WEB GIS BASED REAL-TIME ESCAPE ROUTE PLANNING

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

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DISASTER MITIGATION AND MANAGEMENT

By

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CANDIDATE'S DECLARATION

I hereby declare that the work carried out in this dissertation report entitled, "**Web GIS based Real-Time Escape Route Planning**", is presented on behalf of partial fulfilment of the requirements for the award of degree of "**Master of Technology**" in **Disaster Mitigation and Management** submitted to the Centre of Excellence In Disaster Mitigation And Management (CoEDMM), Indian Institute of Technology, Roorkee, under the supervision of **Dr. Kamal Jain,** Professor, Civil Engineering Department, IIT Roorkee.

I have not submitted the record embodied in this report for the award of any other degree or diploma.

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ABSTRACT

Nowadays, Disasters are unavoidable. Frequencies of Disasters are very high. India is a country with a population of approximately 1.25 billion, as population increases force to use areas sensitive to disaster. Natural hazards (i.e. earthquakes, floods, landslides etc) turn into disaster when they hit the man-made environment that causes lives and properties loss. Due to increase in frequency and intensity of natural disasters the proper disaster mitigation and management planning is inevitable. Disaster cannot be stopped but it can be minimized to take better decision making during disaster.

To effectively reduce the impact of various disasters by availability of spatial data this helps the managers for better decision-making at the time of disaster. Geographical Information System (GIS) can play a very important role to support spatial planning for disaster management as a powerful tool for collecting, storing, analyzing, modelling and displaying large amount of data. Designing a GIS to distribute geospatial information on a network such as Web, gives an opportunity to the managers to easy decision making to get the information about disaster any time and any where they are. Web GIS Decision Support System for Disaster Management enables timely insights, better communication thus making the information rapidly available for better preparedness and action.

Preparedness and mitigation for disasters are very useful to face disaster effectively i.e. minimize loss of life and property cause by disaster. During any disaster, response, rescue and relief operation are also important phase of disaster management to reduce the effects of disaster. These operations are critical when all the existing transportation system get damaged due to disaster. In that case, most of victim trapped in disaster hit areas resulting increased casualities. For immediate rescue and relief, escape routes play a major role to evacuate victims from disaster affected areas to safe places.

In this study, real-time escape routes are generated and access on Web for evacuation purposes. The real-time escape routes can be generating by using Model builder in ArcGIS with various parameters and linked on Web using open source tool like Openlayers and Geoserver etc. All generated escape routes can be easily used as walk able paths and to evacuate victim to safe places during worst circumstances in order to reduce casualities and the impact of disaster.

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CHAPTER 1

1 Project Introduction

1.1 Introduction

Nowadays, Disasters are unavoidable. Frequencies of Disasters are very high. India is a country with a population of approximately 1.25 billion, as population increases force to use areas sensitive to disaster. Natural hazards (i.e. earthquakes, floods, landslides etc) turn into disaster when they hit the man-made environment that causes lives and properties loss. Due to increase in frequency and intensity of natural disasters the proper disaster mitigation and management planning is inevitable. Disaster cannot be stopped but it can be minimized to take better decision making during disaster.

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Preparedness and mitigation for disasters are very useful to face disaster effectively i.e. minimize loss of life and property cause by disaster. During any disaster, response, rescue and relief operation are also important phase of disaster management to reduce the effects of disaster. These operations are critical when all the existing transportation system get damaged due to disaster. In that case, most of victim trapped in disaster hit areas resulting increased casualities. For immediate rescue and relief, escape routes play a major role to evacuate victims from disaster affected areas to safe places.

Uttarakhand is a north state of India has most of the hilly areas. Hilly areas Cities of Uttarakhand is situated in a valley which is vulnerable to flash flood, landslides, and seismic activity due to lies on seismic zone V and IV i.e. very high and high prone to earthquake respectively. When disaster occurs in hilly region causes damaged existing roads etc. Due to it evacuation operation faced many problems to get away victim from this region. Uttarkhand also faced lots of worst past disaster. Recent disaster faced by Uttarakhand is Kedarnath tragedy (Uttrakhand tragedy 2013). In which most of victim trapped in Uttarkashi region and there was no way of evacuation cause to existing road was damaged due to flood or landslides. Disaster cannot be stopped but it can be minimized through proper planning of disaster mitigation and management. For rescue and relief plan, escape routes play a major role to evacuating victims from disaster affected areas to safe places.

Remote Sensing and Geographic Information Systems (GIS), has been playing a major role in the escape route planning. With these technologies the assessment of settlement patterns can be done rapidly. This would help in site selection for safe areas as relief and evacuation camps in the region to implement rescue and relief operation successfully.

Remote sensing has multiple advantages like the availability of data at regular intervals. This can be observed even in Google Earth as their images of same location at different intervals which helps in analysis like change detection. Remote sensing provides pre and post disaster data which is used to generate real-time escape route planning according to disaster affected areas. In most cases remote sensing GIS data is used as the base for monitoring and implementation as it is accurate and due to its updates.

GIS has been playing a major role in spatial planning in the last decade, and is being widely used by most of the disaster management authorities. Use of GIS in disaster mitigation and management is wide on account of availability of information and taking better decision making during disaster. The physical requirement of data storage is reduced to minimum with the introduction of GIS. Large measure of information can be kept and extract according to own requirement with implausible rate. Various modernized programming modules, instruments, and tool used to assessment and estimation of geographic configuration and information control. In addition to all these GIS data can access on Web and easy to get during disaster to take better decision making.

By the use of modern Web technology and Web services, the result of GIS can be access on Web which is known as Web GIS system. Open source tools like Openlayers and Geoserver are of great use in the creation of Web GIS system. These days Internet usage is very high. Disaster managers take better decision through Web GIS system and implemented it to handle disaster scenario successfully. So that people save their lives and effects of disaster can be reduced effectively.

Even though there are many advantages for remote sensing, GIS and Web GIS there are very limitations that are faced in Indian scenario. This includes the requirement of trained personnel. The number of people who is expert who use GIS are very few in number. India being a developing country at present is not in a situation of invest large amount on hardware or software for Remote Sensing and GIS. Changing information organizations and programming creates issues in blending old information with new. One of the other issues faced is the requirement of capacity environment.

In this study, real-time escape routes are generated and access on Web for evacuation purposes. The real-time escape routes can be generating by using Model builder in ArcGIS with various parameters and linked on Web using open source tool like Openlayers and Geoserver etc. All generated escape routes can be easily used as walk able paths and to evacuate victim to safe places during worst circumstances in order to reduce casualities and the impact of disaster.

1.2 Need of Study

Due to increase in frequency and intensity of natural disasters (like earthquake, flash flood and landslides) causes loss of lives, wealth and properties at high scale. In order to control this dangerous situation there is a proper need of evacuation plan using escape routes in response, rescue and relief phase of disaster management to mitigate as well manages the catastrophes cause by the disaster. Route planning can be done by the use of spatial data. SOI maps are used to spatial planning till now. These maps are old may be more than 50-60 years. As population increases, habitation areas changed by 3-4 times resulting changed in Land use/ land cover maps. The information is obsolete got from SOI maps.

Thus, the escape routes should be constructed on the basis of modern technology i.e. DEM/ GIS etc will be beneficial. With these technologies the assessment of settlement patterns can be done in a faster manner. Development in the field of science and technology has provided with various technical resources which use can lead to finding the appropriate solution to these issues. In the field of spatial planning, the creation of GIS technology with the support of remote sensing can provide accurate results in research at a small duration resulting is solving the above mentioned issues.

By the use of modern Web technology and Web services, the result of GIS can be access on Web which is known as Web GIS system. Openlayers and Geoserver is of great use in the creation of Web GIS system. These days Internet usage is very high. So people and rescue personnel access escape routes through Web GIS system using internet and help to evacuate victims from disaster affected areas to safe place timely and safely. So that people save their lives and effects of disaster can be reduced effectively.

1.3 Limitations

The limitations of this study are as follows:

- The key limitation features in the study is due to the lack of availability of high resolution images.
- Investment in hardware and software
- Changing in information and programming of an organization which will make issue in combining old information with new information.
- Trouble and issue in starting phases of GIS information base outline and creation

1.4 Aim and Objectives

1.4.1 Aim

The aim of this study is to generate real-time escape routes between disaster affected areas and safe places and finally access these escape routes on Web.

1.4.2 Objectives

The objectives of this study are as follows:

- For rescue and relief purposes, prepare proper evacuation planning
- To identify vulnerable areas for disaster
- To identify safer places as relief and evacuation camps for evacuating people from disaster affected areas
- To generate real-time escape routes for evacuating people from disaster affected areas to safer places
- To publish these escape routes and safe places on Web GIS.

1.5 Outlines of the Dissertation

- Chapter 1 covers the introduction, need of the study, limitations, aim and objectives of this study. This chapter gives a basic idea on the topic and its relevance in the present day.
- Chapter 2 covers the literature review where study of Web GIS system, related terms, and its history in the field of spatial planning
- Chapter 3 shows a basic description of the study area and its demographic, geographic, and hazard profile.
- Chapter 4 provides the methodology used for this study. This chapter shows the workflow followed in this study.
- Chapter 5 has the results of various analysis performed and visualize it on the Web.
- Finally the chapter 6 covers the final conclusions of this study and its future scope.

CHAPTER 2

2 Literature Review

2.1 The Internet & the Web

At the time of Cold world War in the year of 1960s, the U.S. department of Defense Army i.e. Advanced Research Project Agency (ARPA) developed a network of geographically and physically separated computers which are used to exchange important information at the time of emergency. This computer network is known as ARPANET due to developed by ARPA. After this, other computers were regularly linked to this network. The network of networks of computers are interconnected and interrelated, and forming the Internet. By the year of 1989, lots of computers about 100,000 computers were globally connected and interrelated to the Internet.

But the Internet didn't acquire identification and appreciation until the 1990s. Previous then, the services like e-mail, file transfer, and Telnet offered on the Internet. In previously the Internet was difficult to use i.e. not user friendly, its content was not almost as prosperous and rich as it is now a days, and its clients and users were usually professionals from research institutes and government agencies.

In 1990, Tim Berners-Lee, a researcher at CERN (European Organization for Nuclear Research), significantly modified and changed the way of the use of the Internet was developed and utilized. While efforts to learn and discover a simple method to share and exchange credentials with his social group and officially requirement et. He invented HTTP, HTML, and URL. He developed the world's first and simple Web Server and a Web browser, naming the World Wide Web. With the origin of the WWW, he is known as the "father of the Web".

The Web has made the Internet attention grabbing and easy, and fun to use, interesting, it has forever changed the way of living and working. It has drastically changed the role of computer from computation and calculation to one of communication and entertainment.

The terms Internet and the WWW are synonymous and identical for the general group, but these both terms have different sense and meaning for individual terms. The Internet is used as a huge network of networks of computers that interconnect and interrelate globally. Through

the Internet, computers can communicate with each other by the use of number of protocols such as HTTP, SMTP, FTP, IRC, IM, Telnet and P2P. The World Wide Web (WWW) is a system of interlinked hypertext programs and documents that can be accessed through the Internet primarily by using HTTP specifications. Internet supports simply a HTTP. The main task of Internet is the content reachable and easy to get on the Web for a large number of users. So it can be say that the Web is the "face" of the Internet.

2.2 GIS

The entire things which take place anywhere. Expressing as "what" it is, "where" it is occur, and "why" it is occurred there, these all expressions can be significantly important for making decision and verdict in an organization as well as in personal life and concluded as a final results. GIS is a tool using the science as well as the technology for managing the "what", "where" and "why" type of query and for making quick and intellectual decisions based on space and location.

GIS technology has been introduced and used approximately since before the Internet and the Web. The initial operational and prepared GIS was developed in the year of 1962 by Roger Tomlinson for Canada's Federal Department of Forestry and Rural Development, called the Canada Geographic Information System (CGIS). This GIS was used for Canadian land inventory, database management and planning. Tomlinson developed first GIS system so he is known as the "father of GIS" for his revolutionary work for developing CGIS and encouraging GIS technology.

GIS is a tool to use for producing more than immediately meaningful and attractive maps, although GIS is used to make a numerous maps using different scales, themes and symbols. Most significantly, GIS has a powerful analytical and logical function which is used to produces useful information from data. GIS have feature to relate distinct data according to identical natural features like geography, topography etc, revealing hidden patterns, relationships and trends that are not readily and easily noticeable in spreadsheets or statistical packages, and use to create new information from initial data that can be used to support knowledgeable decision making.

2.3 Web GIS

Web GIS is made up of two word "Web" and "GIS". It means GIS running on Web browsers and has developed interested in Web GIS accessing desktop and mobile clients by the help of Web browsers. Web GIS has a nature of distributed information system. The simplest form of Web GIS system should have at least two components, a client and a server. The server is used as a Web application server, and the client is used in a form of a desktop application, a Web browser, or a mobile application. The server has a URL for every request of Web page by the client. By using these URL clients can access related Web page on the Web. The clients then depend upon HTTP specifications to send requests to the server. The server generates and produces the requested GIS operation and sends a response to the client, again via HTTP. The HTML format is used by the server for sending response that is received by the client side on the Web browser, but it can also be in other formats such as binary image, XML, or JSON. (Fu, Sun, 2011)

Web GIS system is any GIS that running on Web browser in a mobile phones client, desktop client or any Web browser client. In a short definition, Web GIS is known as GIS that uses Web technology to communicate between client and server for perform any operation in the form of request and response.

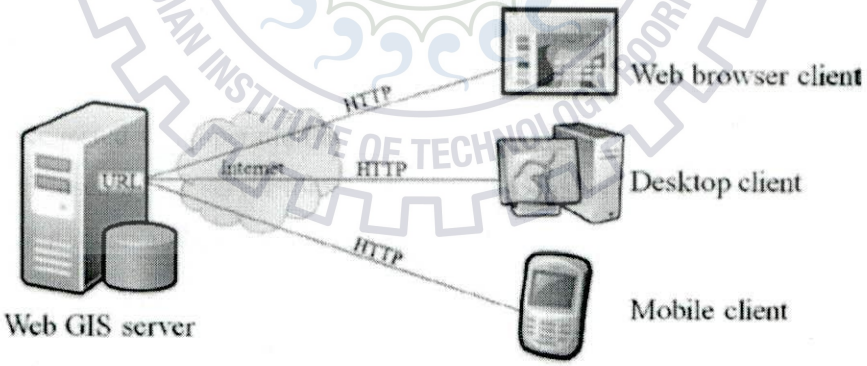


Figure 1: The simplest Architecture of Web GIS

2.4 History of Web GIS

The blending term of the Internet and the Web (World Wide Web) and computer applications has produced many new innovative technologies, and Web GIS system is one of

these disciplines. Web GIS has developed and grow up rapidly since 1993, Web GIS has significantly changed the approach of geospatial and geographical information is obtained, conveyed, published, shared, and visualized. Web GIS was appeared as a wider framework to understand, recognize and visualize our existence on the Earth. It represents a significant objectives and goal in the history of GIS and Web GIS.

