viz. food, clothes, beds, wardrobes, electronic items etc. generally destroyed in such incidents. Since the inhabitats cannot afford such loss so that they use to shift some another public places like, government school, dharamshal, temples, mosques, for a short span of time. Each year buildings collapse due to flood and the people has to shift in the same manner in every two-three years.

Study Area

The geography of Dehradun demonstrated that it is situated at an altitude of 3350 meters and it is at the focal point of Doon Valley, farming part of Garhwal Himalayas. Extending from 29 °58' N and 31°2' N latitude and 77° 34' E and 78° 18'E longitudes, is the capital of Uttarakhand. The area under the administrative control of the Dehradun municipal board is 38.04sq. Km. It is varying at a height from 400m to south side and above 600m at north side. The hilly region Mussorrie goes up to a height of 1800 to 2007m above sea level.

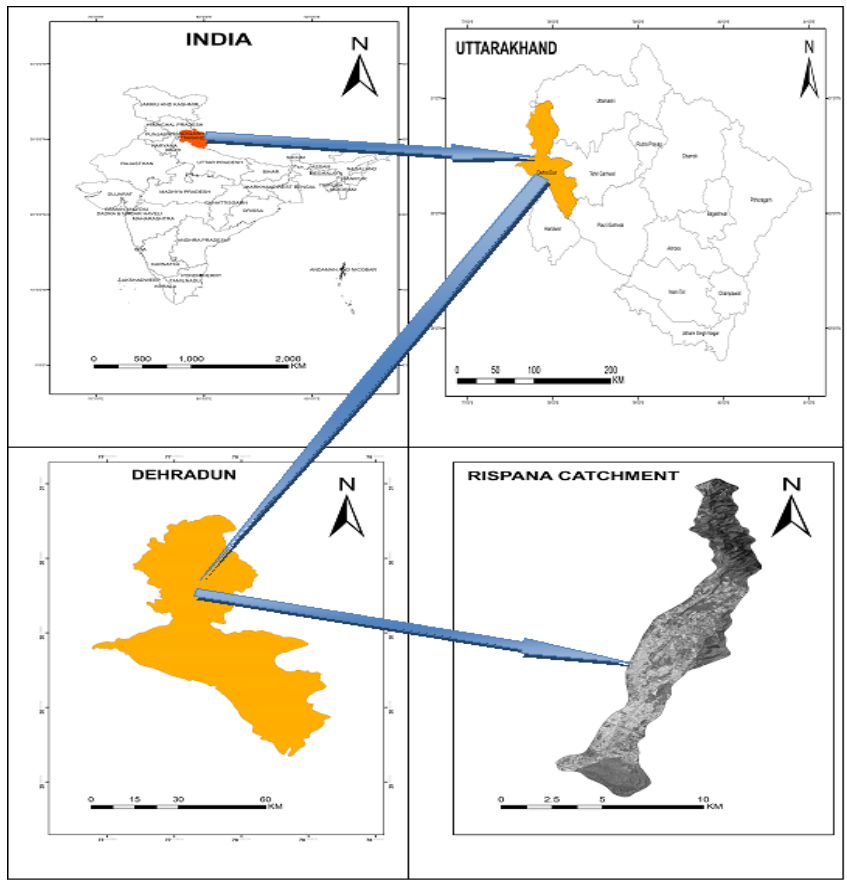

Figure 1. Location of Study Area: Rispana Rao Catchment, Dehradun

Dehradun is the capital city of Uttarakhand state, situated in the north-west corner of the state. The newly municipal corporation area is mostly located on the river bank of Rispana. The population of this area is more than 1, 50,000 people. 350 respondents have been selected for interview during field investigation and around 2,500 people reside in the area under question. It has been observed that from the last five to seven years the area has become most dangerous for habitation especially from June to September. It has also been observed that the rapid urban sprawl taken place especially in these area.

Objectives

The aim of this study is to identify the physical vulnerability of buildings content and losses in residential area.

