ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

CAUSES OF FLOOD DISASTER IN UTTARAKHAND (WEST) A- PHYSIOGRAPHICAL ASPECTS

E.Hemavathy

[1]Ph.D Reseaech scholar, Department of Geography, Bharathi Women's College (A), Chennai-108

Abstract: **Uttarakhand is one of the worst disaster prone states of the India. The state is prone to disasters due to number of factors; both natural and anthropogenic, including adverse geo-climatic conditions, topographical features, environmental degradation, population growth, non scientific development practices etc. In the present paper, an attempt has been made to study detail physiographical aspects of flood disaster in uttarakhand, which itself are west part of the uttarakhand - 1. Dehradun, 2. Haridwar, 3. Garhwal, 4. Tehri-garwal, 5, Rudraprayag, 6. Uttrakashi. For detailed study, we used the geographical information system (GIS) and Remote Sensing (RS) techniques were applied to prepare various thematic maps for the study area. Land use/ land cover, Geomorphology and lineament maps were prepared by visual interpretation from IRSP6 LISS-III Imagery. Slop and aspects, drainage density map was prepared from drainage map using SOI topographical sheet on 1:50,000 scale, lineament intersection and lineament density maps were derived from the lineament map, soil map prepared for existing soil survey and agriculture department map. All the above thematic maps were digitized and converted into real world-co-ordinate system on ARC GIS. GIS overlay analyses were carried out and hazards map was prepared. These studies are very useful for mitigation and management of flood disaster in uttarakhand.**

Keywords: **Flood, GIS, Drainage, Lineament, Intersection, Thematic, West, Factors, Degradation, Condition.**

I. INTRODUCTION

The word disaster is derived from middle French de satre and that from Old Italian disastro, which is turn comes from the Greek pejorative prefix (dus) "bad"+ (aster) "ster", The root of the word disaster {"bad ster in Greek) comes from an astrological theme in which the ancients used to refer to the destruction or deconstruction of a sterasd disaster or a calamity blames on an unfavorable position of a plant.

A disaster is a natural or man-made (or) technological hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. A disaster can be is tentatively defined and tragic event stemming from events such as earthquakes, floods, catastrophic, accidents or explosions it is a phenomenon that can cause damage to life and property and sector the economic, social and cultural life of people.

Depending on impact again the disaster may be

- Economic disaster
- Physical disaster
- Social disaster and so on

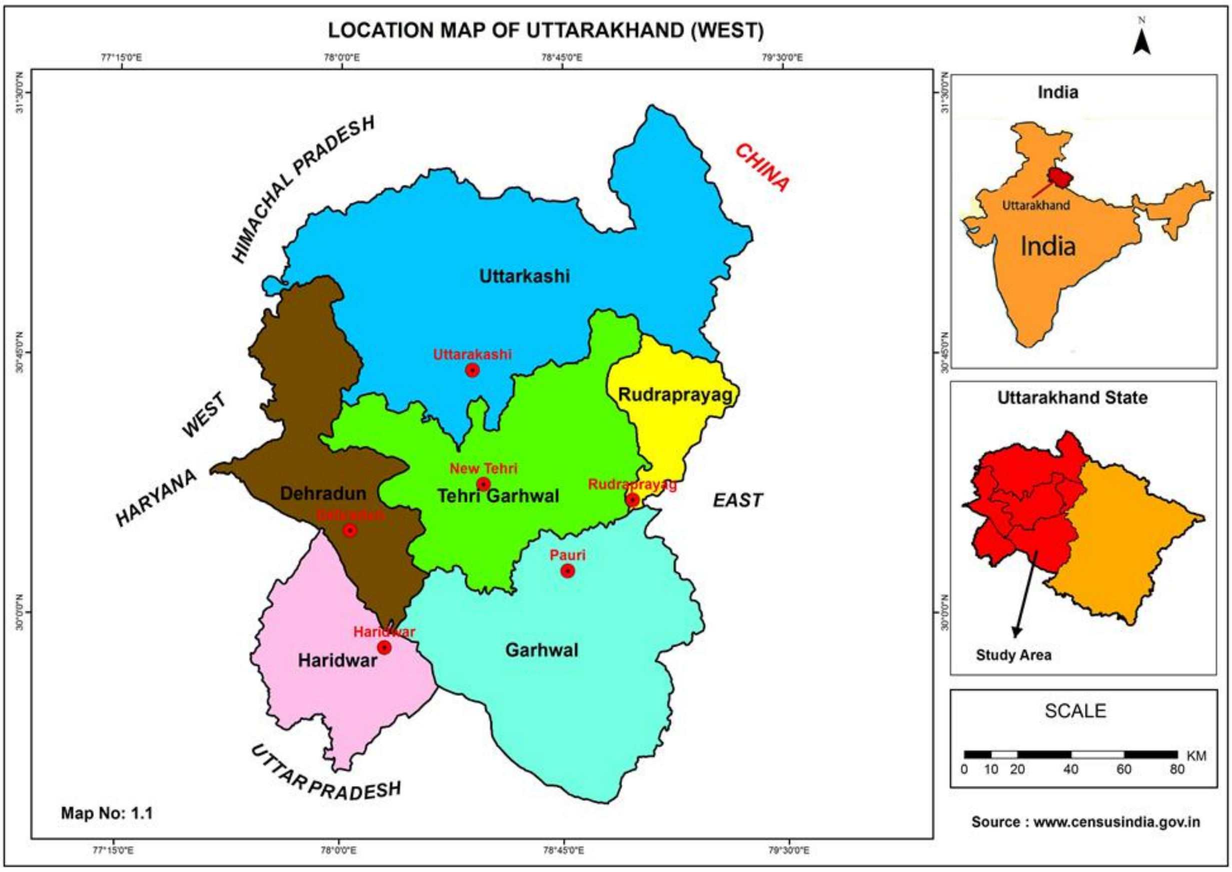
They also overlap and often disaster may cause the other. However economic disaster has is not discussed exclusively. Economic impact is discussed have only an extensions to other forms of disasters. In general it is difficult to measure disaster. But they may be categorized according to the number of persons affected. The disaster caused miseries to a person or to a family may be the first type in thecategory there is various types or expressions such as;

Accidents (and)Suicides, Homicidiesetc,

The second types are the disasters that cause miseries to a number of persons of a village, town, city, state or country depending on the impact. In this category there are various types such as; they may be manmade, natural both. In some case their occurring can be prevented while in some other may not. In second category can be minimized. Thus, handling the disasters in efficient means it should be either to prevent or to minimize the losses.

In contemporary academia, disasters are seen as the consequence of in appropriately managed risk. These risks are the of a combination of both hazards and vulnerability hazards that strike in areas with low vulnerability will never become disaster as is the case in uninhabited regions.

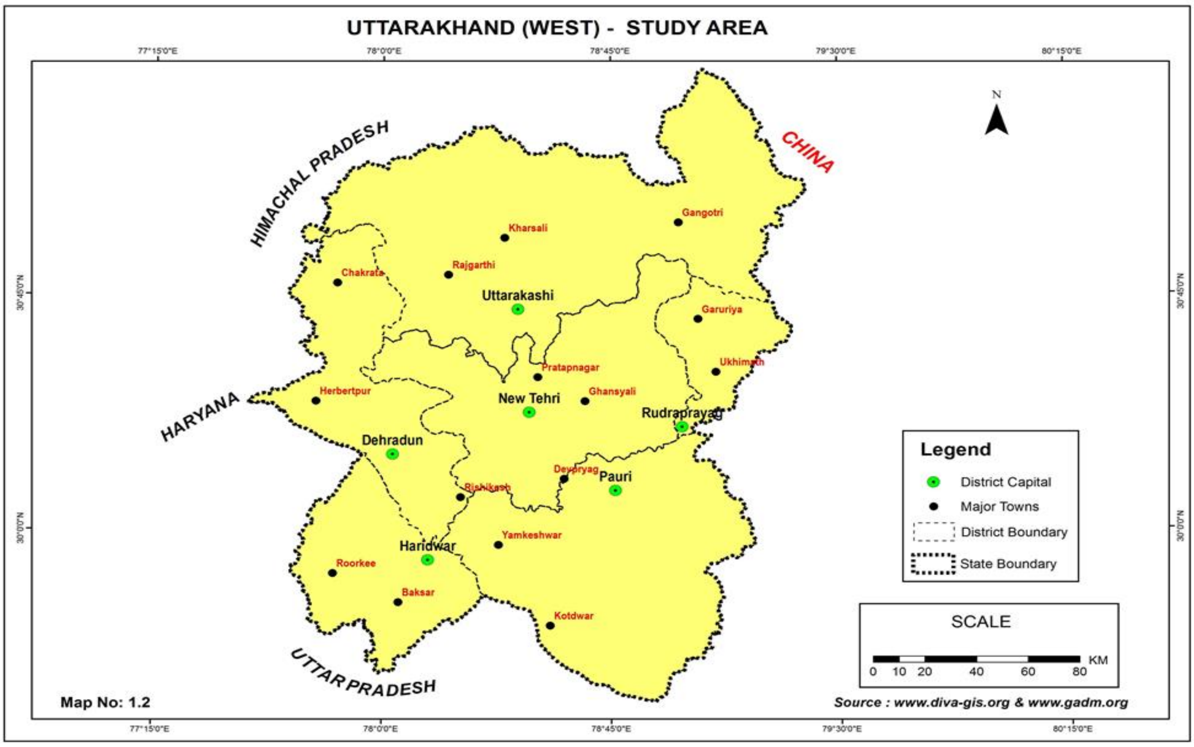
Developing countries suffer the greater costs when a disaster hits – more than 95 percent of all deaths caused by disasters occurs in developing countries, and losses due to natural disasters are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries. The study also makes use of GIS to create a data base that can be effectively used by the managers/decision makers for effective flood disaster management.