Table 1: The history of Web GIS system

S.No.	Year	Developer/Agency	WebGIS System	Concept
1	1993	Steve Putz Xerox Corporation Palo Alto Research Center (PARC)	Web based Map Viewer	Retrieve interactive information on the web
2	1994	Nationwide Planning Agencies	National Spatial Data Infrastructure (NSDI)	collections of ready to use maps and GIS services
3	1994	Canadian National Atlas Information Service	National Atlas of Canada	generate maps on user request
4	1995	Charles Sturt University	World map maker	to create maps on the web and access geographic database
5	1995	University of California, Santa Barbara	Alexandria Digital Library	Search data to specify keywords
6	1995	U.S. Geological Survey (USGS)	National Geospatial Data Clearinghouse	search for maps and satellite images to state keywords and an area on the map
7	1995	ESRI	spatial database engine SDE	storing and managing GIS data
8	1995	U.S. Census Bureau	TIGER (Topologically Integrated Geographic Encoding and Referencing) Mapping Service	query and map the demographic information of states, countries, and cities
9	1995	NGDF(National Geo graphic data framework)	UK framework	data and services are delivered to user which satisfy their

				business needs
10	1995	Susan Huse, University of California, Berkeley	GRASS (Geographic Resources Analysis Support System) Links	Select data using various functions like buffer, overlay, mapping operations
11	1996	MapQuest	MapQuest Web mapping application	view maps for find the most favorable route to a desired location, and plan trips
12	1997	University of Minnesota (UMN)	Map server 1.0	Access needed satellite imagery
13	1997	ESRI	Arc view internet map service (IMS)	publish GIS data over the internet and serve map
14	1998	Microsoft Research (MSR), Bing Maps, and the USGS	TerraServer	Provide aerial imagery topographic map
15	2001	OpenGeo, GeoSolutions	GeoServer	share, process and edit geospatial data
16	2003	NASA	NASA WORLD WIND	provides latest images of Earth. Also, it gives a virtual Moon, Mars, Venus, Jupiter
17	2004	Steve Coast OpenStreetMap Foundations	OPEN STREET MAP (OSM)	Provide free editable map of the world.
18	2005	Google	Google maps	Provide route plan for traveling by foot, car, or with public transportation
19	2005	Google	Google Earth	provides 3D view of Earth
20	2006	OpenLayers Dev Team	OpenLayers	Provide an open source library for displaying map data visualizing on web browsers and provide an API for building rich web-based geographic applications

21	2006	Alexandre Koriakine and Evgeniy Saveliev	Wikimapia	detailed information about every place on Earth
22	2007	Nokia	Ovi services	Nokia`s Internet services provides Games, Maps, Media, Messaging and Music
23	2012	Nokia	HERE Map	Provide location and route plan map

2.5 Role of GIS and Web GIS in Disaster Management

GIS is used to create a map including geographic information having various features like, places, water bodies, land use etc using different scales, themes, and symbols. So, GIS is very useful tool for geographic information analysis. Disaster is also a geographic event because it depends on the geography of places. On the basis of geography of places, disaster hit that area. So, geographic information plays a major role in disaster management. All the phases of disaster management use geographic information to manage disaster. By using GIS, we can get the pre and post scenario of disaster, to assessment and management of disaster. Thus, GIS is very helpful tool in disaster management.

When GIS is on Web, it is known as Web GIS, it means geographic information accessing on the Web to manage and reduce disaster in a real time manner. As, all the information about places and disaster hit, can get through Web in timely and accurately. So that disaster managers can get decisions in a real time scenario and implement it on necessary places to reduce disaster effects. We can communicate through Web at the time of disaster and access real and accurate information. Thus, Web GIS is play a most important role in disaster management.

2.6 Escape Route and Its Need

Escape route is a route through which we can evacuate victims from disaster hit areas to safe places. Escape route is not a general road or street network. It is a dedicated route for get

away affected victims by evacuating them to safe places. These routes is connected disaster prone places to safe places like relief camps, evacuation camps etc. These routes may be varies according to situation and intensity of disaster. Escape route is like a fire exit in a building, it does not use properly but it always use in disaster situation to exit people from building to outside area so that people save their lives. Thus, escape route is also a way from which people can get away when disaster hit. These routes are very useful when existing routes get damaged due to disaster and people have option to evacuate through it. The real-time escape routes generated according to disaster situation i.e. affected areas and passes through all the possible safe areas for evacuation. Hence, escape routes are very useful for disaster scenario to evacuate victims and brought to them on safe places, so that they save their lives and the effects of disaster can be reduced.

2.7 Slope of Walk able Routes

In this study, evacuation planning is performed in hilly region causes existing roads etc get damaged during disaster. People are trapped in this area due to no way for get away from this area. Escape route can be a useful way for evacuate victims to safe places. These real-time generated escape routes are walk able and help to get away victims from affected areas to safe areas. Escape routes generated on slope surface is a very challenging task.

The maximum recommended slope is 12% throughout the routes. This is feasible and use as a ramps. At a disaster situation it can be increases up to 15% because at that time evacuation is more important than comfortable. (NBC, 2005)

In a steeper slope, routes can have stairs cases of slope degree in between 25°-40°. These are also feasible and use as a walk able way. (Rangarajan et. al., 2001)

The maximum recommended slope is 12-15% throughout the slope surface of route i.e. 1:8 – 1:6.5 respectively. These routes designed as ramps are very comfortable and feasible for walking. (DESA, UN, 2007). In a steeper slope, routes have stairs cases of slope degree in between 34°-42°. These are also feasible and use as a walk able way. (Scottish Building Standard, 2013).

CHAPTER 3

3 Study Area Profile

3.1 Introduction

Uttarkashi district was formed on 24th Feb, 1960. It spreads in the extreme north-west corner of the state over an area of 8016 sq. km in the mystical Himalayas in the form of the rough terrain. It is the district headquarters of Uttarkashi is situated on the banks of river Bhagirathi at an altitude of 1352 m above sea level.

Uttarkashi name suggests the Kashi of north (Uttar) is a town in Uttarakhand, India is famous almost as high as Kashi of the plain (Varanasi) same as kasha of the hill (Uttarkashi). Both, the Kashi of hills (Uttarkashi) as well as the Kashi, Kashi of the plain (Varanasi) are situated on north and the banks of the river Ganga (Bhagirathi). The town of uttarkashi lies along with hill named Varunavat Parvat, on confluence of two rivers Varuna and Asi. The Kashi of the plain also situated in between two rivers Varuna and Asi. Both have temples dedicated to Shiva (Kashi Vishwanath Temple) in the center of the town.

Uttarkashi is known as an ancient place with well cultural tradition and heritage, and also known as hub of many ashrams and temples. So, Uttarkashi is famous for its attractive and holy temples. Every year, this holy and beautiful place had visited by large numbers of devotees and tourists. Some of the famous and sacred temples of the Uttarkashi region are the Pokhu Devta Temple, Vishwanath Temple, Kuteti Devi Temple, Bhairav Temple, Gangotri Temple, Karna Devta Temple, Shani Temple and Yamunotri Temple. Divya Shila, Gangnani, Surya Kund and Sattal, are some of the other famous tourist spots of the region.

The Vishwanath Temple of the Hindu Lord Shiva is most famous for tourists. This famous temple is on walking distance from the local bus stand of uttarkashi just 300 m away. Opposite to the Vishwanath Temple, Shakti Temple is located, is also a famous holy and religious site in Uttarkashi. One of the primary and major attractions of the temple is the 26 ft

high trishul. The Manikarnika Ghat is another most important religious and pious centre of that region.

The Nandanvan Tapovan is the surrounding areas, located at a distance of 6 kilometers from Gangotri, this place is hub of natural beautiful views of different mountain peaks, like the Bhagirathi, Shivling, Kedar Dome, Thalay Sagar, and Sudarshana. Uttarkashi is also known as a hub of entertainment and an adventure sports place, famous for various like superb white water river rafting with wonderful rapids, skeiing, outstanding trekking tracks and mountaineering. Nehru Institute of Mountaineering (NIM) is also visited by large number of tourists.

3.2 Location

Uttarkashi is a district of Uttarakhand state. It is located in north of Uttarakhand state of India. Uttarkashi comes under the Garhwal division of Uttarakhand.

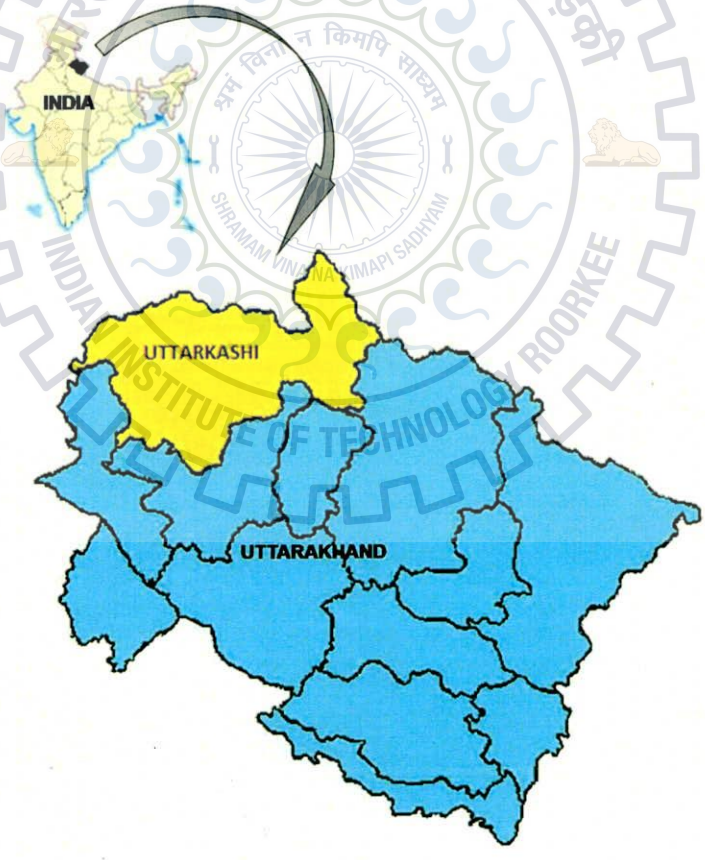


Figure 2: The location of Uttarkashi

Figure 3: Uttarkashi lies in Garhwal division of Uttarakhand

On north side of Uttarkashi lie Himachal Pradesh State and the territory of Tibet. In the east side of Uttarkashi lie the district of Chamoli. On south side of Uttarkashi lie Dehradun city which is Capital of Uttarakhand state. On south area of Uttarkashi lie Tehri Garhwal district and Rudra Prayag district of Uttarakhand state.

Figure 4: The neighbourhood places across Uttarkashi

3.3 Accessibility

By Air

Jolly Grant Airport is the nearest Airport to Uttarkashi at a distance of 160 kms. It is well facilities of daily flights connecting to Delhi. Jolly Grant Airport have well facilities like buses, cars, bikes etc by road connected to Uttarkashi.

By Train

Rishikesh is the nearby and adjacent railway station to Uttarkashi. Rishikesh is a well known city on NH58 road at a distance 143kms before Uttarkashi. Major cities of India is well connected by railways networks with Rishikesh. The frequent and numbers of trains is available from or to rishikesh. Rishikesh provides well connectivity by motorable road vehicles to Uttarkashi. Taxis, cabs and buses are available from Rishikesh, Tehri Garhwal and many other destinations to Uttarkashi.

By Road

Uttarkashi is connected through NH58 and NH108 roads. Uttarkashi is well connected by motorable roads vehicles with major towns or cities of Uttarakhand state. Buses, cabs and Taxis to Uttarkashi are easily available without any difficulty from major destinations of Uttarakhand state like Dehradun, Rishikesh, Tehri, Chamba, Barkot etc.

3.4 Geographical Features

Uttarkashi is located at 30.73°N 78.45°E. It has an area of 8016 km^2 and an average elevation of 1,352 metres (4,436 feet) above sea level. Most of the terrain land and topography is hilly and undulating. Uttarkashi district have many rivers. The Ganga and the Yamuna are two major and holiest river in Uttarkashi, their origin is Gangotri (Gomukh) and Yamunotri

respectively. The other significant river of this district is jad ganga and Asi ganga are some of the streams of the river Ganga.

Table 2: The general information of Uttarkashi

Coordinates	30.73°N 78.45°E
Country	India
State	Uttarakhand
Division	Garhwal
Headquarters	Uttarkashi
Area	8,016 km^2 (3,095 sq mi)
Elevation	1,352 m (4,436 ft)
Population	329,686
Population Density	41/km^2 (110/sq mi)

Uttarkashi have resides in the higher Himalayas range, surrounding by within itself varying geographically environments varies from deep valleys without snow and high hill peaks with eternal snow. High hills have glaciers in higher region of Uttarkashi. Uttarkashi have the terrain lands so it has sequence of valleys and ridges. Uttarkashi have rare flat pieces of land. The land of Uttarkashi region is useful in agricultural cause by fertility due to bulky substance of out crops of annoys and rocks. Uttarkashi have valley is in a stream bed, alluvial soil. Generally forests take place on the higher ridges that bound the valleys. On their inclined hill sides region lie a series of meagerly occupied settlements interspersed with terrace agriculture and cultivation.