Methodology

With the help of questionnaires and base map prepared by ArcGIS software using satellite image Cartosat 1 with 2.5meter spatial resolution were used for this investigation. The primary data were collected through questionnaires, digital camera and GPS were used for field photography and for demarcating the coordinates. The aim of the field study is to collect data of the elements at risk (building structure, goods and related materials inside the house properties, outside properties, number of persons per house), flood duration and depth of flood water entries inside the house. 350 households were selected on the basis of random sampling technique for the detailed relevant building inventory. For assessing the vulnerability of the buildings various categories of data have been collected viz, (wall material, number of floor, age of the buildings, height of the buildings, height of first floor from the surface, damage of building etc.). The building data was stored in point format and data from the interviewed were input into a tabular format. Spatial analysis of data was done through ArcGIS 10.2 software. Using this software queries were generated to present different types of building structure, elements at risk, damages house, people coping mechanism against flood. Secondary data were collected from Dehradun Nagar Nigam and Disaster Mitigation and Management Centre (DMMC) Uttarakhand Secretariat Dehradun, Uttarakhand.

Table 1. Data Used

Cartosat_1_2008		Cartosat_1_2015	
Columns	3679	Columns	3340
Rows	9827	Rows	8921
No of bands	1	No of bands	1
Cell size	2.5, 2.5	Cell size	2.75, 2.75
Spatial reference	WGS_1984 UTM_Zone_44N	Spatial reference	WGS_1984 UTM_Zone_44N
Datum	D_WGS_1984	Datum	D_WGS_1984
Spatial resolution	2.5m	Spatial resolution	2.5m
Scene Spec	527-258	Scene Spec	527-258
Sat-Sen	P5-PANA-SR	Sat-Sen	P5-PANA
Date of acquisition	24-March-2008	Date of acquisition	17-April-2015