STUDY AREA:

Uttarakhand is the capital city of the state of "Dehradun" It's Established 9th November 2000. The largest city of the DehradunisUttarakhand or, formerlycalleduttranchal state in the northern part of India. It is often referred as the "Land of the Gods" due to many holy Hindutemples and pilgrimage centers found through the state uttarakhand is mainly known for its natural beauty of the Himalayan the Bhabhar and the Terai.

It is lies between 33° 30' Northern Latitudes and 78° 06' Eastern Longitude. India was covered out of the Himalayan adjoining North western districts of uttrapradesh it borderes the Tibet autonomous region on the north; the mahakalizone of the far-western region, Nepal on the east; and the Indian states of uttarapradesh of the south and himachal Pradesh to the northwest. (Map No.1.1)The state is divided into two divisions, garhwal and kumanon, with a total of 13 districts. The Study Areas has been chosen part of Uttarakhand for time constrains and also highlighted flood prone zone for disaster. It is west part of Uttarakhand State viz., 1. Dehradun,2.Haridwar, 3.Garhwal,4.Tehri-garwal, 5.Rudraprayag, 6.Uttrakashi. (Map No.1.2)



AIM AND OBJECTIVES:

AIM:

The main aim of the study is to analysis the existing "Disaster management of floods in Uttarakhand". In order to achieve the above mentioned aim, the following objectives are framed.

UttarakhandCity faces the problems of disaster of floods as it is irregular or in adequate in natural because of the Natural increase in the Global warming to develop and Faster research activity in the field of disaster.

OBJECTIVES:

- The analysis the causes of flood disaster in uttarakhant-(west).
- To examine the physical and geographical aspects of uttarakhand-(west).
- To assess the disaster impact on the uttarakhand-(west) in the context of landslides, earth quakes, geology, drainage and lineament and etc.,
- To assess the overlay and buffer analysis to arrive the decision making map as well as solution.
- To examine the mitigation and management in uttarakhant (west)

SCOPE OF STUDY AREA:

The present study will be helpful in understanding the existing "Disaster management of flood in northern part of india (or) uttarakhand. The comparative study with the increasing global warming in turn helps in analysis the trend planning and development of flood prone area.

LIMITATION OF THE STUDY:

The study is limited to the Northern part of India (or) uttrakhand. Due to the data constraint, the present study deals within the Dehradun limits.Due to the time constraint, the study area has been narrowed from the whole state Uttarakhand reduced into part of Uttarakhand which includes the west part of the Uttarakhand State. West part of the Uttarkhand State covers six districts. They are 1. Uttarakashi, 2.Dehradun, 3.Tehri, 4.Rudraprayag, 5.Haridwar, and Gharwal.The disaster management of floods have taken into consideration based on the availability of the data using the collected secondary data sources.

DATABASE AND METHODOLOGY

The geographical information system (GIS) and Remote Sensing (RS) techniques were applied to prepare various thematic maps for the study area. Land use/ land cover, Geomorphology and lineament maps were prepared by visual interpretation from IRSP6 LISS-III Imagery. Slop and aspects, drainage density map was prepared from drainage map using SOI topographical sheet on 1:50,000 scale, lineament intersection and lineament density maps were derived from the lineament map, soil map prepared for existing soil survey and agriculture department map. All the above thematic maps were digitized and converted into real world-co-ordinate system on ARC GIS. GIS overlay analyses were carried out and hazards map was prepared.

II. RESULT AND DICUSSION

THE INCIDENCE:

During the course of the fieldwork in the area devastated by flash floods and landslides geological observations were taken all along the Asi Ganga valley with specific focus on Gangori - Dodi Tal section that falls in Survey of India toposheet numbers 53 J/5, 53 J/6 and 53 J/9.

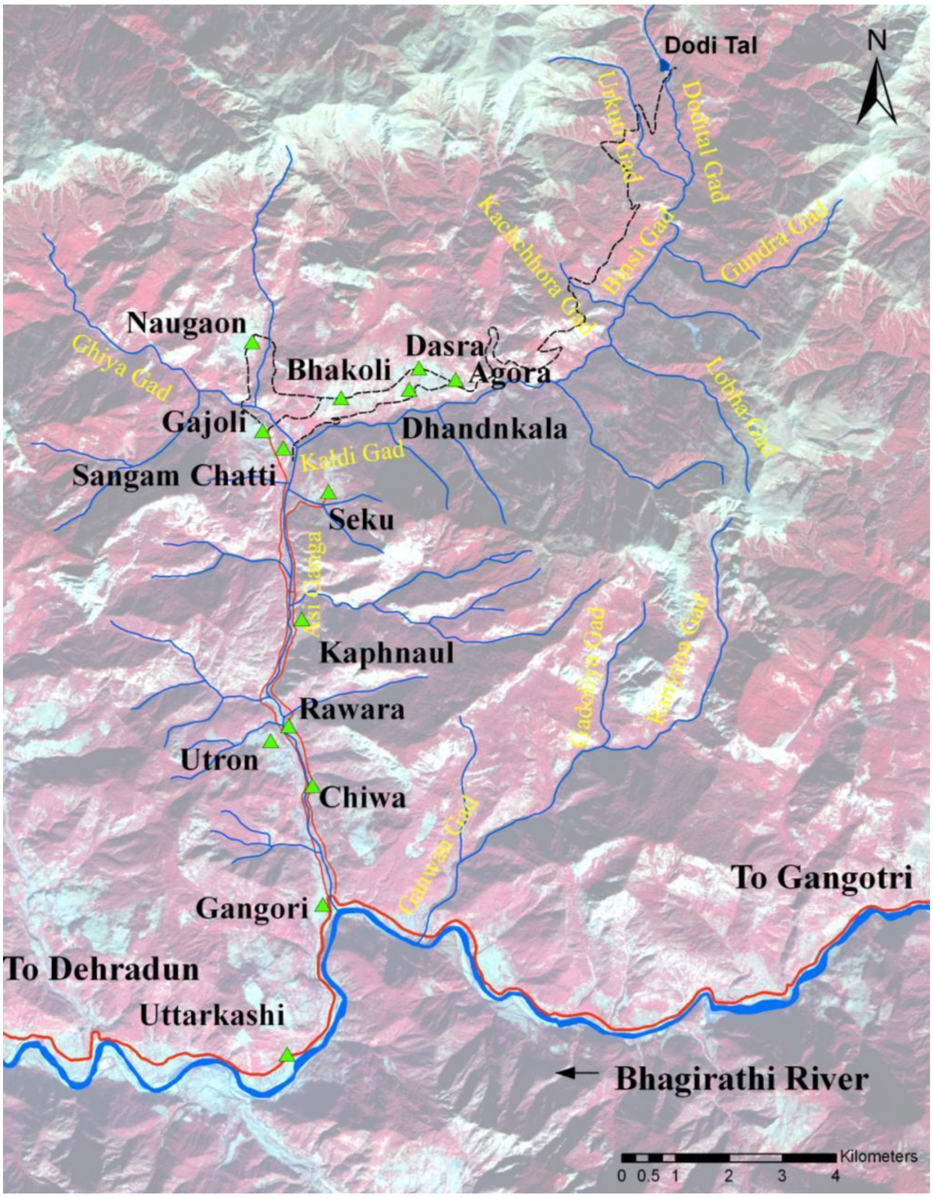


Fig 1.1: Location map of the area around Uttarkashi – Gangori – Dodi Tal.

Uttarkashi town is located in the hilly terrain of Lesser Himalaya and enjoys good road connectivity and can be approached from Dehradun by Mussoorie – Suakholi – Chinyalisaur – Uttarkashi and Rishikesh - Chamba– Dharasu – Uttarkashi motor roads. In the Asi Ganga valley most motor roads were disrupted by landslides and flash floods and the area was largely approached on foot (Fig.1.1).

In the year 2012 the monsoon was relatively weak and both during June and July the rains were deficient throughout the state. It seemed as if the Rabi crops were to face drought conditions heavy and concentrated rainfall was witnessed in the month of August.

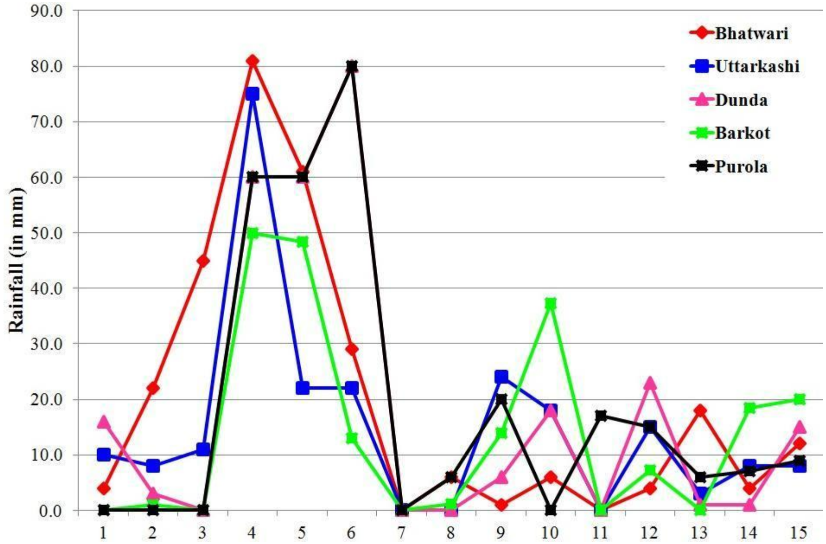


Fig 1.2: Daily rainfall received in Uttarkashi district in the month of August, 2012.