3.5 Demographic Profile

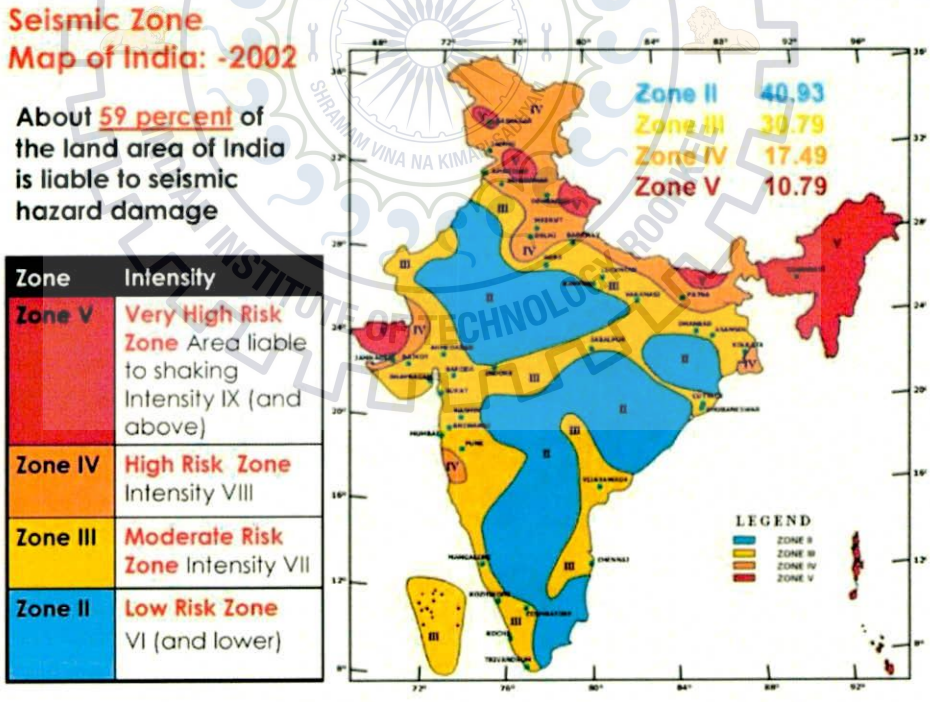
According to the 2011 census, Uttarkashi district has a population of 329,686. This gives it a ranking of 567th in India (out of a total of 640). The population density of this district is 41

inhabitants per square kilometre (110/sq mi). The population growth rate of Uttarkashi district over the decade 2001-2011 was 11.75%. Uttarkashi is also comes in tourist places, and it is passed on the way of gangotri and kedarnath. So, in Uttarkashi always tourist visit and stay.

3.6 Hazard Profile

Seismicity

Uttarkashi lies in Zone V of the Seismic Zoning Map of India. It has a recorded seismic history. The major earthquake of the year 1803 had devastated the old township of Uttarkashi then known as Barahat. The epicentral tract of the recent Uttarkashi Earthquake of 6.6M, which rocked the Garhwal Himalaya and adjoining areas on 20 Oct 1991, was located around Maneri in the vicinity of Uttarkashi Town. This destructive earthquake had caused extensive damages in this town and also brought about terrain changes and triggered some landslides in the area around Uttarkashi.



Seismic zonation and intensity map of India

Source: National Institute of Disaster Management, Ministry of Home Affairs, Govt of India

Figure 5: The seismicity map of India

Tectonics

Uttarkashi town is placed in the minor Himalayan geotectonic mass and it is bounded by two major thrust faults - **Main Central Thrust (MCT) and Srinagar Thrust (ST)**. The MCT exists in the northeast of Uttarkashi, separating rocks of the Garhwal Group and Central Crystalline. The Srinagar Thrust (ST) lies in the south west of Uttarkashi and along this tectonic plane rocks of Garhwal Group and of Jaunsar Group are juxtaposed.

Geology

The Varunavat hill made up of rocks which are composed of thinly bedded quartzite and phyllites which are highly weathered, distressed, decomposed, jointed and fractured. The hill slopes are of the order of 45°-60°, except the top of the hill where the slopes are gentle.

The top portion of Varunavat hill is occupied by loose, unconsolidated, overburden mass exhibiting gentle topography. The top is at El ± 1800m whereas toe part of the hill is at EL ± 1100mm.s.l. The interface of overburden mass and underlying rocks is at El ± 1660m.

Figure 6: The landslides in Uttarkashi

Uttarkashi is loacated in a valley and the Bhagirthi river is passed through the Uttarkashi. Almost all settlement is on right side of the Bhagirthi river. And some settlement is also on the left side of the river. So, Uttarkashi is very prone to flash flood.

Hence, Uttarkashi is prone to earthquake, landslides and flash flood which are natural hazards. Uttarkashi is also prone to forest fire, fire hazards etc.

3.7 Major Disaster in Uttarkashi

Every year, Natural disasters occur at Uttarkashi. Uttarkashi is prone to various natural disasters like earthquakes, landslides, and floods etc. Uttarkashi faced lots of major and worst disaster resulted wide spread loss of lives and properties. Here, major disaster of Uttarkashi is shown as below:

Table 3: The major and worst disaster in Uttarkashi

S. No.	Date/Year	Types of Disaster	Remarks
1	1978	Flood	Ganga Uttarkashi is highly affected by it.
2	20,October1991	Earthquake (6.6 in Richter scale)	Uttarkashi is highly affected.
3	March,1999	Earthquake (4.5 in Richter scale)	Uttarkashi is affected
4	1999	Flood	Indravati(tributary) Some parts of Uttarkashi affected by it.
5	2003	Flood	Jalkur(tributary) Uttarkashi and surrounding areas affected.
6	23,September,2003	Landslides	Varunavat landslides rainfall induced
7	16,August,2005	Earthquake (4.8 in Richter scale)	Uttarkashi is affected by it.
8	14,December,2005	Earthquake (5.2 in Richter scale)	Uttarkashi is affected and earthquake induced landslides occurred.
11	2011	Flood	Ganga Uttarkashi is highly affected by it.
12	16,June,2013	Flood	Mandakini Kedarnath is highly affected and some parts of Uttarkashi also affected by it.

CHAPTER 4

4 Methodology

The methodology used in this study is as below:

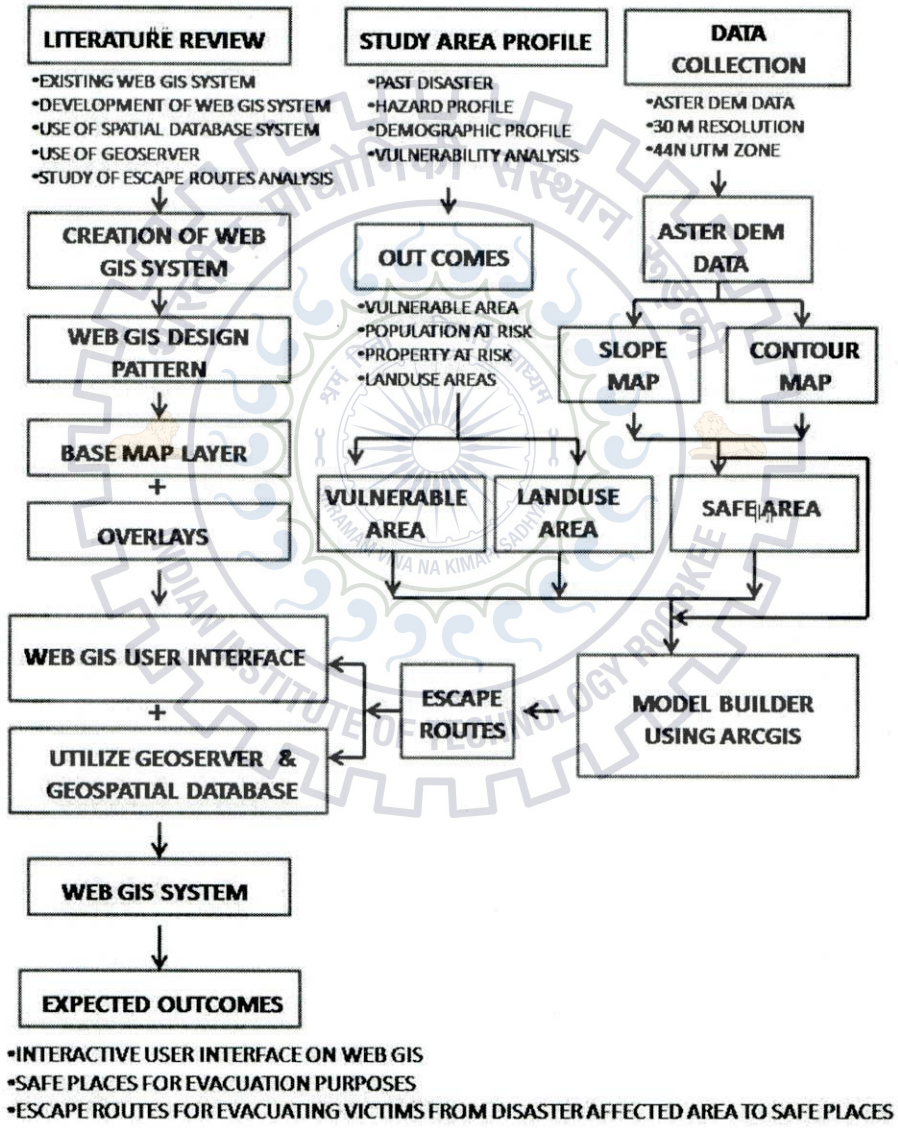


Figure 7: The methodolgy used in this study

4.1 Methodology for creating Escape Route

For the purpose of escape route planning multiple GIS functions has been carried out. The functions are carried out integration using the model builder tool in order to achieve the final results.

4.1.1 Model Builder

Model builder is an application in ArcGIS which is used to creating a model for a particular function. These models can be reedited even at later stage of analysis which makes it suitable for modifications if required thus making the work faster and results more accurate. (ESRI, n.d)

To create a model a toolbox needs to be created first. After creating a toolbox in a specific folder connection a model can be created within the toolbox. A model looks like a workflow diagram through which various spatial analyst tools are connected. The output of a particular function can be used as the input for the next. By using this method the multiple analysis can be one at same time. While using GIS some analysis the files might get heavy and display of the output might take a long time and can even result in crashing of the system. But while using model builder we have an option for displaying only the required.

Model builder is generally used when we require a large number of parameter to compute results or when multiple steps are required to compute results. In real time application, we use for analysis like land suitability, hydrology, etc. In addition to all these advantage it helps the user get a visual relationship between different parameters and makes it easier to explain to a third person on how the analysis is performed thus making this one the most advanced tools in the field of GIS.

4.1.2 Topographical Analysis

Topographic survey of the slope has carried out and a contour map have prepared on 1:10,000 scale with 10 meter contour interval by using ASTER DEM data of Uttarkashi by the help of Arc GIS. A slope map has also generated from the ASTER DEM data to see the

distribution of slope amounts in that area. Then, slope map has reclassed and derived reclassify slope map to identified elevation increase and the distribution of slope amounts in the specified area.

ASTER DEM data of 30 meter resolution got from USGS site, Its is not already projected by our projection coordinates system. So, it is needed to project according to our related projection coordinate system by the help of Data management tools > Projections and Transformations tool. Uttarkashi comes under the UTM zone of 44N.

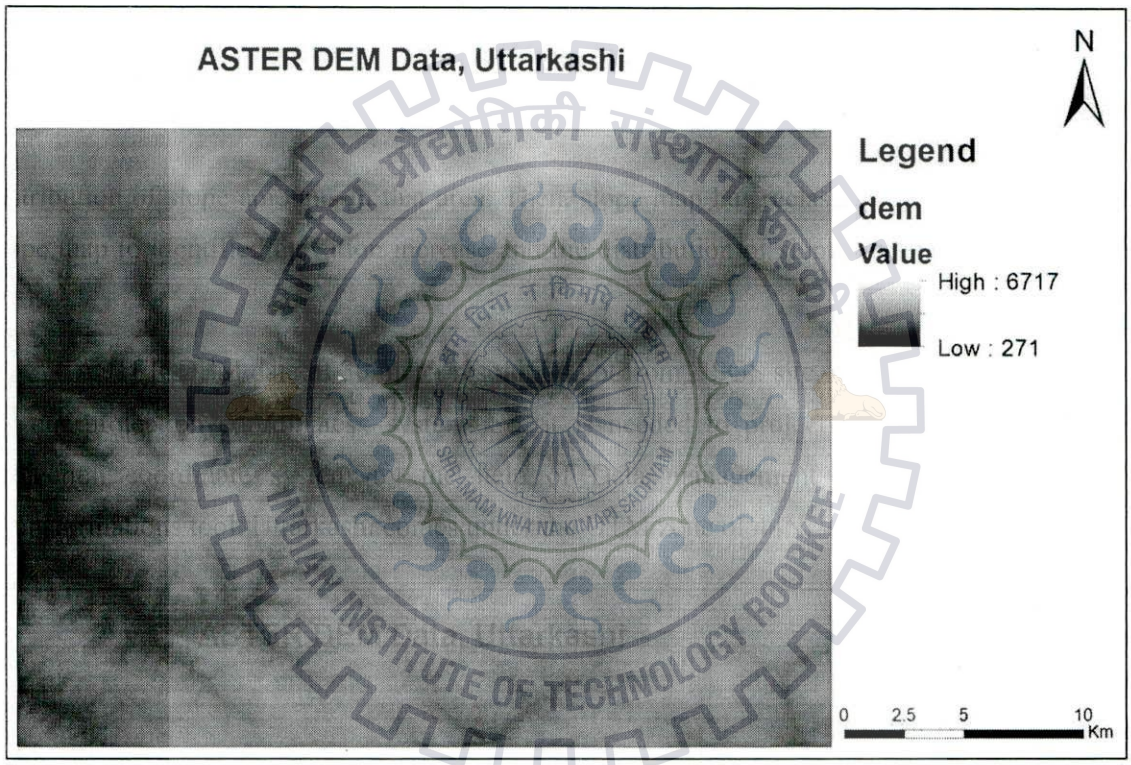


Figure 8: The ASTER DEM data

4.1.2.1 Contour Study

A contour map is defined by a map demonstrated with contour lines, which give details about valleys, planes and hills, and the steepness of slopes. The contour interval is defined in a contour map is used to explain the difference in elevation between successive contour lines.