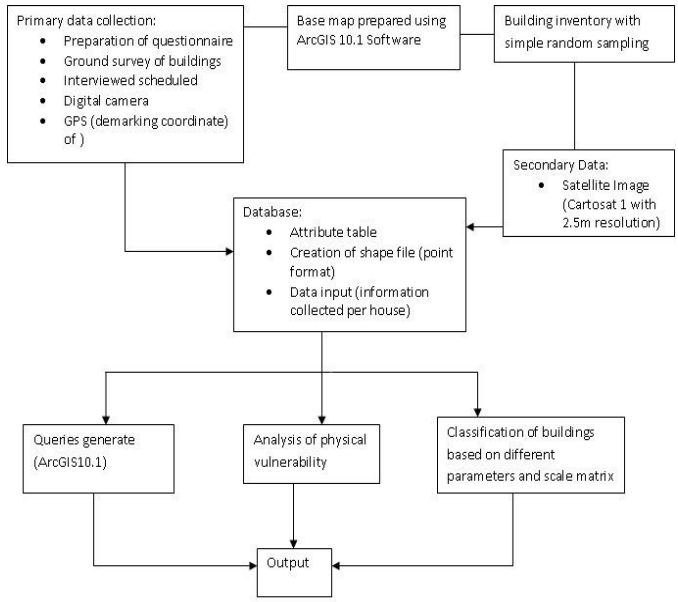

Figure 2. Flow chart of the Methodology

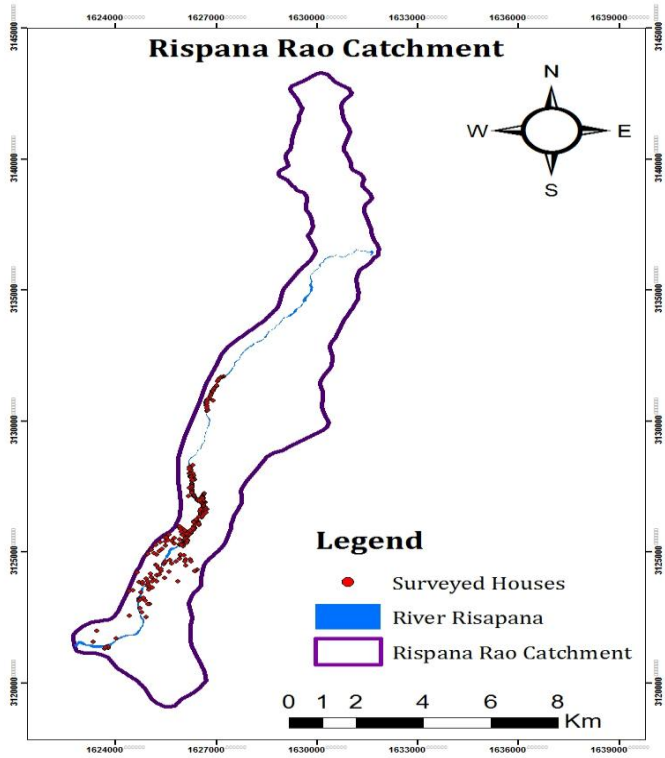

Figure 3. Surveyed houses

Results and Discussion

The study area is highly prone to natural hazards like earth quake, landslide and flood. Dehradun experiences heavy rainfall during monsoon season (from June to September). The study is carried out along the river side encroached by the migrated labourer class mostly from the outside of the regions. Since the area is ecologically sensitive and geologically vulnerable, the unplanned human habitat along the river side caused landslides and heavy floods. Due to rapid urbanization of Dehradun city multiple water channels flow into Rispana River and make the area prone to flood.

The built-up of the study area was 13.14sqkm in 2008 and it has become 18.67sqkm in 2015. It shows that 5.53sqkm land cover has been increased in between eight years.

The survey has been conducted in the month of June and July 2018. During the survey, it has been found that the people built their houses with single floor, roof type i.e., tin shade, wall material is used as brick and cement, thickness of wall is four inches, age of buildings is above twenty years. It has also found that 50% of buildings have more than 3-4 i.e., multidirectional openings which make their house more vulnerable as water enters very easily during flood. 65% of houses need to repair or construct entire part of wall and floor. Based on the responses from the interviews, the authors have concluded that wall, floor, roof and columns etc. elements are at risk.