Particularly high rainfall was received in the first week of August, especially in Uttarkashi district between 4th and 6th August, 2012 (Fig. 1.2). Localised heavy rains in the early hours of 4th August, 2012 in the catchment of the tributaries ofBhagirathi river, particularly Asi Ganga and Swari Gad, caused the waters of Bhagirathi to rise as much as 04 meters above the danger level at Uttarkashi. Water level thus rose to 1127 meters above msl as against danger level of 1123 meters. This caused widespread devastation in the district and even the district headquarter was not spared by the fury of nature.

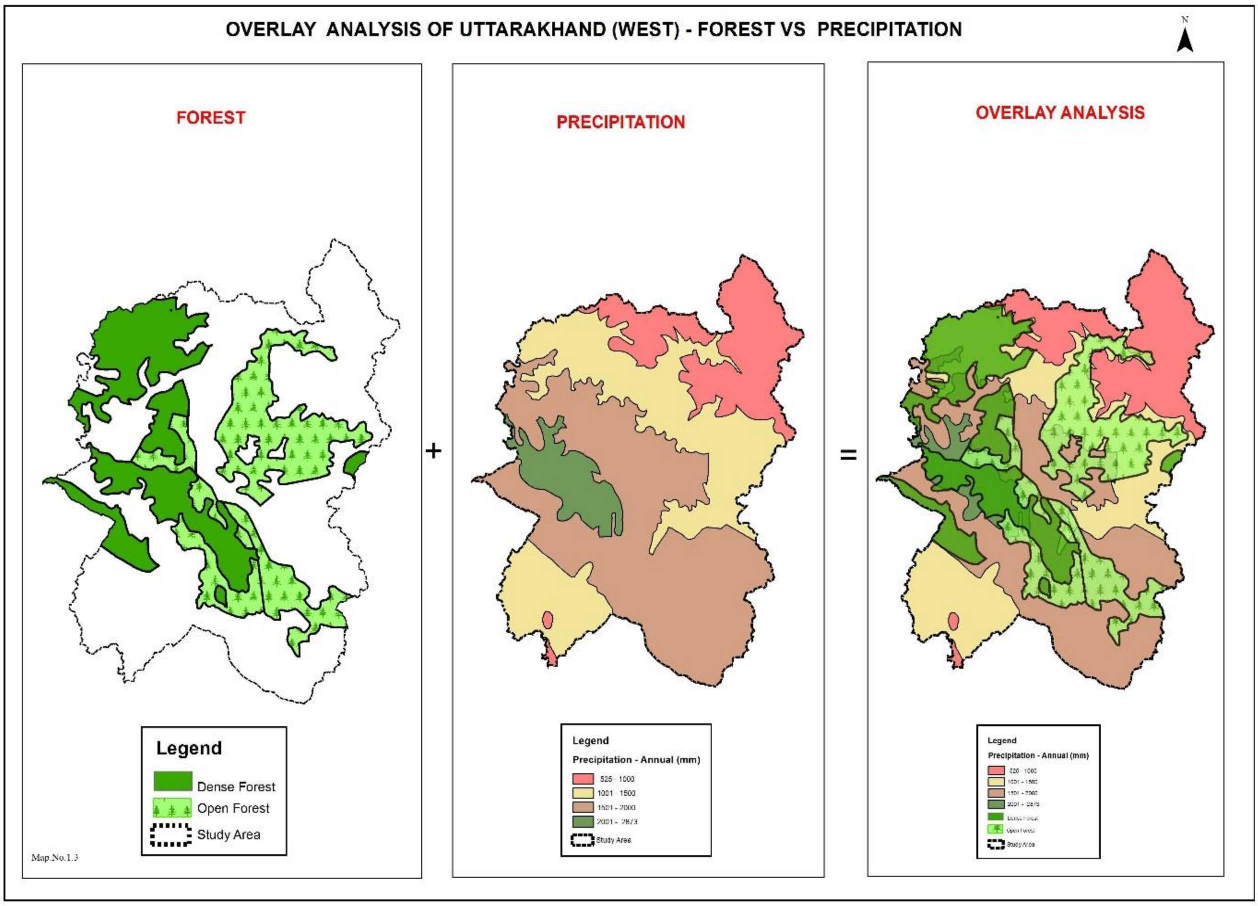
Heavy precipitation and ensuing flash flood resulted in washing off of a number of vehicular and pedestrian bridges including motor bridge at Gangori on the Rishikesh – Gangotri National Highway. The entire area ahead of Gangori was thus physically cut off from the outside world. In the Asi Ganga valley many stretches of Gangori – SangamChatti motor road were washed off together with the motor bridge over Asi Ganga near Kaphnaul.

A number of stretches of the Rishikesh – Gangotri National Highway and other connecting roads were also washed off in the event. Connectivity to as many as 85 villages was disrupted by this event and more that 500 persons were stranded at various stretches of the Rishikesh – Gangotri National Highway beyond Uttarkashi.

The event at the same time caused widespread devastation in the area. As many as 29 persons, including 03 Fire and Emergency Service personnel, were washed off in the event and 06 are still missing. Besides this heavy losses were incurred by public infrastructure and other properties.

FORST & PRECIPITATION OVERLAY ANALYSIS

The map No.1.3 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Forest map and Precipitation map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of forest influence to the precipitation which is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Have been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of forest and precipitation are positively correlated to each other.



ADMINISTRATIVE RESPONSE:

High alert was sounded on the aftermath of the flash flood event and the ensuing devastation in the area around Uttarkashi (Figs. 1.3 – 1.4). The State Government deployed all its resources and all possible measures were taken to manage the situation. All educational institutions of the district were closed down and leave of all the government officials was immediately cancelled. Additional Revenue officials (04 SDMs and 05 Tehsildars) were sent to the district to assist the local administration. Support was sought from Army, ITBP and NDRF and IAF was called in for rescue, evacuation and distribution of relief.

Figs 1.3: and 1.4: Photographs depicting devastation by flash flood in Uttarkashi.

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

The losses in the event were aggravated due to the topographic affects and inherently fragile nature of the terrain. High relief of the area promoted fast and high surface runoff and enhanced pore water pressure together with reduced frictional forces promoted mass wastage in the area. Heavy and concentrated rainfall in the upper reaches of the catchment of Asi Ganga resulted in flash flood like situations in the downstream areas. Evidences of blockade of thecourse of Asi Ganga at many places and their subsequent breach added to thefury of flash floods. Sudden and unexpected rise in the water levels thusoverwhelmed masses and administration.

Figs 1.5: and 1.6: View of the bridges damaged by the flash flood in Uttarkashi.

Transport sector was hit particularly hard by landslide and flash flood events (Fig. 1.5 and 1.6). Rishikesh - Gangotri National Highway, along with link roads were disrupted and the State Government had to strive hard to maintain normal supply of essential commodities in the remote areas. The summary of traffic disruption along the Char DhamYatra route is enough to highlight the situation (Table 1.1). It is worth noting that both the National Highways of Uttarkashi; Gangotri and Yamonotri, remained closed all through in the month of August.

Table 1.1: Details of traffic disruption along Rishikesh - Gangotri as also other National Highways in the state between June and August (till 18th).

Sl. No.	**Highway**	**Number of days when traffic was disrupted on the Highway**			
		June	**July**	**August**	**Total**
		(30 days)	(31 days)	(18 days)	(79 days)
1.	Rishikesh – Gangotri	05	09	15	29
2.	Yamunotri	03	09	16	28
3.	Rishikesh – Badrinath	00	08	10	18
4.	Kedarnath	02	07	05	14

The monsoon season coincides with the peak pilgrim season of the State and people in large numbers from across the nation visit Badrinath, Kedarnath, Yamunotri, Gangotri and Hemkunt Sahib Shrines situated in the Higher Himalayas. Pilgrims and tourists in large numbers were thus stranded at various places during the current monsoon season.

The situation however became serious on Rishikesh - Gangotri National Highway that was blocked continuously for a long period due to the washing off of the vehicular bridge at Gangori. Resuming the vehicular traffic to Gangotri was thus taken up on high priority and material for construction of a Bailley bridge was mobilized and the same was put in place on 26th August and traffic was resumed up to Gangotri on 3rdSepetember, 2012.

Figs1.7: and 1.8:View of the roads damaged by the flash flood in Uttarkashi.

In the mean time the State Government ensured that the pilgrims and tourists are evacuated at the earliest. IAF helicopters were thus pressed into action to evacuate the stranded pilgrims as also those requiring medical aid (Fig.1. 9 and 1.10). Every effort was made to ensure the supply of essential commodities and medicines and medical teams were air dropped at remote locations.