These contour lines illustrate various features written as below:

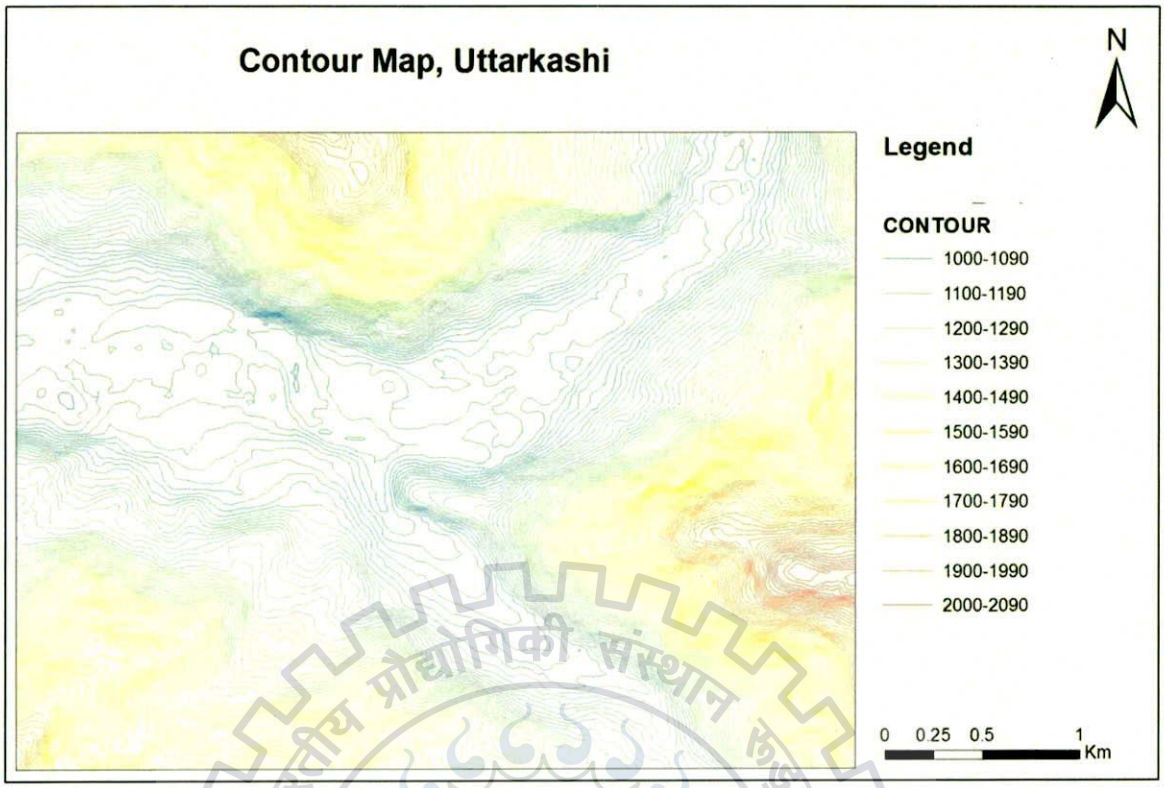


Figure 9: The contour map of Uttarkashi

- **V's Form** : sharp-pointed vees shape generally shows the stream valleys.
- **O's Form** : closed loops identified as usually uphill on the inside and downhill on the outside, and the innermost loop is the highest area.
- **Spacing of contours**: close contours specify a sharp slope; distant contours indicate a low slope. Two or more contour lines merging show a cliff.

4.1.2.2 Slope Study

A slope map indicates the high rise area and low rise area of the land surface. The slope map also identifies the distribution of slope amounts on the land surface. Highest slope is on approximately 75^{o}.

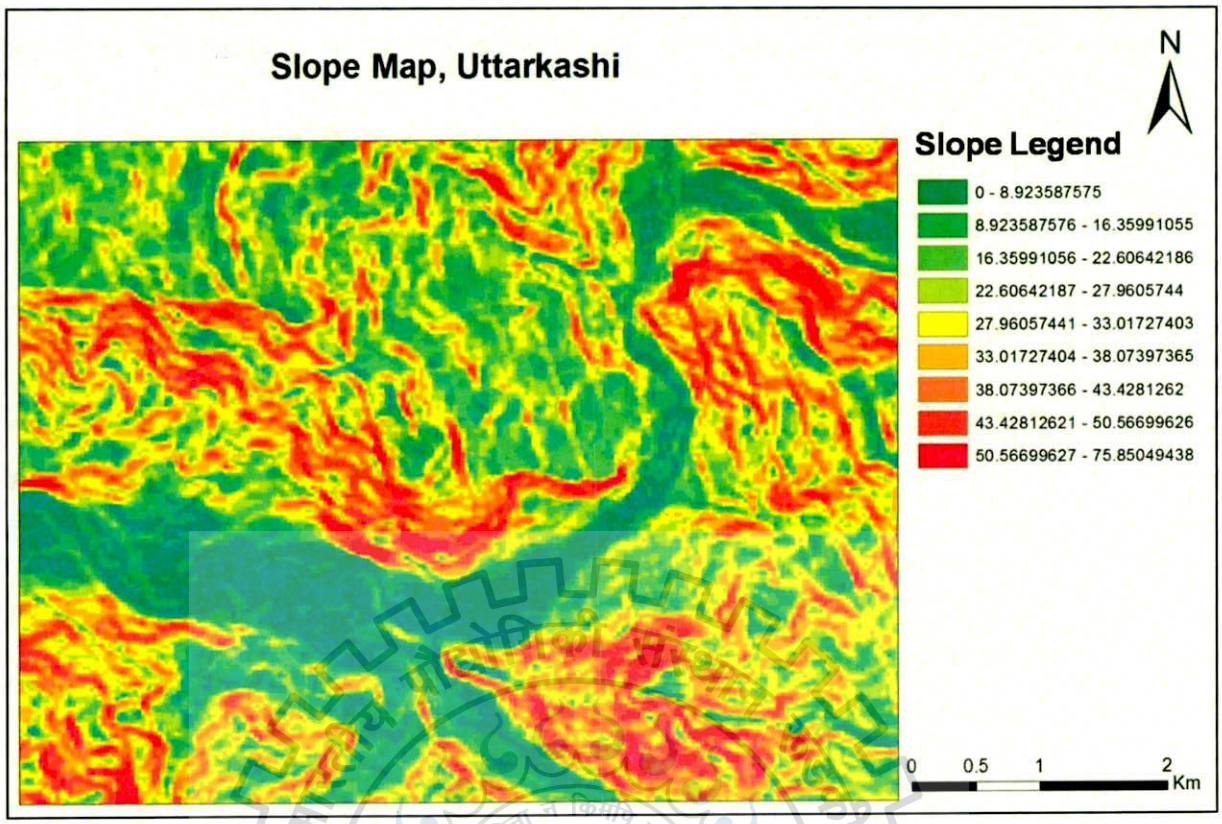


Figure 10: The slope map of Uttarkashi

4.1.3 Land use Study

Land use map is required to understand for what purpose and how much of different areas put into use. Land use map is a polygon feature. For examples, Residential area, Agricultural land, Commercial land etc.

4.1.4 Identification of Vulnerable Areas

Uttarkashi have many vulnerable areas as shown in fig. like, right side of the river is prone to flood as its low lying area, foot hills area of Varunavat hill is very prone to landslides. All the vulnerable areas or prone to hazard shown in fig. marked by red color. Almost all population of Uttarkashi comes under these areas and major road of Uttarkashi comes under these area i.e., along with foot hills. So, tourist also comes under the vulnerable areas.

Area near to river about 10-20 m is vulnerable for flash flood because these areas have too much settlement of uttarkashi. Some public building also comes into this region so these areas have proper mitigation planning to deal with disaster and reduce the effects of it.

Area near to foothills is also too vulnerable for sudden landslides. In this area, major road of uttarkashi is also comes so this area is too much vulnerable concern with tourist visiting by this route.

Figure 11: The vulnerable areas in Uttarkashi

4.1.5 Identification of Safe Areas

By using contour map and slope map in Arc GIS, various safe places identified. These places should be placed on high lying areas so that flood could not effect these places and also safe from landslides. These places can be used as relief camps at the time of disaster to temporarily evacuate people from affected areas. These relief camps can be used as a shelter and medical camps. These relief camps is a temporarily shelter for execution of rescue and relief

phase after the disaster happens. So that disaster victims evacuate to these places safely and timely and save their lives.

Here, we identified two types of safe places as relief camps marked as green triangles and evacuation camps marked as green rectangles. When disaster intensity is moderate then we can evacuate victims to relief camps so that we can provide rescue and relief facilities easily. When disaster intensity is high then we firstly rescue victims to relief camps so that they save their lives after this evacuate them to evacuation camps and brings them to faraway disaster free places.

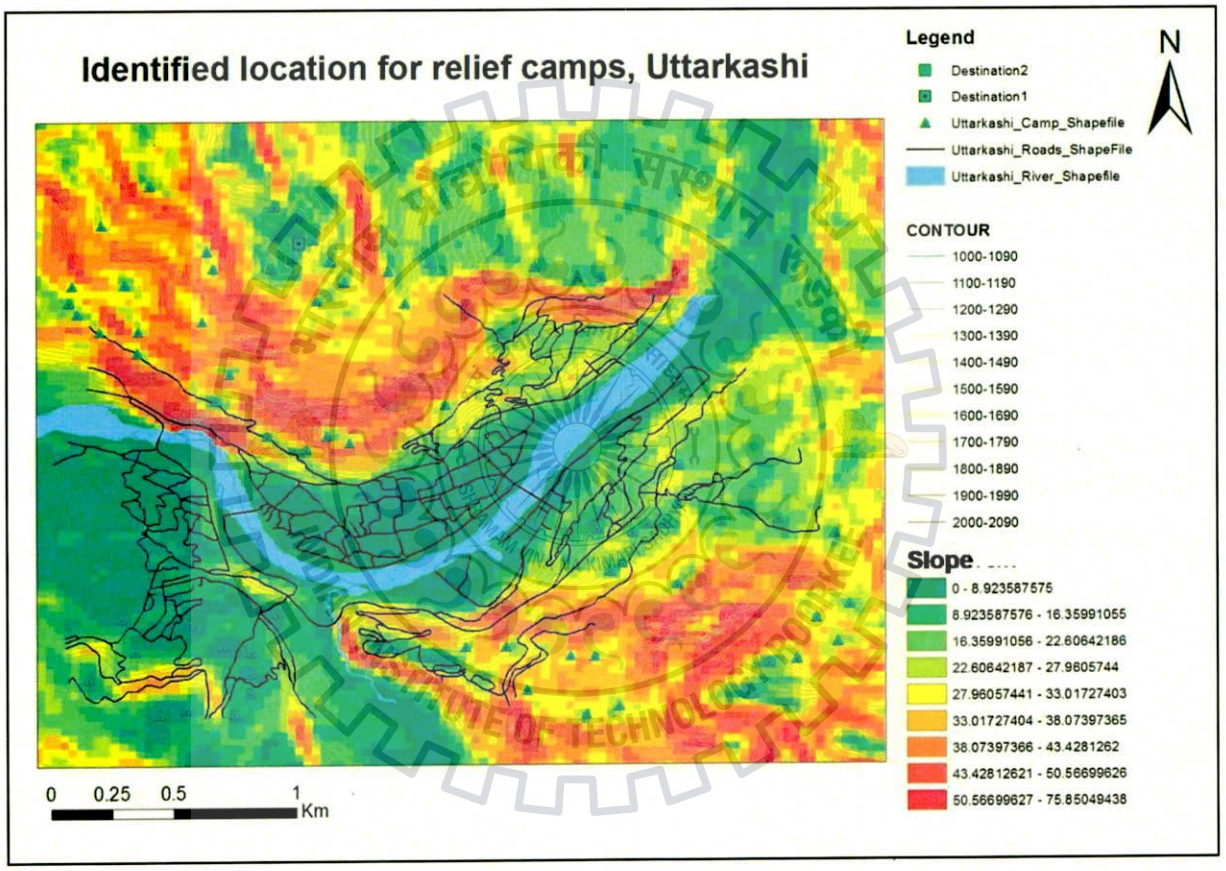


Figure 12: The identified safe places at high lying area in Uttarkashi

4.1.6 Generating Escape Routes for Evacuation

After identification of safe places for relief camps, focused on generate escape routes to connecting these safe places from various vulnerable areas. For creating escape routes in Arc GIS, created new model for finding escape routes between vulnerable areas as origin to safe places as destination, taking into consideration the slope of the land using weighted overlay tool.

4.1.6.1 Weighted Overlay

Weighted overlay tool is used to combines all the parameters used in a study to get a desired result. Each parameter can be given in different percentage weightage depending upon its importance. The evaluation scale can be decided as per requirement. In this study, final evaluation will be done at a scale of 10. It will be set as '1 to10 by 1', meaning the range is from 1 to 10 and the smallest value will be 1. Even each parameters classes can be given in different values depending on the evaluation scale. At some situation when a specific area can be used for any purpose because of a parameter. The evaluation scale for that particular class in the parameter can be defined as 'Restricted'. This helps in achieving more accurate results.

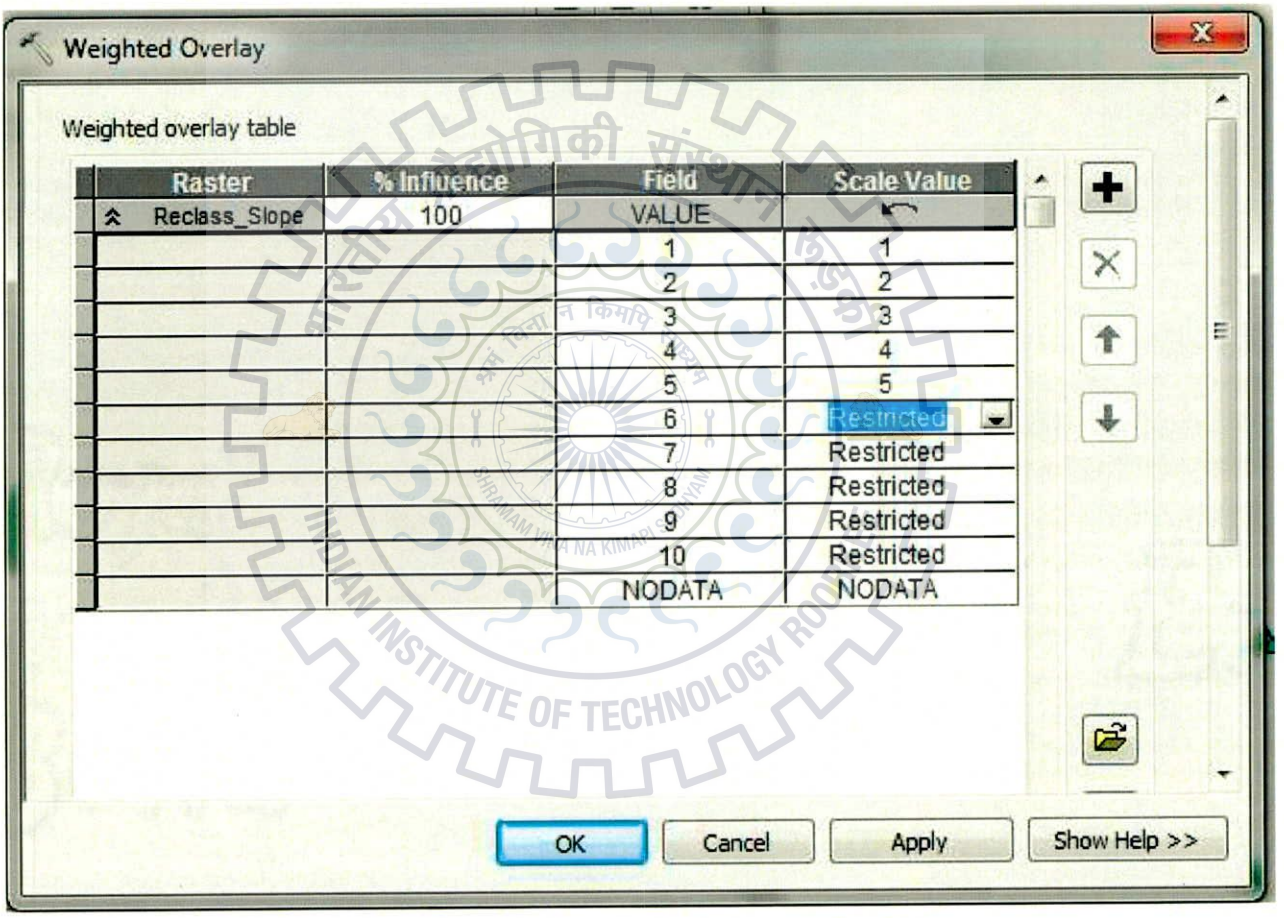


Figure 13: The weighted overlay tool

By the help of weighted overlay tool, we can set different parameter as per requirements. According to our requirements and as per parameter, we have got various escape routes between origins to destinations. Hence we have got eight escape routes on the basis of parameter used.