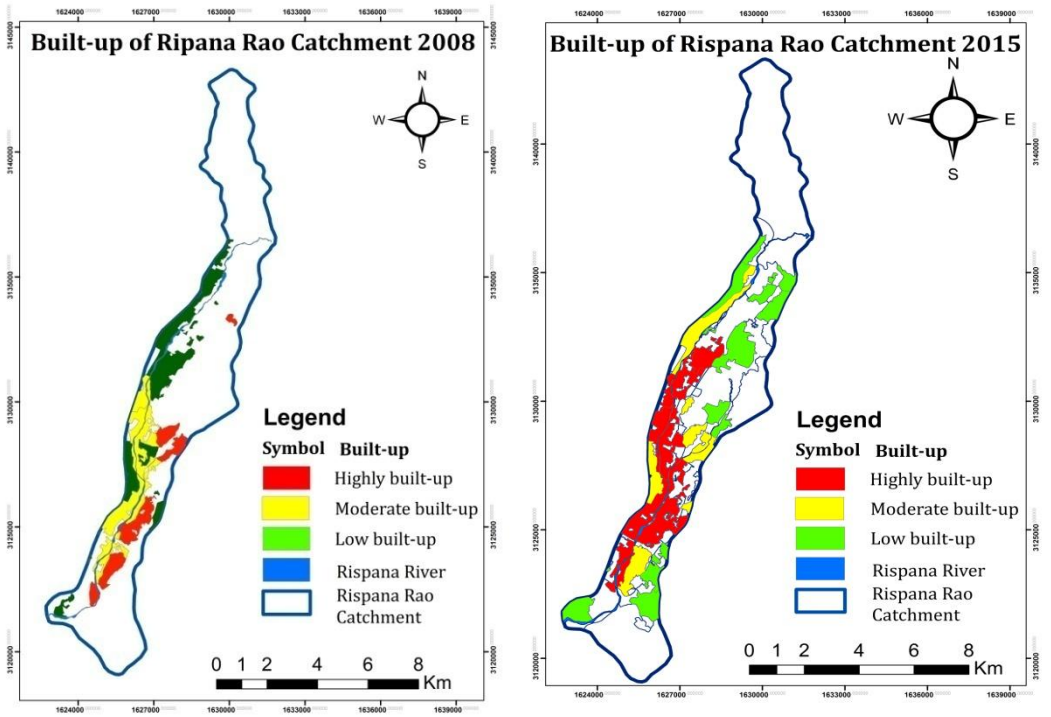

Figure 4. Built-up area of Rispana River between two years 2008-2015

Matrix: This matrix has used to classify the impact of flood hazard. Based on the table 2 classes have been divided into four divisions and value has given from 1 to 4. Value 4 is showing highly destructive and value 1 is showing minor destructive. It has been found that

within five years minimum 5-10 people died every year and 40 to 60 people get injured. In this category the numbers of children are more. 55 houses are highly damaged and 160 houses are partially damaged. Only 40 % of people get proper services within 4-5hrs rest 60% people do not get any help till 12 hrs from the incident.

Table 2. Matrix showing impact of hazards

Value	Classification	Classification indicators
4	Highly destructive	• Number of death • Number of injured
3	Destructive	• Number of destroyed houses • Number of people affected by destroyed infrastructure
2	Moderate	• Duration of services disruptio
1	Minor	

Value	Classification	Classification indicators
4	Highly destructive	• 5-10 people per year • 40-60 people per year • No of children are more
3	Destructive	• 55 house inside damage • 160 houses damaged outside
2	Moderate	60% of people do not get proper services fo
1	Minor	40% of people do not get service for 5-6

Table 4. Parameters of buildings

SN	Parameters	Categories
1	Building type	Residential
2	Floor material	Cement
3	Wall material	Brick & cement
4	Number of floor	1 & 2
5	Roof type	Tin
6	Age of building	20-40
7	Number of openings	3-4
8	Thickness of exterior wall	4inch
9	Maximum height from the surface(ft)	1ft
10	Height of the building(ft)	<20ft
11	Soil type	Sandy and loam

Assessment of physical vulnerability: The below table 4 is showing the parameters which we have taken to estimate the vulnerability of buildings. Most of the buildings were residential type, and they have used only cement for floor materials which are very prone to flood as it observe water easily. Their wall materials were made of bricks and cement without columns that is also risky as columns give support between two floors. We found that most of their roofs were made up of tin as tin shade is not properly safe during monsoon season

and heavy wind can damage it. We also found that most of the houses were newly constructed and it is continued in that area but they are not using the maintaining the quality of materials. Every house has more than 3 to 4 opening, during flood the water enters into the house from all the side and creates problems for the locals. The thickness of their exterior wall is 4inch as it cannot bear the force of heavy flood and damage very easily. Single floor buildings are more vulnerable to flood because they do not have enough space to shift in comparison to double floor buildings. Soil type is sandy and loamy as this soil is not good for flood protection it is easily floodable into water. Table 2 show that children and old age people (above 65) are most vulnerable as they need someone to help them out.

Existing and proposed mitigation measures: The study area has high requirements of mitigation measures: Proper retaining wall should be constructed. Encroachment should be stopped. A-forestation. D-siltation specially at Bhagat Singh colony

Conclusion

The study conducted that Dehradun is facing tremendous problem of urbanization. Due to urbanization the study area is becoming vulnerable to multi-hazards. The analysis of remote sensing and GIS data enables to monitor the vulnerability of urban flood. It clearly (figure: 2) shows that the urbanization has increased 5.53sqkm in Rispana Rao catchment. Based on the field study it observed that the river bed has encroached badly and due to this community and people both are becoming vulnerable to flood hazards.

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