The blockade of traffic along the link roads, however, hampered supply of essential commodities to the far flung remote areas and extra effort had to be put in for ensuring that the masses do not face scarcity of the essential supplies. On many occasions the State Government resorted to manual or animal transportation of essential supplies to ensure that there is no scarcity in remote areas.

Figs 1.9: and 1.10: View of the evacuation of stranded pilgrims and medical relief post at Matli, Uttarkashi.

GEOMORPHOLOGY AND PHYSIOGRAPHY:

The AsiGnaga valley exhibits characteristically distinct rugged mountainous topography of the both lesser and Higher Himalayan terrains. The imprints of geologicalstructures and lithology are observed in the area in the form of strike ridges and deeply incised valleys. The area is observed to be dissected by several ridges and the ground elevations vary from about 1150 to 3045 meters above mean sea level.

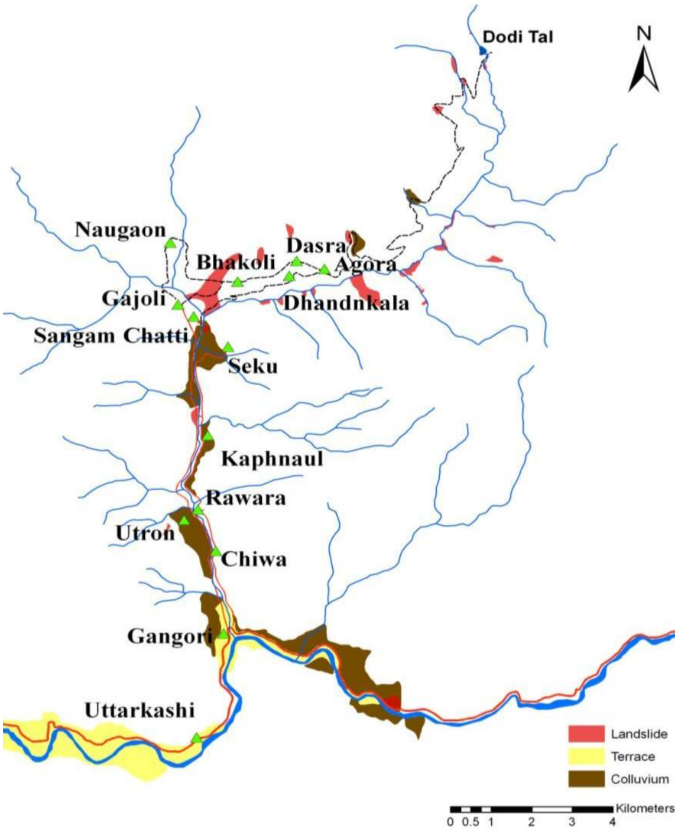


Fig 1.11: Map showing distribution of Quaternary deposits in the area.

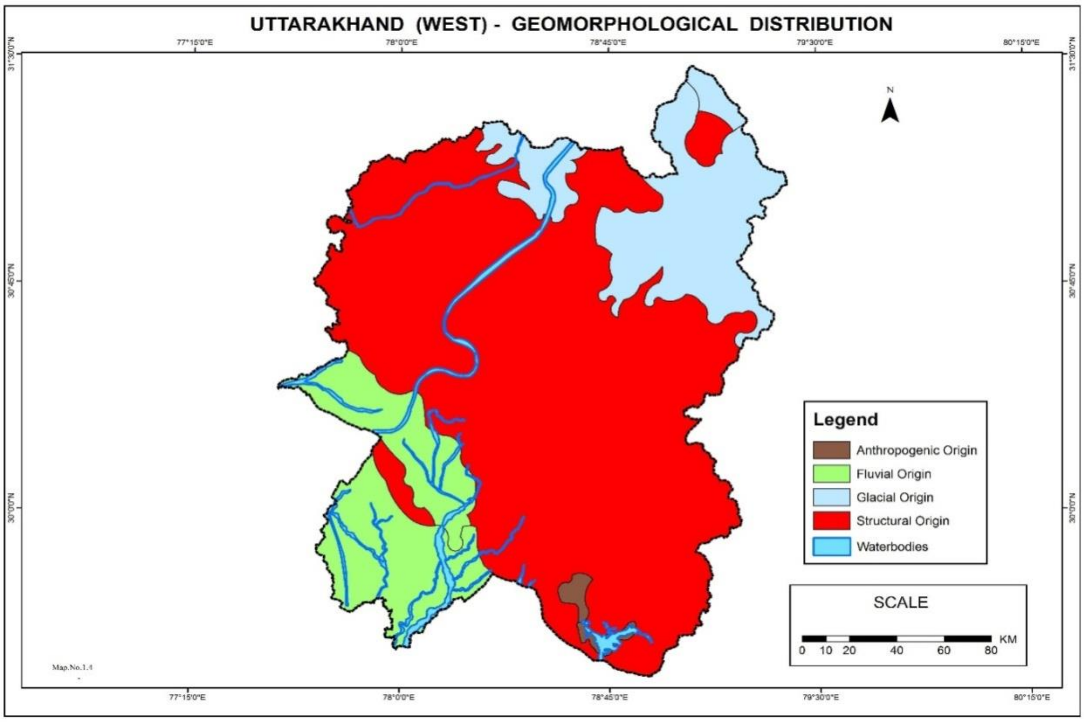
Appreciable exposures of Quaternary deposits are encountered at several places in the area together with active slides (Fig. 1.11). Landslides often initiate in these deposits due to toe erosion and heavy precipitation.

The geo-hydrological condition of the hill slopes is an important parameter influencing the stability of the slopes as water reduces the shearing strength of the slope forming materials causing instability. Several streams are observed to be present in the study area. Ghiya Gad and Kaldi Gad meet at SangamChatti to form Asi Ganga that has confluence with Bhagirathi at Gangori. Other important tributaries of Asi Ganga include Dodi Tal Gad, Dirga Gad, Urkuti Gad, Gundra Gad, Kachchhora Gad, Indri Gad, Lobha Gad and KaldiyaniGad.Asi Ganga is generally observed to flow in N-S direction. The hills on either side of the stream are observed to form high rocky surfaces that clearly reflect the action of snow and these rocky surfaces are observed to rise up to 3000 meter elevation. The local streams of the area are generally observed to flow with great force through steep and narrow channels. This is largely responsible for excessive erosion and collapse of the banks. This area is thus observed to be prone to landslides due to high relief, presence of overburden and high precipitation.

The area has sub - tropical climate and experiences high monsoonal rainfall. The summers are pleasant while the winters are cold. Average summer temperature remains around 25° C while the winter temperature may even drop to 0° C. The rainfall pattern in the area shows high spatial variability that is largely controlled by slope aspect.

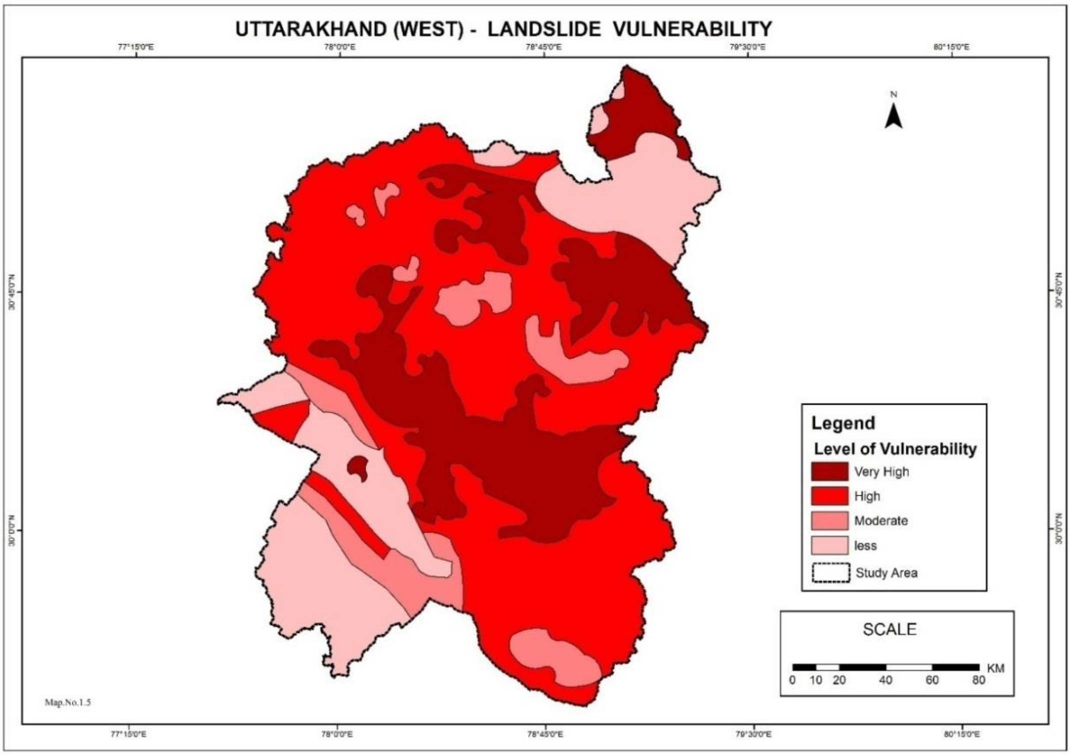
GEOMORPHOLOGY:

Geomorphology is the study of shape or configuration of the earth's (or, by extrapolation, any other planetary body's) solid surface, above and below ocean level, involving the classification of landforms and the processes by which they develop. In other words, geomorphology is the study of landforms and landscape, including the description, classification, origin, development, and history of planetary surface, which seeks to identify the regularities among landforms and what processes lead to patterns (Predictability). Geomorphology deals with different landforms that characterize the earth's topography. Their origin, sequences of evolution, present status, and their future trend. The lithological unit (rock type) and geomorphic unit (land forms) are the fundamental unit's geology and geomorphology, respectively. The map 1.4 explains the detailed geomorphological structure of the study area.