4.1.6.2 Parameter used for Generating Escape Routes

For generating escape routes, we use parameter set in weighted overlay table. We use slope parameters in which minimum slope have value 1 and highest slope have value 10 because we set 10 divisions. Thus, when we set parameter 6-10 restricted, then route avoid major slope ways. When we did not change any parameter then route has major slope ways. For walking, slope route should have minor slope so that a person can easily walk without any difficulties. So, escape routes generated consider slope parameter. Some routes consider slope parameter restricted from 6 to 10. Some routes consider slope parameter restricted from 8 to 10. Avoid higher slope and consider lowest to generate escape route cause it is used as a walk able path to evacuation during disaster.

To creating new model for escape routes, used following steps as below:

Step1: Generate slope map using slope tool input as DEM.

Step2: Derived reclass slope map using reclassify tool input as slope map.

Step3: Generate weighted slope map taking into consideration the slope of the land using weighted overlay tool input as reclass slope.

Step4: Generate slope distance using cost distance tool taking input as weighted slope and destination point. It produces two output slope distance and slope distance backlink.

Step5: Generate escape route using cost path tool taking input as origin point and output of cost distance tool.

Step6: After creating this model, run the cost path tool which gives the appropriate route between origin and destination according to parameter set for slope of the land.

4.2 Identified Escape Route Analysis

Below figure shows the generated escape routes as defined a name for particular escape routes to give identity to the escape routes. This gives a special identity to distinguish escape route among all together.

4.2.1 Identified Relief Camps site analysis

Here, approx 80 sites are identified for relief camps. According to area of site, 63 sites will be used as relief camps. Relief camps have maximum area of 27301.95 m^2 and minimum area of 1012.37 m^2. Area and perimeter of safe sites given in below table:

Table 4: The Area and Perimeter of Relief Camps

S.NO.	RELEIF CAMP NAME	AREA (sq. m)	PERIMETER (m)
1	S1	3284.6	245.48
2	S2	3312.22	216.44
3	S2	3872.94	260.47
4	S4	1354.72	152.65
5	S5	2518.25	195.13
6	S6	1779.1	183.3
7	S7	2719.24	210.33
8	S8	2480.1	199.1
9	S9	3050.2	233.84
10	S10	2418.4	214.12
11	S11	2952.92	202.26
12	S12	2676.42	200.34
13	S13	3149.02	209.56
14	S14	2244.47	184.45
15	S15	3334.89	228.12
16	S16	2840.63	216.49
17	S17	5128.71	286.55
18	S18	5824.16	324.65
19	S19	27301.95	671.96
20	S20	6188.69	302.05
21	S21	4708.84	256
22	S22	5262.31	319.81

23	S23	3728.11	258.36
24	S24	2931.88	230.3
25	S25	3592.82	223.82
26	S26	2129.55	190.78
27	S27	5451.37	291.58
28	S28	7080.71	344.75
29	S29	3988.97	233.49
30	S30	3753.49	226.94
31	S31	5890.51	290.11
32	S32	7195.41	324.2
33	S33	9705.96	401.27
34	S34	3321.15	246.39
35	S35	7576.17	380.8
36	S36	2731.66	199.98
37	S37	2897.33	217.48
38	S38	15173.88	480.51
39	S39	5228.61	285.04
40	S40	3281.23	213.85
41	s41	5194.19	274.35
42	S42	2486.17	186.04
43	S43	7229.81	313.79
44	S44	2294.62	185.83
45	S45	2999.68	207.33
46	S46	2543.87	196.48
47	S47	3134.23	207.67
48	S48	3322.37	221.23
49	S49	4269.08	261.14
50	S50	2537.24	191.31
51	S51	1012.37	125.46
52	S52	2378.22	191.35
53	S53	3727.2	254.62
54	S54	16151.74	558.55
55	S55	9916.65	389.51
56	S56	2366.05	195.37

57	S57	2660.79	215.82
58	S58	1968.07	175.93
59	S59	2832.32	194.41
60	S60	2922	214.24
61	S61	3969.37	249.9
62	S62	3175.21	218.73
63	S63	10082.89	375.16

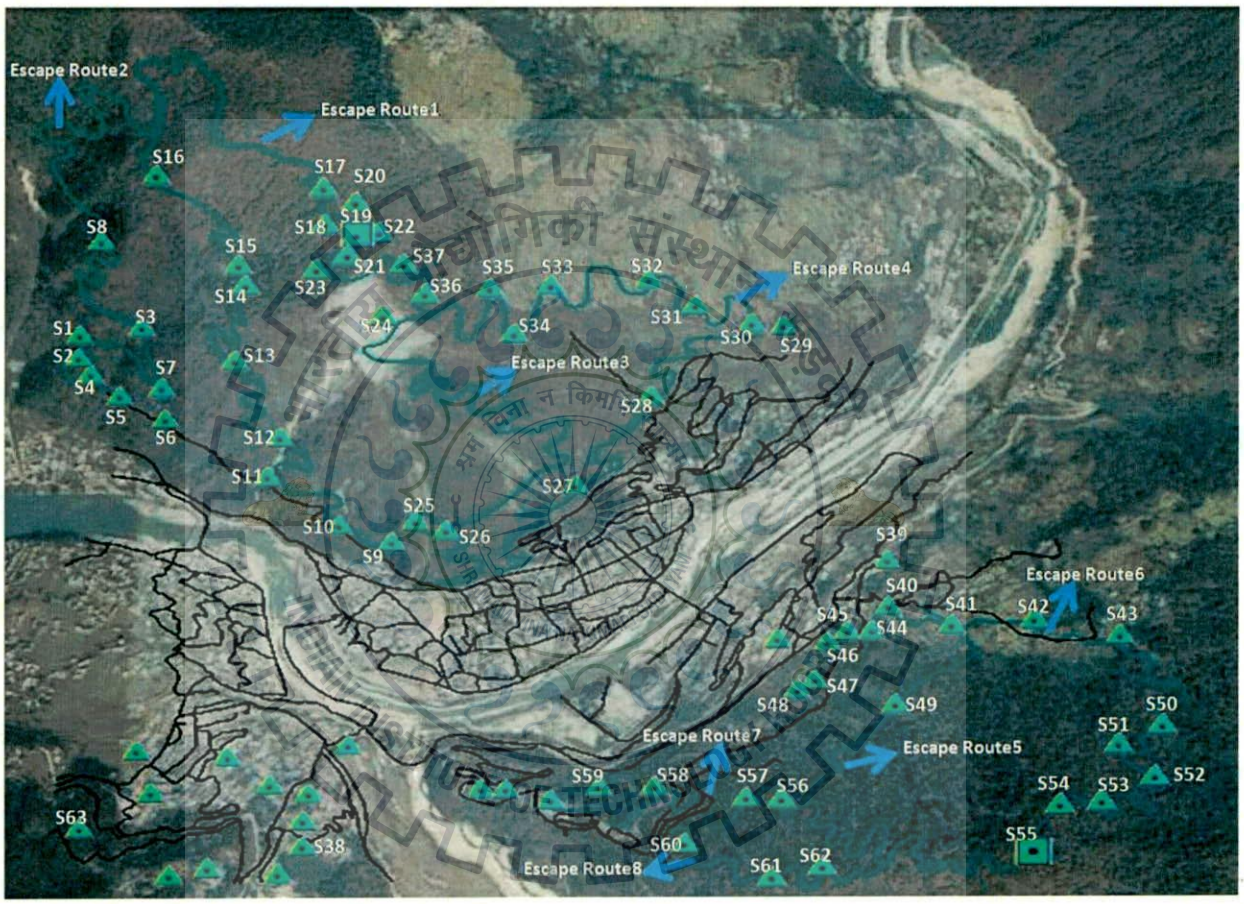


Figure 16: The generated relief camps and escape routes in Uttarkashi

4.2.2 Slope Profile

Slope profile gives the information about the slope of the surface. The slope of the surface has some vertical height (distance) and some horizontal distance. That means slope of the surface, vertical height and horizontal distance make a right angle triangle with two angels, one in between vertical height and horizontal distance which always be 90^{o} and second angle is known as slope angel in degree in between horizontal distance and slope of the surface. When slope of the surface is passed through a uneven slope of the surface, then slope angle is given by slope percent. Slope percent is defined by the percentage of the ratio of vertical distance and horizontal distance. Because slope of the surface is uneven so slope percent is also varied. So, whole slope of surface does not have same slope percent throughout the slope. Hence, slope percent is changed throughout the slope as well as slope angel.

Thus, slope profile gives the important information about sloping route like, maximum and average slope percent, by which we can calculate the maximum and average slope angel in degree respectively. So, we can evaluate the feasible pedestrian route for walking easily and safely. Slope profile also gives the elevation gain/loss. Elevation gain is defined as the sum of all elevation rises throughout the sloping route.

4.2.3 Identification of Slope Profile of Escape Routes

Here, the slope profile of generated escape routes is identified using the Google Earth open source tool to analysis of escape routes. The properties of escape routes find out like maximum and average slope percentage, slope distance, altitude, etc.

Escape Route 1: It has maximum slope percent of 71.1 % and average slope percent of 26.6 %.

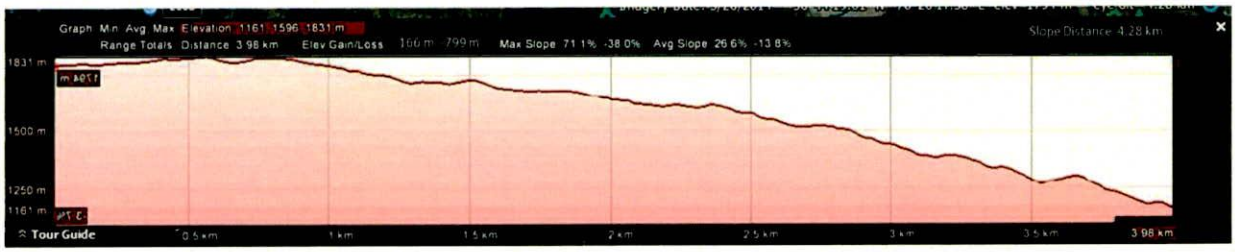


Figure 18: The Slope profile of Escape Route 1

Escape Route 2: It has maximum slope percent of 52.7 % and average slope percent of 17.4 %.

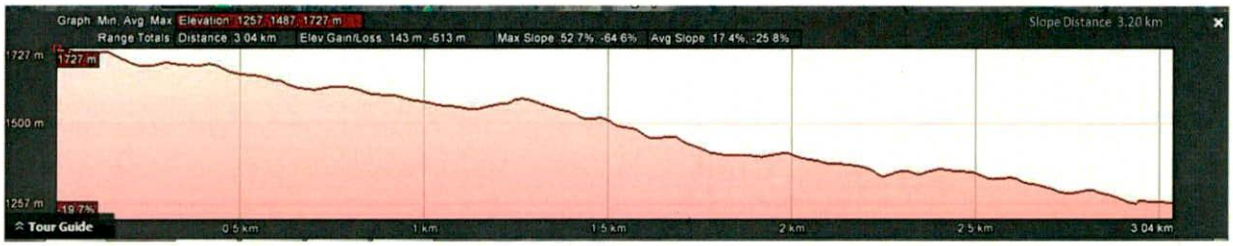


Figure 19: The Slope profile of Escape Route 2

Escape Route 3: It has maximum slope percent of 59.2 % and average slope percent of 14.8 %.

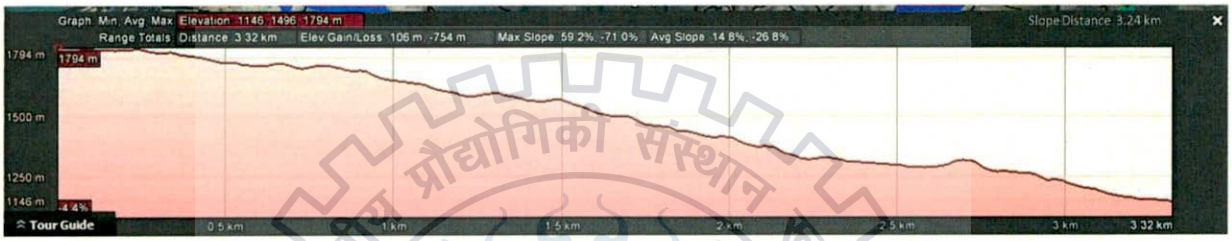


Figure 20: The Slope profile of Escape Route 3

Escape Route 4: It has maximum slope percent of 42 % and average slope percent of 12.4 %.

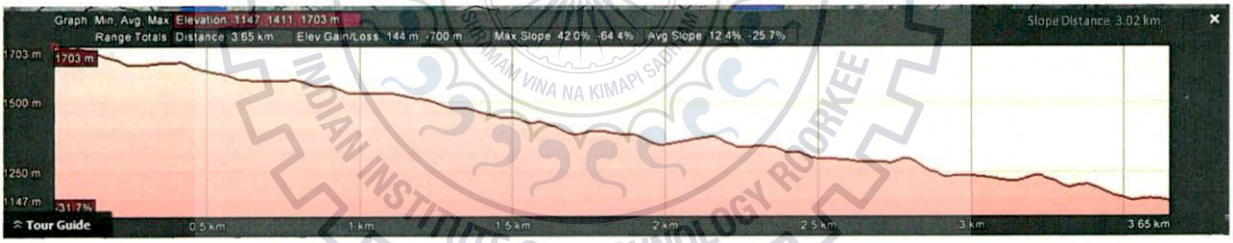


Figure 21: The Slope profile of Escape Route 4

Escape Route 5: It has maximum slope percent of 47.3 % and average slope percent of 12.9 %.

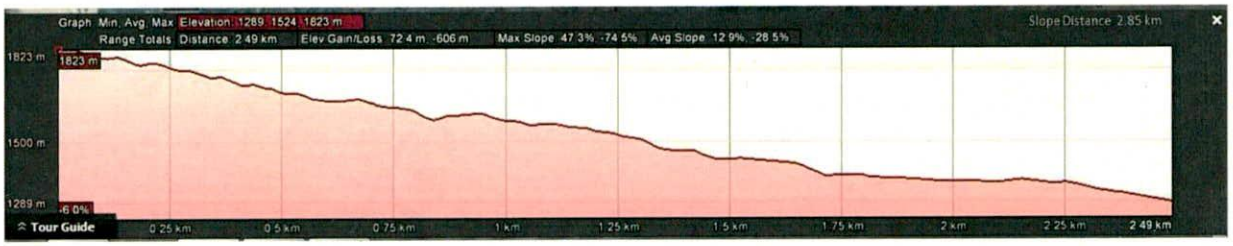


Figure 22: The Slope profile of Escape Route 5

Escape Route 6: It has maximum slope percent of 79.2 % and average slope percent of 15.3 %.

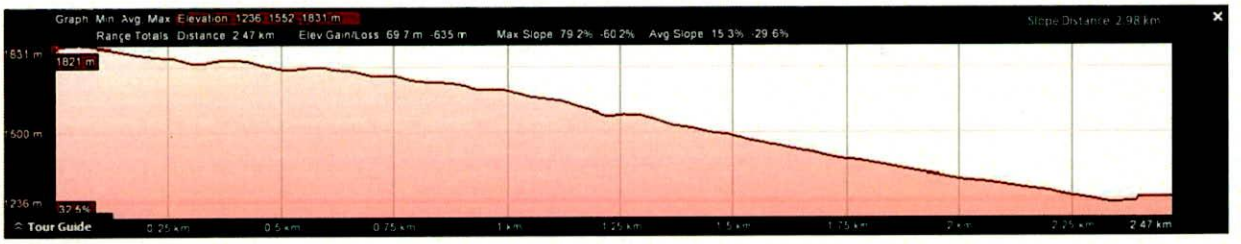


Figure 23: The Slope profile of Escape Route 6

Escape Route 7: It has maximum slope percent of 46.5 % and average slope percent of 10.9 %.

Figure 24: The Slope profile of Escape Route 7

Escape Route 8: It has maximum slope percent 79.4 % and average slope percent of 16.3 %.

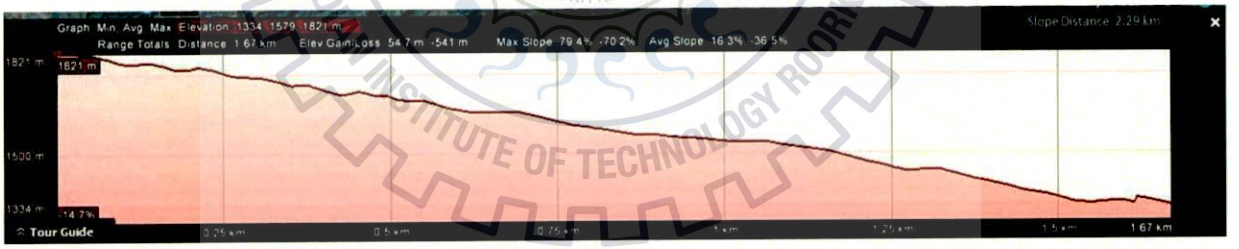


Figure 25: The Slope profile of Escape Route 8

4.2.4 Relation between Slope Percent and Slope Degree

The slope can be defined by two terms like slope percent and slope degree. The slope also called grade, gradient, incline, rise or pitch of a physical feature, landform or constructed line refers to the tangent of the angle of that surface to the horizontal. Generally, slope is

calculated as a ratio of "rise" to "run", or as a fraction ("rise over run") in which run is the horizontal distance and rise is the vertical distance.

The grades or slopes of existing physical features such as canyons and hillsides, stream and river banks and beds are often described. Slopes are typically specified for new constructions (such as roads, landscape grading, roof pitches, railroads, aqueducts, and pedestrian or bicycle circulation routes). Slope is a measure of change in elevation. One way to express slope is as a percentage. Below diagram illustrating how slope may be calculated as a percentage (in left).

(James L., 1997)

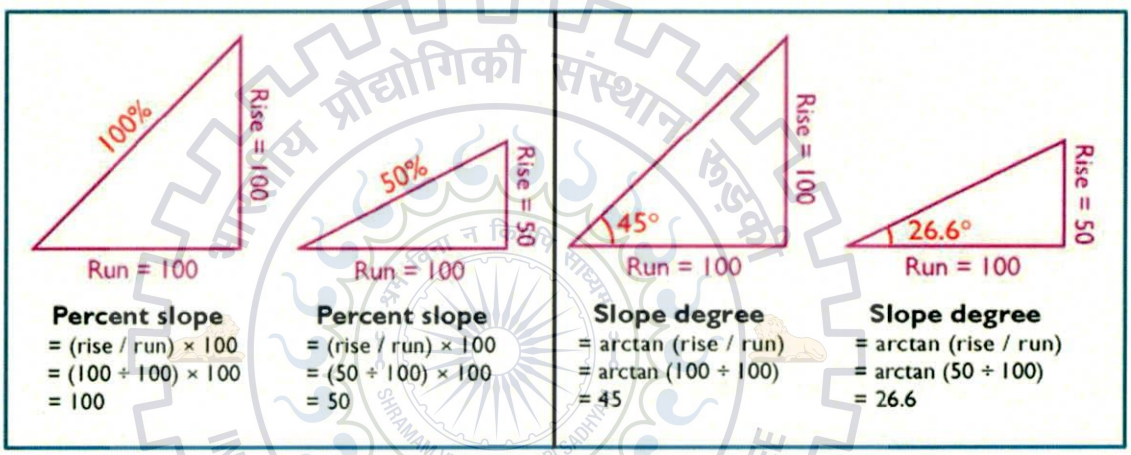


Figure 26: The slope percentage (in left) and slope degree (in right)

Another way to express slope is as a slope angle, or degree of slope. As shown below, if you visualize rise and run as sides of a right triangle, then the degree of slope is the angle opposite the rise. Since degree of slope is equal to the tangent of the fraction rise/run, it can be calculated as the arctangent of rise/run. Above diagram illustration showing how slope may be calculated as degrees (in right). Below diagram shows the relationship between slope percentage and slope degree to identify slope.

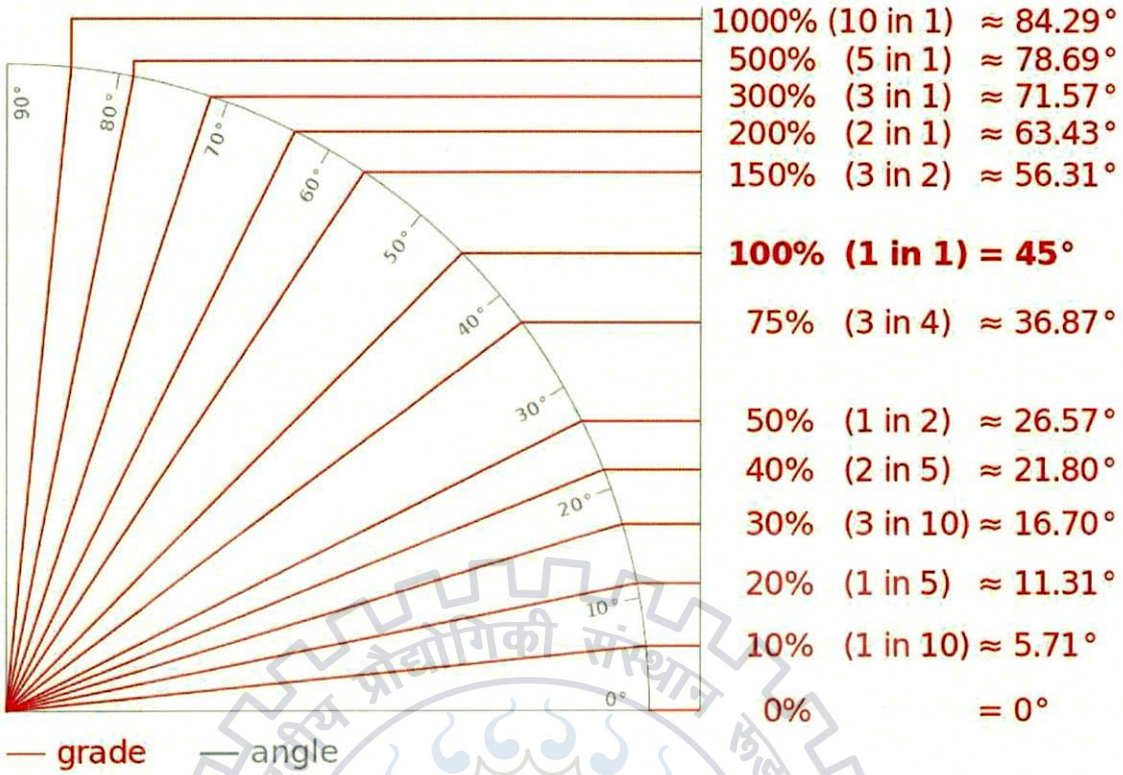


Figure 27: The relation between slope percentage and slope degree

4.2.5 Analysis on the Basis of Slope Profile of Escape Routes

All escape routes have maximum slope percentage less than 80 % and average slope percentage less than 30 % approximately. Slope degree can be obtained using slope percentage. All escape routes have maximum slope degree less than 40° and average slope degree less than 15°. For walking, maximum slope degree should be less than or equal to 42° in steeper slope. In less steep slope, maximum slope degree should be less than or equal to 34°. So, all the escape routes are feasible for walk and they are used as an escape route at the time of disaster.

Table 5 : Shows the slope profile of generated escape routes

S. No.	Escape Route	Vertical Height (m)	Horizontal Distance (m)	Elevation Gain (m)	Maximum Slope		Average Slope		Walking Distance (km)
					(%)	(deg.)	(%)	(deg.)	
1.	ER1	670	3980	166	71.1	35.5	26.6	15.0	4.28
2.	ER2	470	3040	143	52.7	28.5	25.8	14.5	3.20

3.	ER3	648	3320	106	59.2	30.5	14.8	8.5	3.24
4.	ER4	556	3650	144	42.0	23.0	12.4	7.0	3.02
5.	ER5	534	2490	72.4	47.3	25.5	12.9	7.2	2.85
6.	ER6	595	2470	69.7	79.2	38.5	15.3	8.9	2.98
7.	ER7	616	2910	83.7	46.5	25.0	10.9	6.2	2.33
8.	ER8	487	1670	54.7	79.4	38.6	16.3	9.3	2.29

4.2.6 Appropriate Escape Route for Evacuation Purposes

Earlier, we have identified vulnerable areas and nearest safe places to these vulnerable areas. Now we identified escape routes between vulnerable areas to nearest safe places using ArcGIS tool. This escape routes initiated from the buffer zones of vulnerable areas and passes through the nearest safe places and reach to high lying evacuated camps from where we can evacuate victims to other safe sites.

Figure 28: The escape routes according to disaster affected areas

4.3 Methodology used for creating Web GIS

For creating Web GIS based real-time escape route planning System, We used a design pattern as following:

4.3.1 Design Pattern

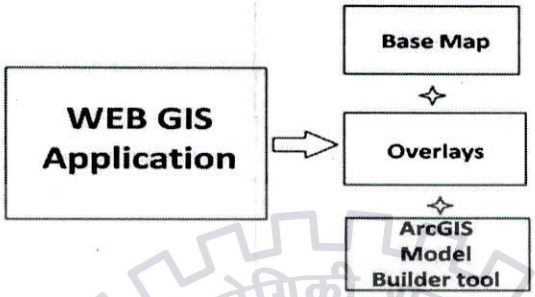


Figure 29: The design pattern of User Interface Web GIS system

4.3.2 Web GIS Architecture

Web GIS system normally consists of "three-tier architecture" which allows a flexible separation of the domain logic (Application Tier) from the data source (Database Tier) and the data presentation logics (Presentation Tier).

The system architecture of the Web-enabled-GIS is depicted in the Figure. The architecture of Web GIS have three layers: the user interface layer, the application logic layer and the database layer.

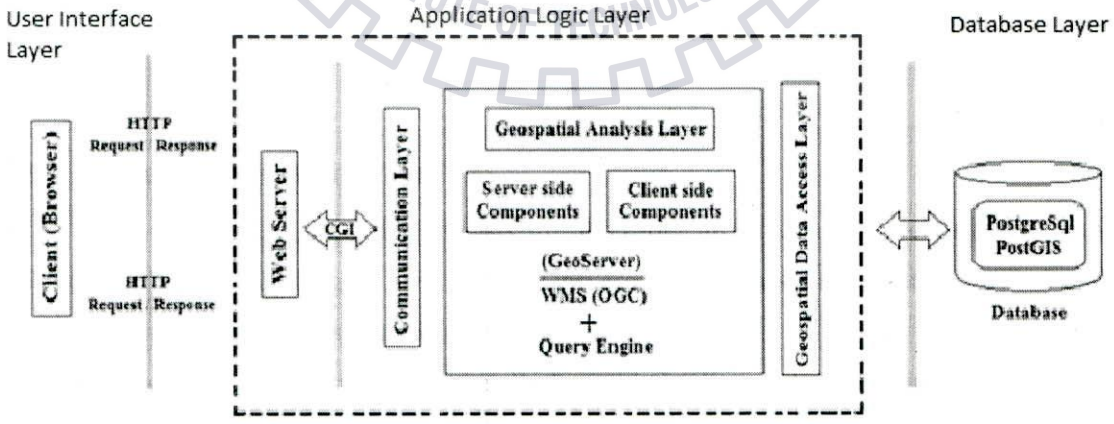


Figure 30: The architecture of Web GIS system

User Interface

User-interface layer is the layer through which user can interact with the application. It focus on efficient user interface design and accessibility. As system is prototyped application on the Internet so users have permission for allowed to access the system by using any existing web browser. Results of user queries are available in the form of table, map, chart and text boxes. In our system, the major web-server site language used is HTML, and Java Script.