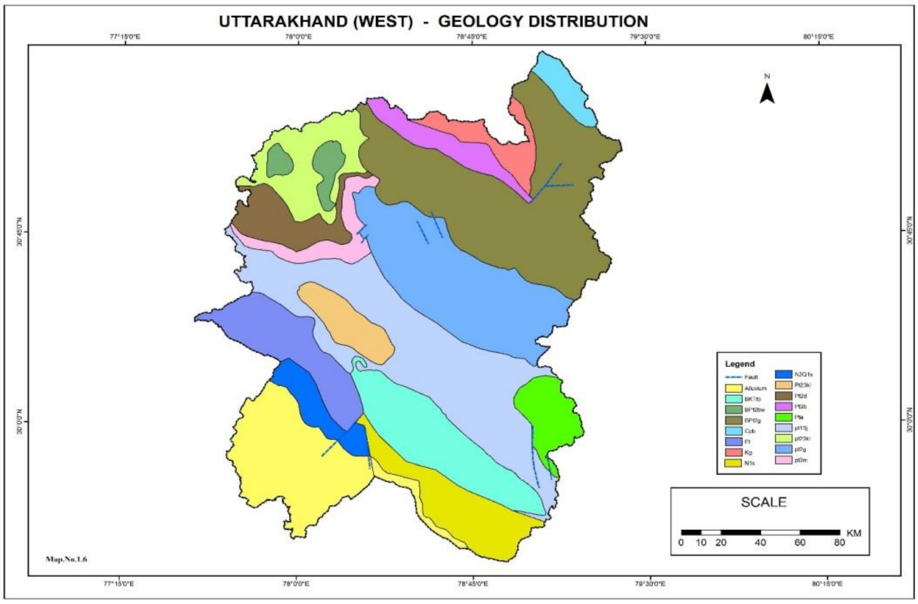
LANDSLIDE VULNERABILITY:

The down- slope gravitational movement of a body of rock or earth as a unit owing to failure of the material is known as landslides. It may be induced by natural agencies, e.g., heavy rain, earthquake, or it may be caused by human over-interference with the slope – stability. Earth flow, mass movement, mud flow, rotational slip, and avalanches are all examples of landslides. The frequency and intensity of landslide is h in the however, more serious in the district of upper Uttrakashi, Bhatwari, Rudraprayag, &Garhwal district. The landslides areas have been shown in the map 1.5it may be observed from that the Rudraprayag, Dehradun, part of Uttarakashi, Garhwal and little part of Tehri- Garhwal have the largest landslide affected areas. Landslides are a common phenomenon in the Hardwar andVikasNager.Map.No.1.5.



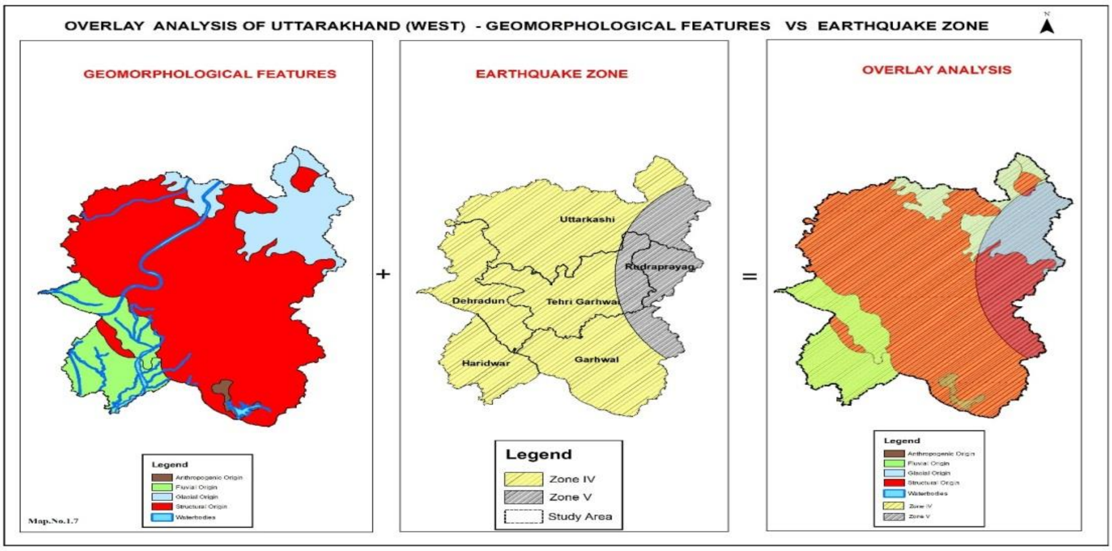
GEOLOGY:

Geology involves the study of land forms, structures, and the subsurface to understand the physical processes creating and modifying the earth's crust. It is most commonly understood as the exploration and exploitation of minerals and hydrocarbon resources, generally to improve the conditions and the standard of living in society. Petroleum provides gas and oil for vehicle transportation, aggregate and limestone quarrying (stand & gravel) provides ingredients for concrete for paving and construction; potash mines contribute to fertilizer; coal to energy production; precious metals and gems for jewelry; diamonds for drill bits jewelry; and copper, zinc, and assorted minerals for a variety of uses. Geology also includes the study of potential hazards such as volcanoes, landslides, and earthquakes, etc. the geology map explains the detailed geological structure of the study area. Map.No.1.6



GEOMORPHOLOGY AND EARTHQUAKE OVERLAY ANALYSIS:

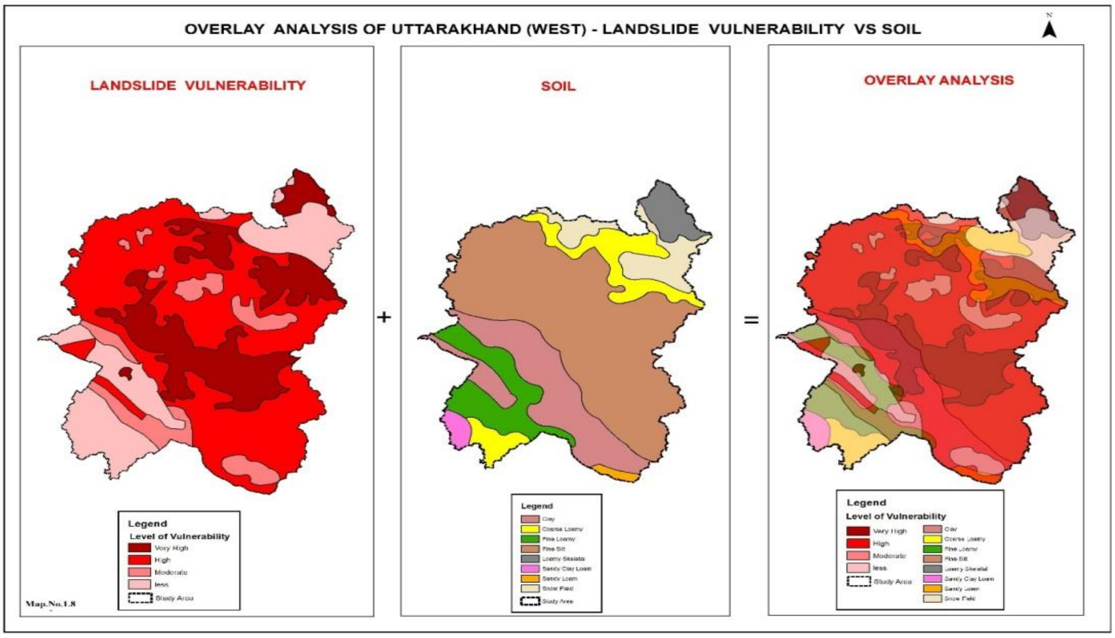
The Map No.1.7explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Geomorphology map and Earthquake map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of Geomorphology influence to the Earthquake. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of Geomorphology and Earthquake are positively correlated to each other. Map.No.1.7



ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

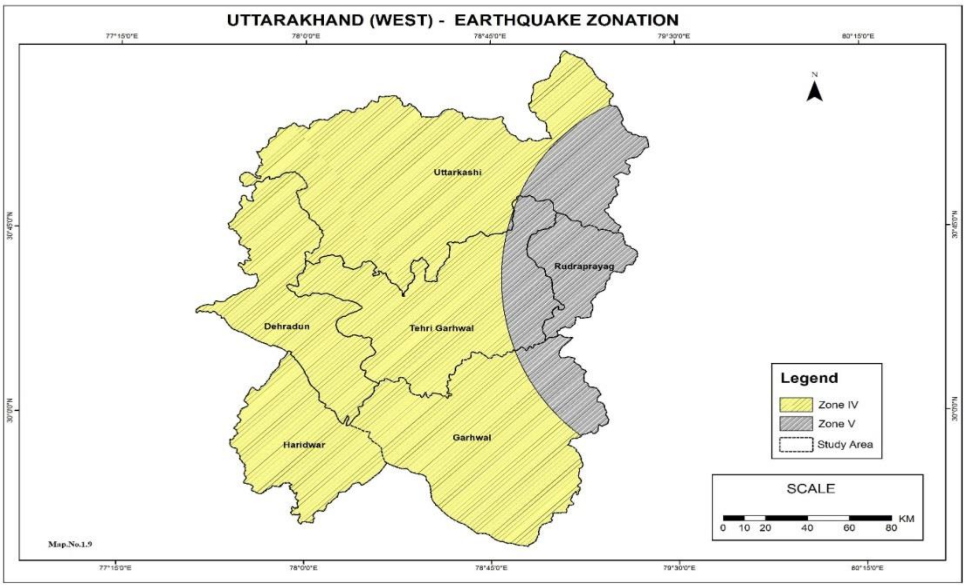
LANDSLIDE AND SOIL OVERLAY ANALYSIS:

The Map No.1.8 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Landslide map and Soil map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of landslide influence to the soil. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of landslide and Soil are positively correlated to each other.



EARTHQUAKE ZONATION IN UTTARAKHAND

Earthquakes are vibrations of earth caused by ruptures and sudden movements of rocks that have been strained beyond their elastic limits. In other words, "an earthquake is a motion of ground surface ranging from faint tremor to a wild motion capable of shaking building apart". The experts of Indian seismology have divided India into five seismic zones. Mainly two seismic zones in uttarakhand,given in map 1.9 it may be observed from that the Uttarakashi, Dehradun, Tehri-garhwal, Hardwar, Garhwal belongs to the highest and high rick categories (zone IV, & v). The most destructive earthquakes are occurred in the district of Rudraprayag especially in the cities, Ukhimath, Jakholi, Pokhari, Ghansali and Devaprayag.



LANDUSE / LAND COVER:

Subtropical and temperate montane vegetation are observed in the area that has appreciably dense forest cover. Based upon the ground truthingduring the field work landuse /land cover characterization of the satellite imagery of the area around Uttarkashi – Gangori – Dodi Tal has been carried out. Eight broad landuse / land cover classes have thus been identified (Fig.1. 12).

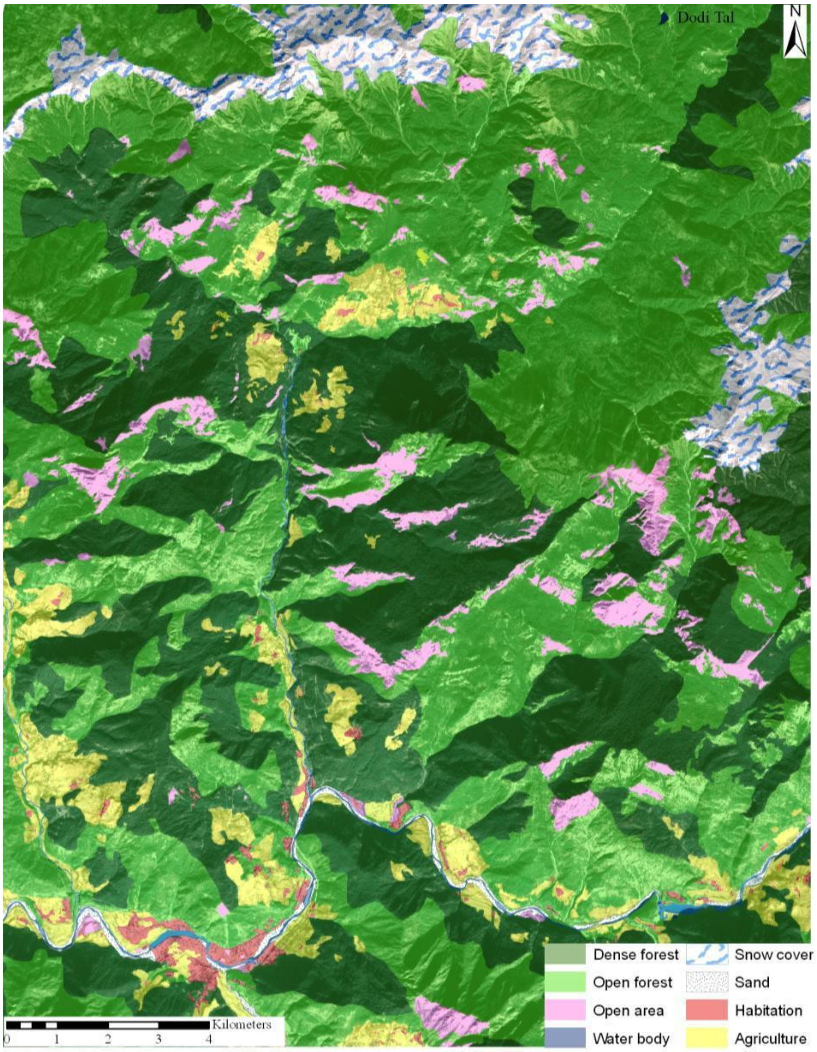


Fig 1.12:Landuse map of the area around Uttarkashi – Gangori – Dodi Tal.

The satellite imagery shows that the area has appreciable forest cover and agriculture is restricted to just 6.5 percent of the total area (Table 1.2), that is confined in the vicinity of the habitations. This is attributed to the fact that the area is sparsely populated and the density of population is low.

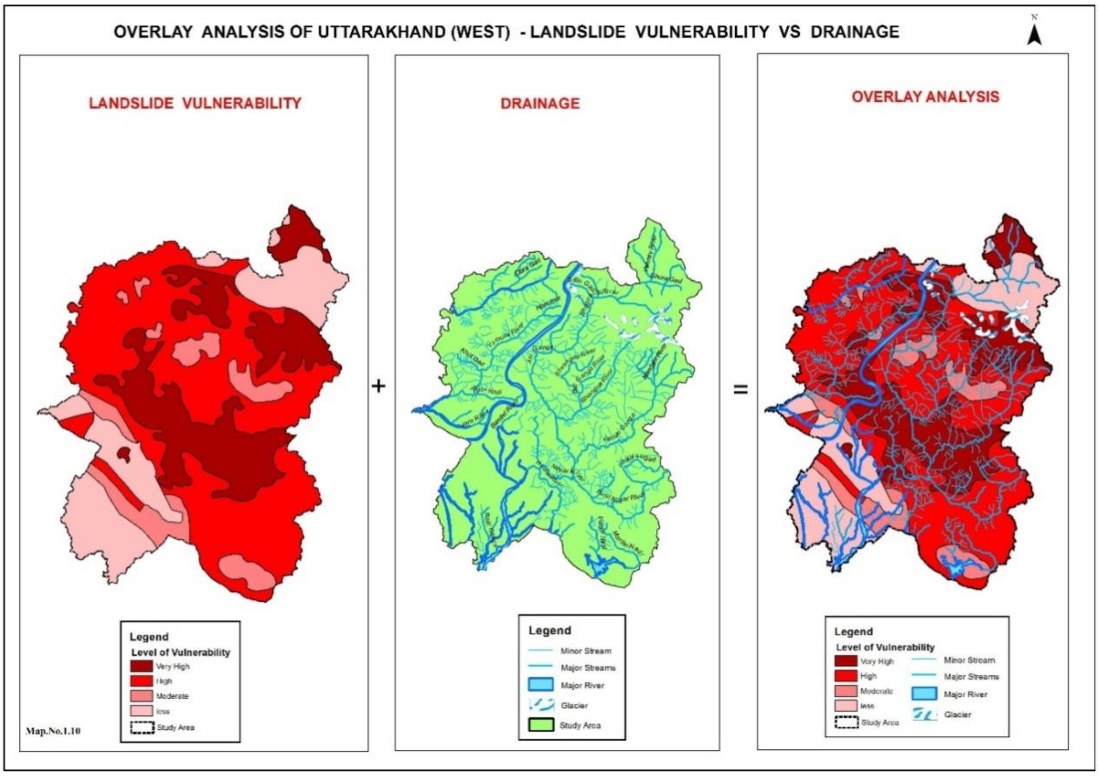
Table 1.2: Land use / land cover details of the area around Uttarkashi – Gangori – Dodi Tal.