Figure 31: The User Interface of Web GIS system

Application Layer

It can be subcategories into two server components i.e. Web Server and Web Map Server. Web server interacts with the client and vice versa through a web browser. The client sends HTTP specification as a request to the server for accessing any data or query. The server sends as web pages as a response to the client and to an application by using the web browser and HTTP protocols respectively. We used world's most popular open source Web server Apache 2.2.x in our project to provide access to Web pages via Internet or other network.

Web Map Server provides set of tools for building spatially-enabled web mapping applications and web services. It makes it possible to access and display spatially enabled content of the geodatabase and enable querying and analysis of the displayed data. To publish the project's geodata sources on the web we used GeoServer as web map server. GeoServer provides an interoperable infrastructure that is useful to share spatial information according to Open GIS Consortium Standards.

Database Layer

It contains the database management system that manages all persistent data. Here, metadata information is stored and retrieved. It's also responsible for managing updates, allowing simultaneous (concurrent) access from web servers, providing security, ensuring the integrity of data, and importantly, allows quick and flexible access to metadata. We used open source object-relational database management system (ORDBMS) PostgreSQL with PostGIS that provide a spatial extension for PostgreSQL.

4.3.3 Software and Technology used

There is a variety of technologies used for developing WEB GIS. The system uses a technological design pattern based on the Windows Operating System, the Apache Web Server, Post GIS spatial database extended and PostgreSQL Database Management System.

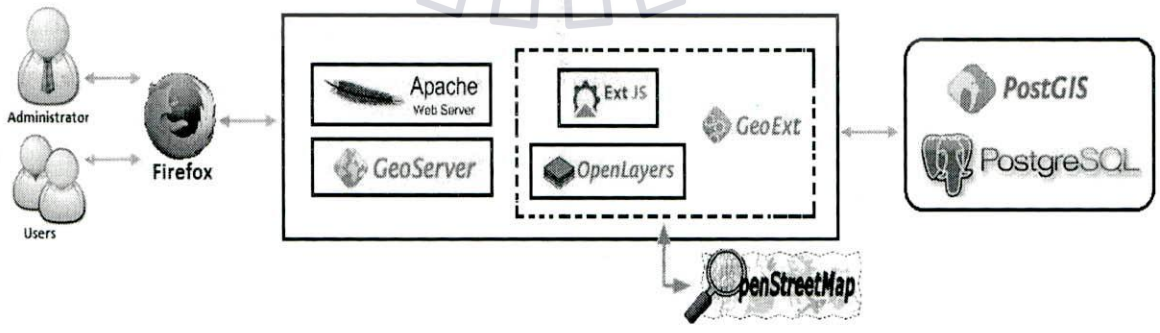


Figure 32: The software and technology used

4.3.3.1 Client-Side Component

Openlayers

Openlayers is an open-source client-side pure JavaScript library for displaying map data in modern web browsers, with no server-side dependencies. OpenLayers implements a JavaScript API for building rich web-based geographic applications, similar to the Google Maps, Bing Maps etc.

EXTJS

ExtJS is a client-side JavaScript framework for building client Applications. ExtJS is a best collection of UI elements. It includes a set of GUI-based form controls for use within web applications. These come with a 'pixel-prefected' style and are useable out of the box.

GEOEXT

GeoExt is extensions to ExtJS that bind basic ExtJS components to the spatial features of OpenLayers that provides a ground-work for creating web-mapping applications. It is a set of components that allow ExtJS and OpenLayers to work together as a single spatial framework.

4.3.3.2 Server-Side Component

Apache

Apache is the world's most popular Web server (HTTP server). The Apache Web server provides a full range of Web server features, including CGI, SSL, and virtual domains. Apache provides a variety of Multi Processing Modules (MPMs) which allow Apache to run in a process-based, hybrid (process and thread) or event-hybrid mode, to better match the demands of each particular infrastructure.

Geoserver

GeoServer is open source server-side software written in Java that allows users to share and edit geospatial data. It publishes data from any major spatial data source using open standards. It is built on GeoTools, an open source Java GIS Toolkit.

PostGIS

PostGIS is an open source, freely available, and fairly OGC compliant spatial database extender for the PostgreSQL Database Management System. It is a spatial language extension module to the PostgreSQL backend server.

PostgreSQL

PostgreSQL is a general purpose and object-relational database management system (ORDBMS). It allows us to add custom functions developed using different programming languages. PostgreSQL is the obvious cahoice for new development projects because it offers superior data protection.

4.3.4 Publishing Shapefile on Geoserver

After prepared maps, we have to need to publish them to geoserver. For publishing map into geoserver follows various steps which are written as below:

Step 1: Add shapefile and its interrelated files to a folder under $GEOSERVER/data_dir/data

Step 2: Open and login in Geoserver administrative tool usually http://localhost:8080/geoserver/web

Step 3: Pick to add a new data store

Step 4: Pick shapefile

Step 5: Choose a Workspace and enter necessary information and then click OK

Step 6: Enter the data source name

Step 7: Using "connection parameters" click "browse" to locate and add shapefile and then click "save"

Step 8: After this next shown screen click "Publish"

Step 9: After this "Data" tab, enter Name.

Step 10: Select "Coordinates Reference Systems" click Find to locate the SRS that shapefile use

Step 11: After clicking a SRS, click "Compute from data" under Native bounding box" and compute from native bounds under "Lat/Lon bounding box"

Step 12: Click "save" to publish the layer.

Step 13: For access layer on Web, click "Layer Preview" and show shapefile on Web page

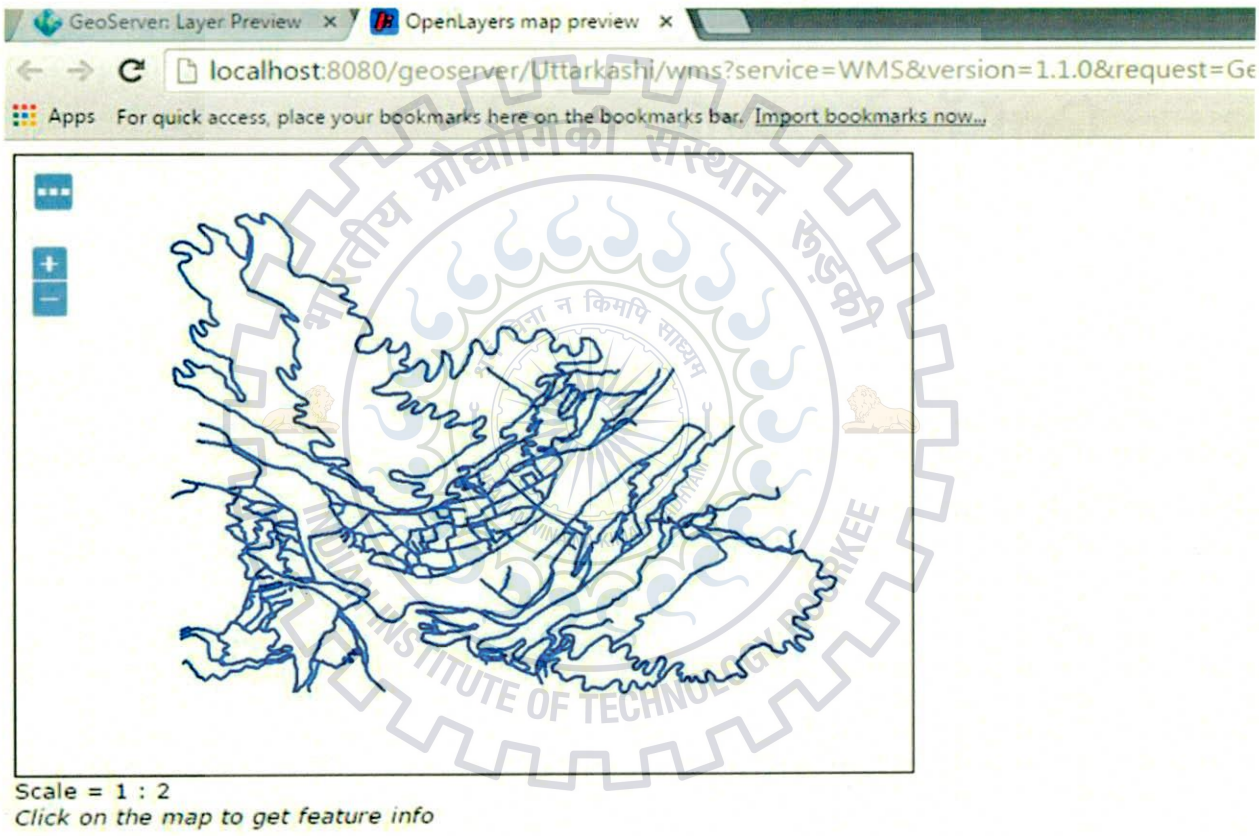


Figure 33: The escape routes and existing road on Web using GeoServer

After getting shapefile on Web page, we got an API for our shapefile. By the use of that API we can access our shapefile layer using OpenLayers library on the Web pages.

CHAPTER 5

5 Results & Discussions

5.1 Visualization on Web

Web page have various features like zoom in, zoom out, panning, draw, insert, delete, modify etc features like polygon, point and line on Web GIS. Web GIS show views base layer like aerial, road and hybrid etc. Web GIS have features to select various overlays using checkboxes for showing on Web GIS like Uttarkashi Site, Uttarkashi Road, Uttarkashi affected areas according to situation, Uttarkshi Relief Camps, Uttarkashi Escape Routes.

5.1.1 Study Site shown on Web

On Web GIS, by clicking on "Overlays" and select "Uttarkashi Site" checkbox, Uttarkashi site is shown on Web page.

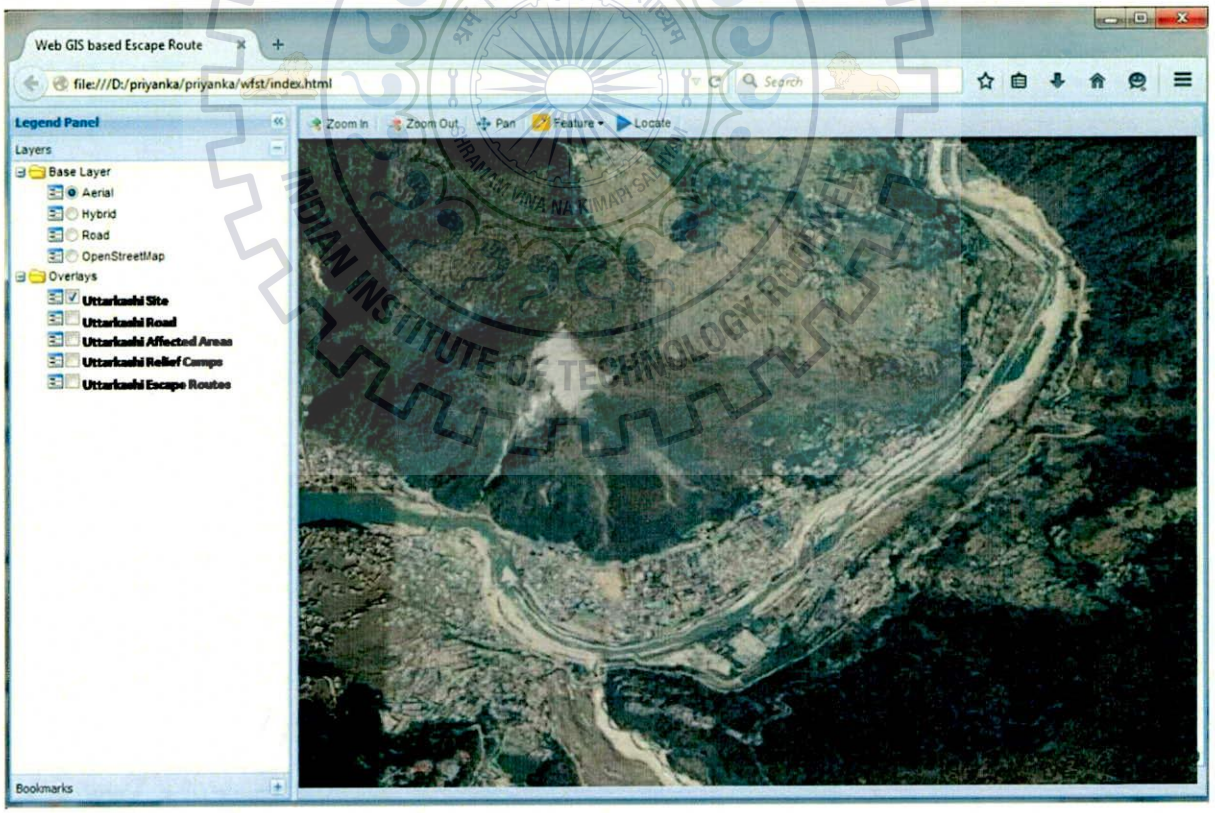


Figure 34: Uttarkashi site on Web GIS User Interface

5.1.2 Study Site Roads shown on Web

Uttarkashi existing roads and street network is shown on Web GIS by clicking "Uttarkashi Road" checkbox.

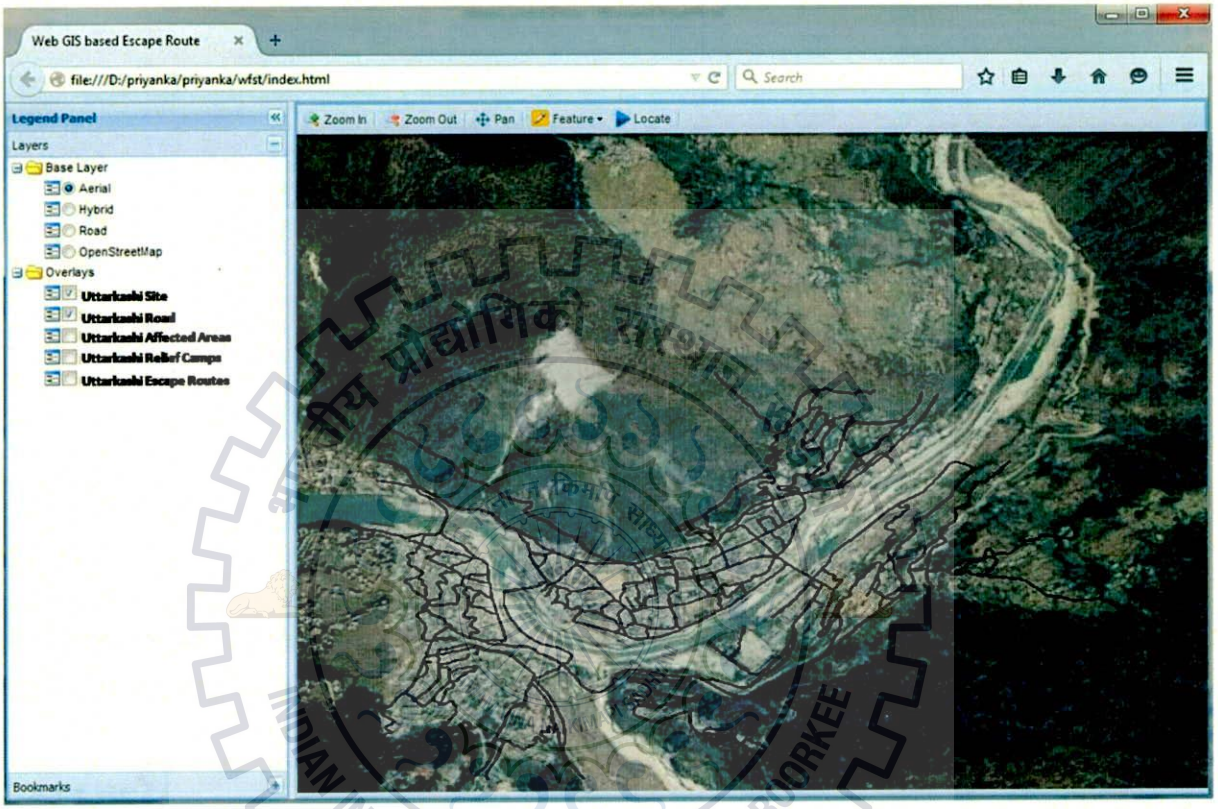


Figure 35: Uttarkashi existing roads on Web GIS User Interface

5.1.3 Study Site Vulnerable Areas shown on Web

Vulnerable areas of Uttarkashi are shown on Web by clicking on "Uttarkahsi Affected Areas" checkbox. These affected areas can be varies according to type and intensity of disaster will be occur. Here, most vulnerable areas of Uttarkashi are shown in various disaster scenarios. These red colour polygons is made by create feature "Draw Polygon".

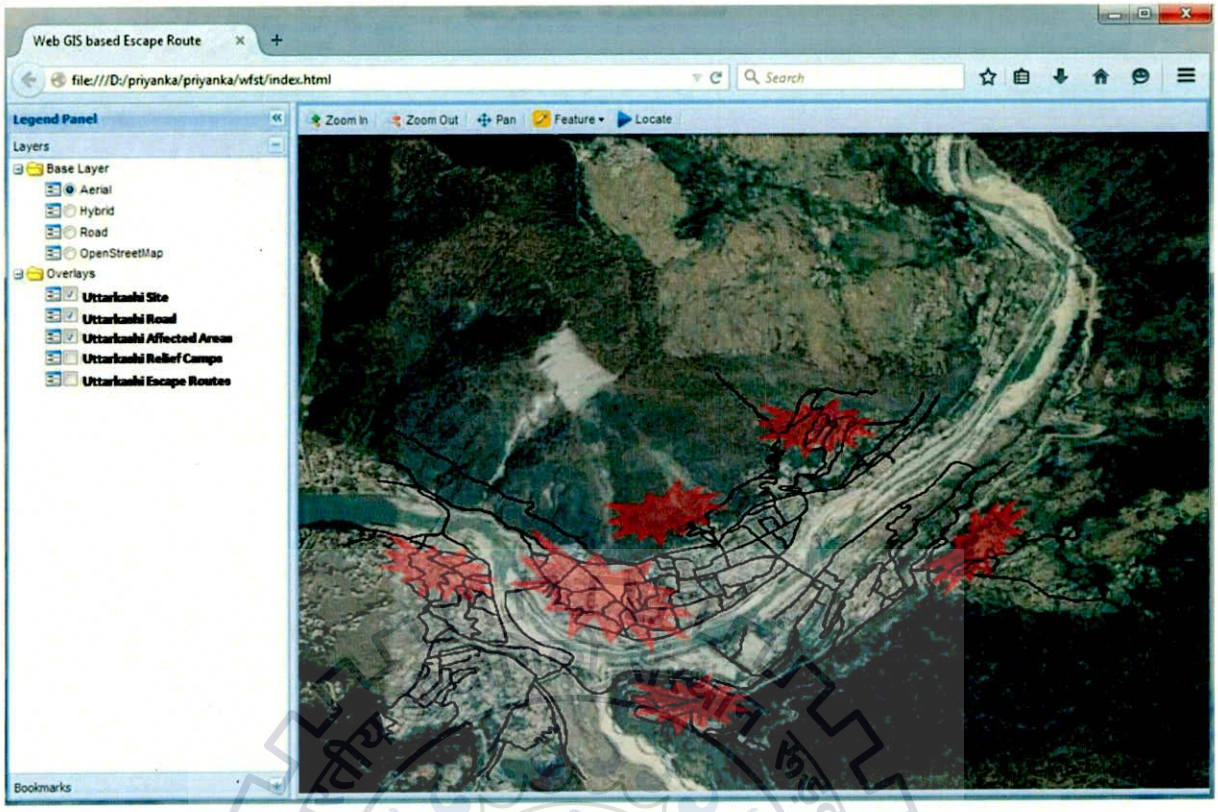


Figure 36: Uttarkashi affected areas on Web GIS User Interface

5.1.4 Study Site Safe Places shown on Web

As, we have identified various nearest safe location using ArcGIS tool. These identified safe locations are shown on Web by clicking on "Uttarkashi Relief Camps" checkbox.

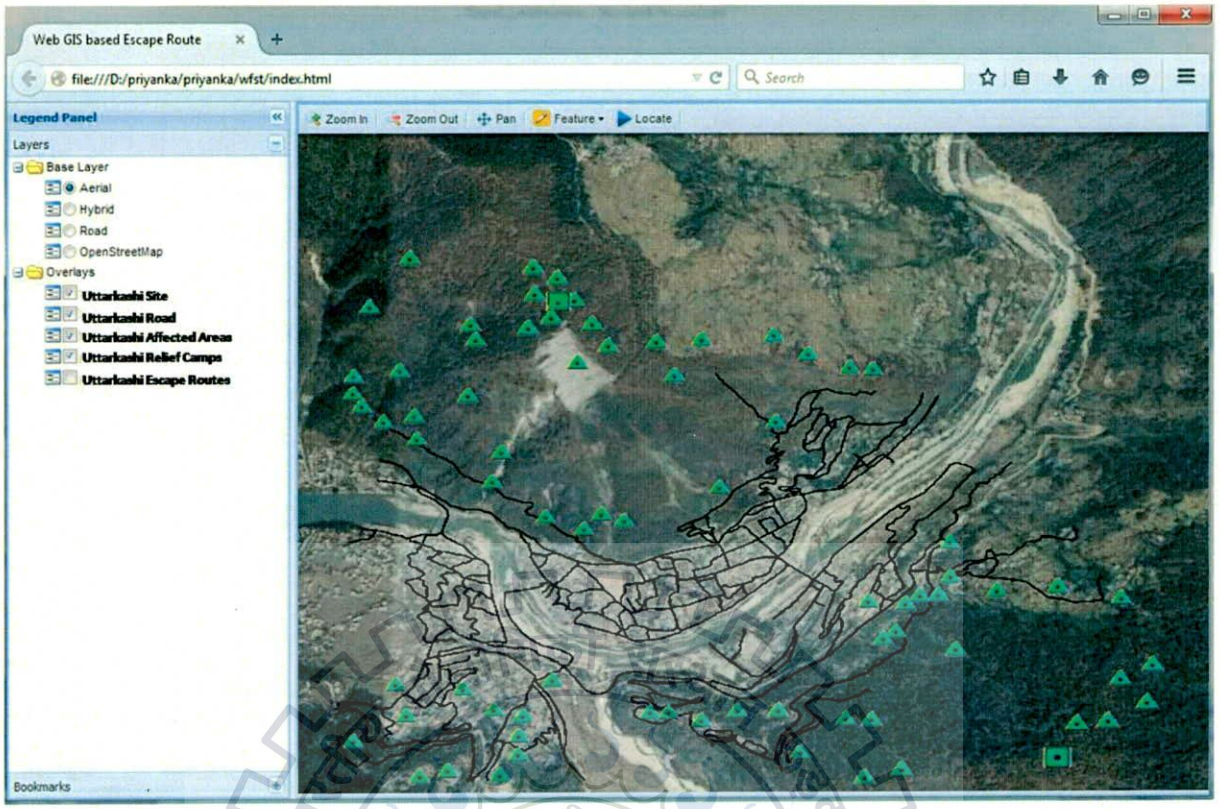


Figure 37: Uttarkashi safe places during disaster on Web GIS User Interface

5.1.5 Study Site Escape Routes shown on Web

As, we have generated various escape routes between disaster affected buffer areas to safe places using ArcGIS tool. These escape routes are shown on Web by clicking on "Uttarkashi Escape Routes" checkbox.

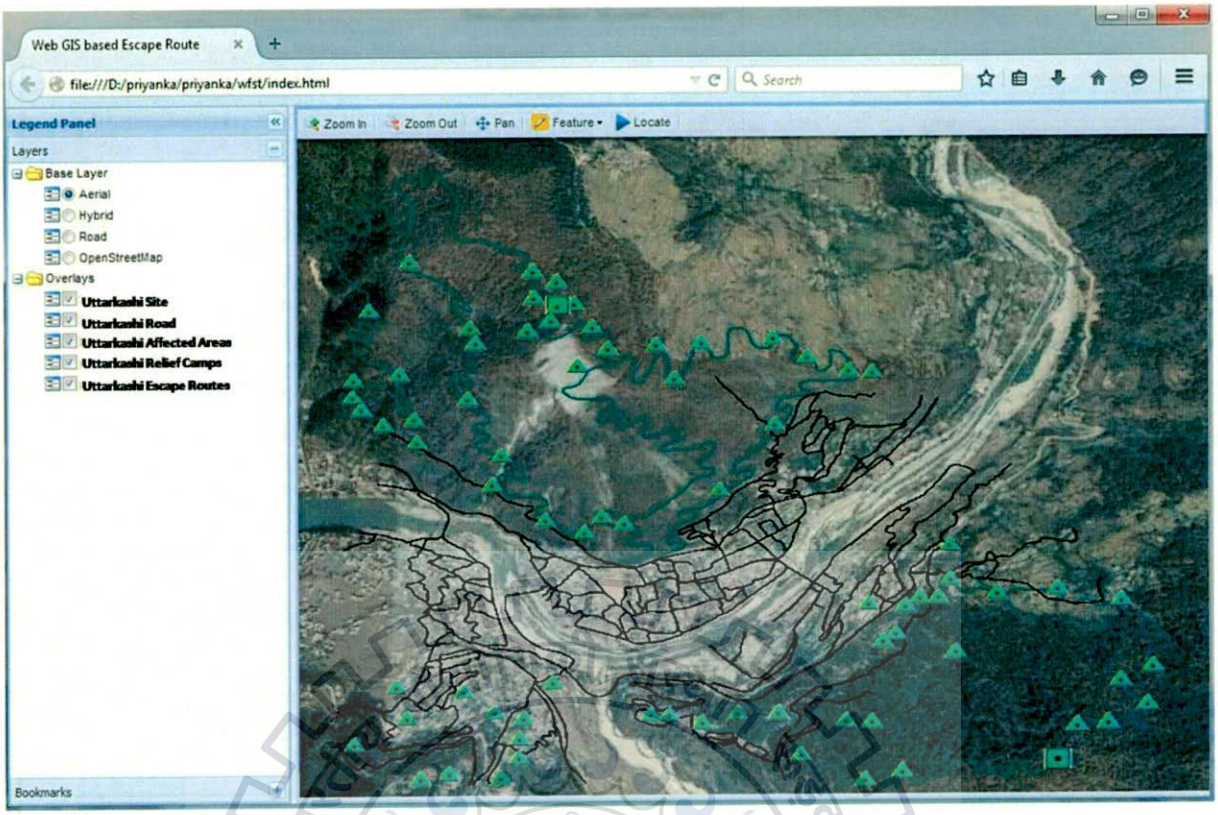


Figure 38: Uttarkashi escape routes during disaster on Web GIS User Interface

CHAPTER 6

6 Conclusion & Future Scope

This study shows the process of generating real-time escape route during the disaster scenario according to damaged areas between disasters affected areas to safe places. This type of planning process is applicable when existing roads are damaged during disaster and victims captured on disaster affected areas. Then, escape routes is used to evacuate victims from disaster affected areas to safe places easily and safely so that victims save their lives and effects of disaster can be reduced effectively.

Openlayers and geoserver is of major use in the creation of Web GIS system and combining the result of model builder to generating escape routes on Web GIS. Model builder using ArcGIS is play a great role in identifying safe places and generating escape routes using different parameters between affected areas as an origin and safe places as a destination. Even the other tools like spatial Analyst, Data Management, Conversion, Editor and analysis are of high use when data has to be prohibiting in a specific process. Like in the case of weighted overlay when all the data has to be in raster format and has to be reclassified into equal number of classes. Remote sensing data used the ASTER DEM of 30 meter resolution which was not already projected. For using this DEM data, we have to project according to the 44N UTM zone by using data management tool. Then DEM data is used for contour study, slope study of Uttarkashi region.

This study shows the results as escape routes for low lying area to high lying area i.e. route on slope surface have maximum slope angle less than 40° and average slope angle less than 15°. For walking, slope angle should be less than or equal to 42°. In a steeper slope, routes have stairs cases of slope degree in between 34°-42°. These are also feasible and use as a walk able way. So, all the escape routes are feasible for walk and they are used as an escape route during the disaster scenario in rescue and relief phase to evacuate victims from disaster affected areas to safe places. Relief camps are used as safe places maximum area of 27301.95 m^2. Thus, the final result of this study shows the most appropriate real-time escape route and relief camps according to disaster affected areas during disaster scenario on the Web GIS system.

This type of study has high scope in future especially due to increase in frequencies as well as intensities of disaster day-by-day. Using model builder in ArcGIS many of the analysis can be performed very fast and using Web GIS system it provides visual interface for people according to the area. Hence if any work would be done for evacuation purposes under rescue and relief plan, and disaster mitigation and management phases. Then this type of study would be very useful in future.

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