Land use / land cover Class	**Area under the Land use / land cover class (in sq km)**	**Percent of the area under Land use / land cover class**
Dense Forest	102.1	31.7
Open forest	164.1	50.9
water body	1.5	0.5

Sand	1.6	0.5
Agriculture	20.9	6.5
Habitation	3.4	1.1
Snow covered area	14.6	4.5
Open area	14.1	4.4
Total	322.4	100

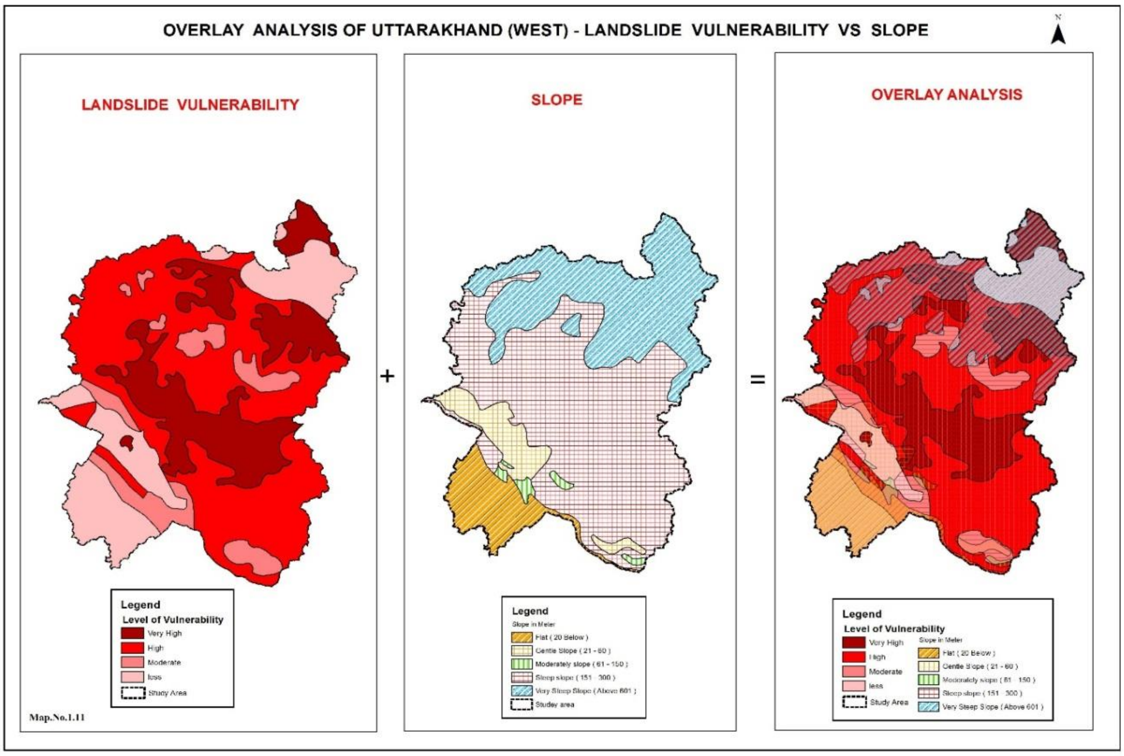
LANDSLIDE AND DRAINAGE OVERLAY ANALYSIS:

The Map No. 1.10 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Landslide map and Drainage map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of landslide influence to the Drainage. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of landslide and Drainage are negatively correlated to each other.



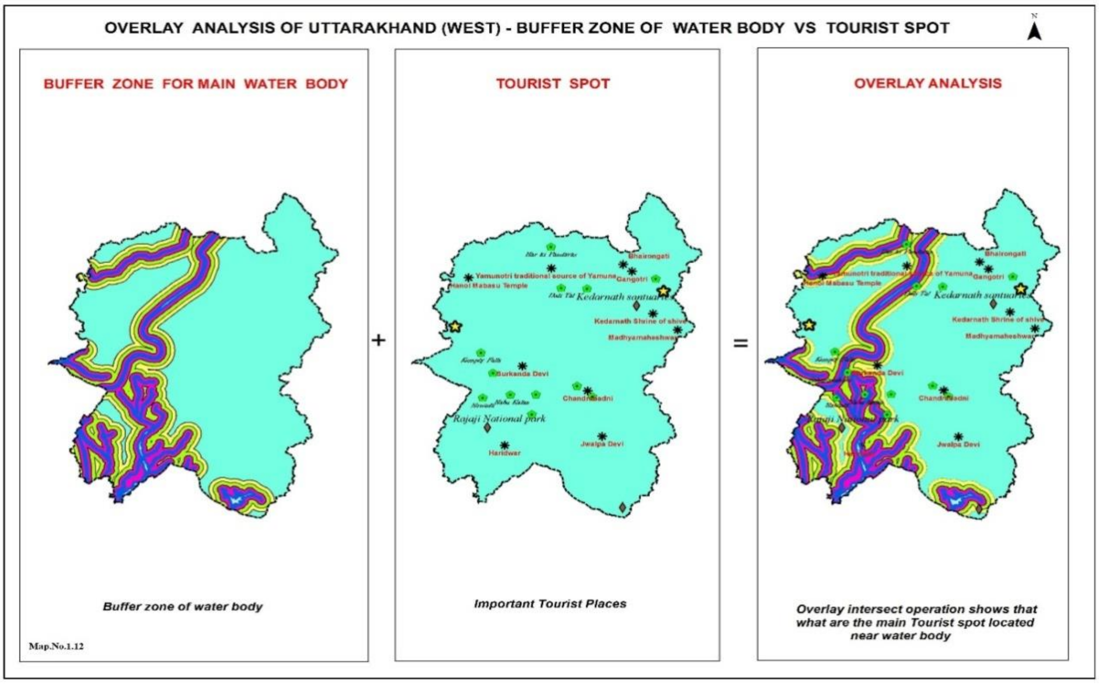
LANDSLIDE AND SLOPE OVERLAY MAP:

The Map No.1.11explains the adopted overlay techniques for the two different themes (Independent and dependent factors) of Landslide map and Slope map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the independent factor of landslide influence to the slope. This is a dependent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 independent and dependent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of landslide and Slope are positively correlated to each other



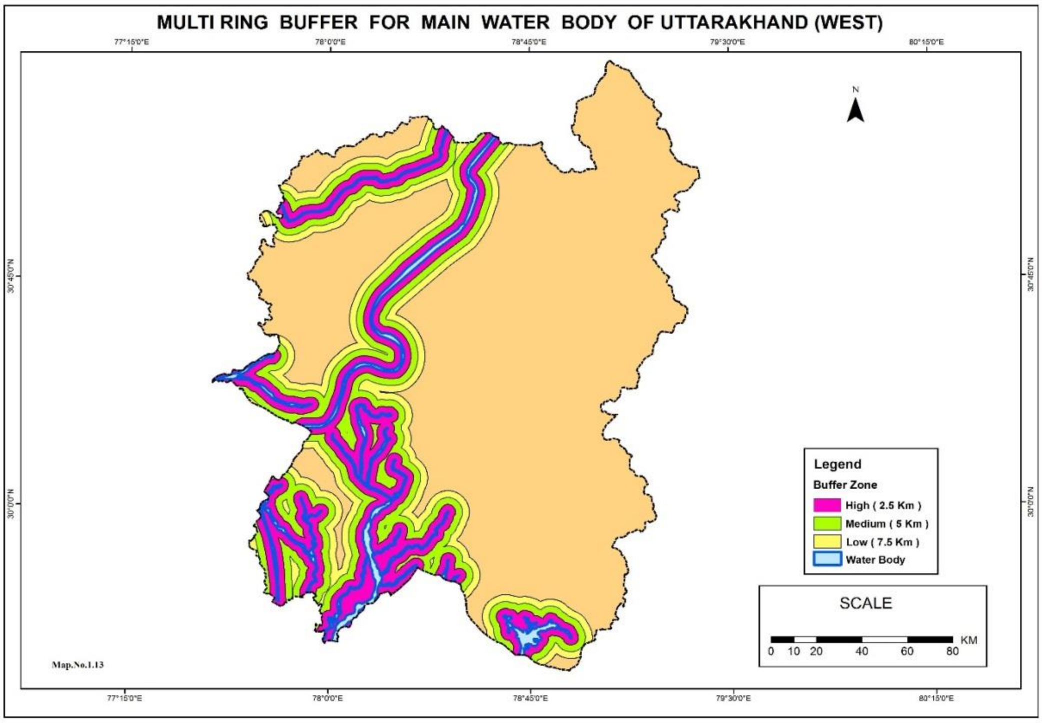
WATER BODY AND TOURIST SPOT OVERLAY ANALYSIS:

The Map No.1.12 explains the adopted overlay techniques for the two different themes (Independent and dependent factors) of Water body map and Tourist spot map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the independent factor of Water body influence to the Tourist spot. This is a dependent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 independent and dependent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of Water body and Tourist spot are positively correlated to each other.



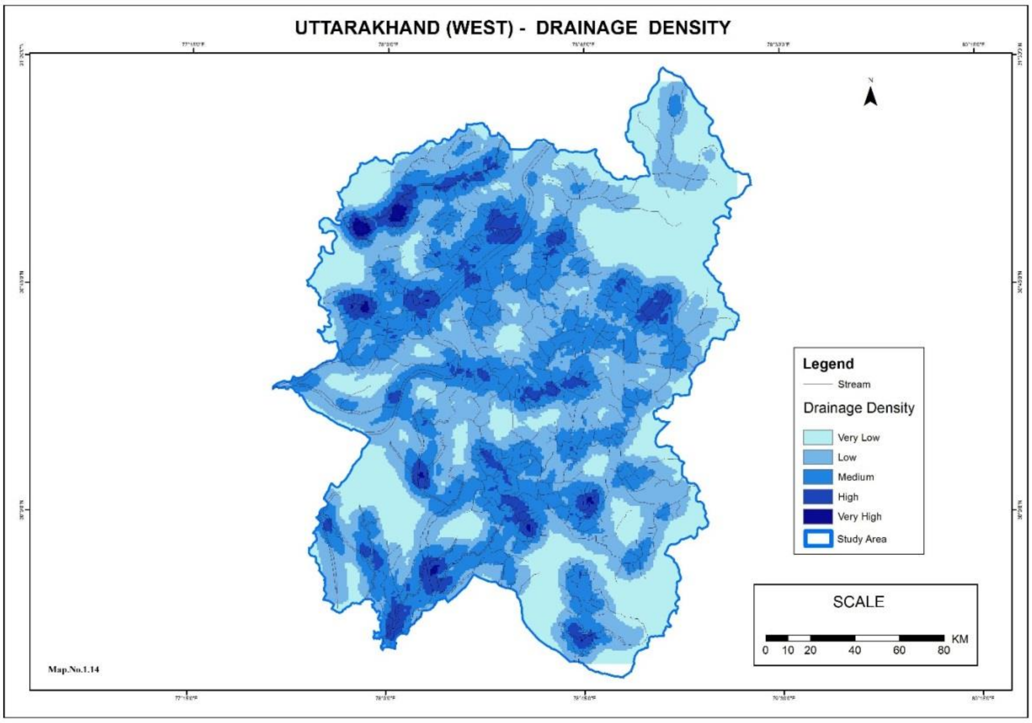
MULTI RING BUFFER MAP FOR MAIN WATER BODY OF UTTARAKHAND:

The map shows the influence of a river by flood may be analyzed by three different buffered zones. Highly affected zone it is represented in the pink color. Moderately affected zone it is represented in the green color and less affected zone it is represented in the yellow color. Thewaterbody it is represented in the blue color.Map.No.1.13



DRAINAGE DENSITY MAP:

This map shows the very highest to very lowest density area base on the classification of the 5 level intervels. The adjoining places of the two are more than two streams area shows the "Highest drainage density area" it is represented in the dark blue color.Map.No.1.14.



GEOLOGY AND TECTONICS:

The Uttarkashi region is observed to consist of two main tectonic units namely Lesser Himalaya and Central Crystalline. The Lesser Himalaya rocks are observed to be thrusted over by Central Crystalline rocks along the Main Central Thrust (MCT).

The Lesser Himalayan rocks of the Garhwal group are observed to be exposed in the Asi Ganga section along the foot track to Dodi Tal. These rocks are observed up to Kachchhora Gad beyond Gajoli and Naugaon villages. These are observed to comprise of quartzite, limestone, metavolcanics, chlorite schist and metabasics with quartzite being the prominent lithology. These rock types are observed to form prominent high rising hill ranges on either side of Asi Ganga and are exposed in the road and foot path sections as also along the tributaries.

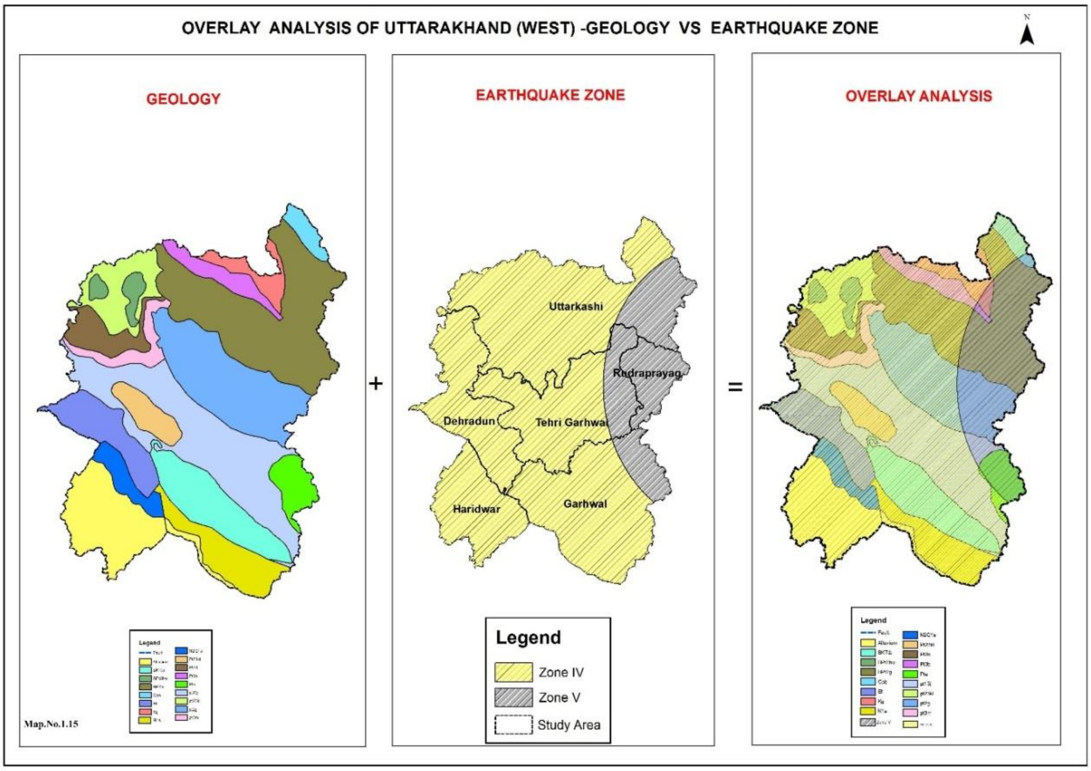


Table 1.3: General litho-tectonic succession of rocks exposed in the Asi Ganga valley.

Tectonic Zone	**Formation**	**Lithology**
NORTH		
Central Crystalline	Martoli Fm.	Banded augen gneiss, kyanite gneiss, mica schist and Interbeddedaugen and porphyritic gneiss. Banded augen gneiss and garnet - mica schist containing Tourmaline. Migmatite zone of mica schist, gneiss, granite, marble / Calc-silicate with amphibolites.
----------------------- Main Central Thrust -----------------------		
Lesser Himalaya	Nagni Thank Fm.	GamriQuartzites that are white to purple in colour and are medium to coarse-grained and show massive current and graded bedding and occasionally has lentiform Conglomerates in basal part. KotMetavolcanices that consist of green, amygdaloidal

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

		Schist with thin bands of quartzite and slate.
	Uttarkashi Fm.	Netala Quartzite that consist of white to buff coloured, fine grained, current bedded quartzites and interbedded Slate with lentiform limestone.
SOUTH		

The rocks are generally observed to dip towards northwest to northeast at angles varying between 20 to 65but some of the places southwesterly dips are observed due to local folding. The rocks are intruded by quartz veins of varying dimension. The metavolcanic rocks between Simori and Utron are observed to form a local antiform.

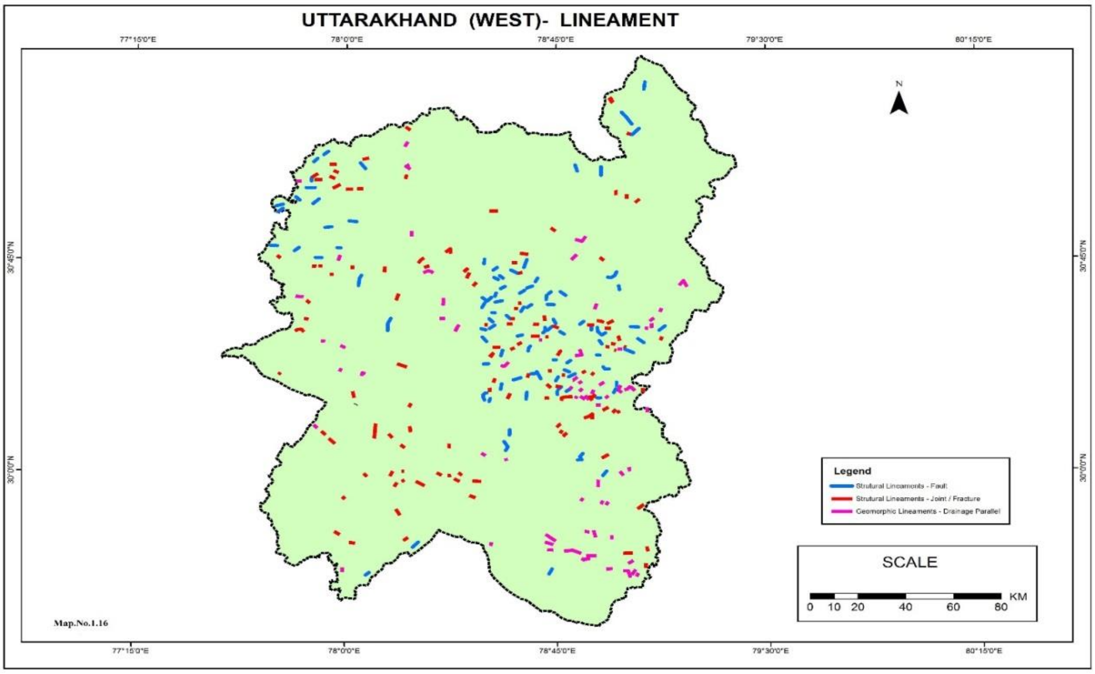
In Kachchhora Gad to Dodi Tal section in the northeastern part of SangamChatti Centre Crystalline gneisses are observed to be exposed. These are thrusted over the Lesser Himalayan metasedimentaries.

Major portion of the area is thus observed to fall under the Lesser Himalayas that include meta-sedimentary and plutonic igneous rocks. The litho-tectonic succession of the area is given in Table 1. 3.

The Map No.6.15 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Geology map and Earthquake map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of Geology influence to the Earthquake. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of geology and Earthquake are positively correlated to each other.

LINEAMENT MAP:

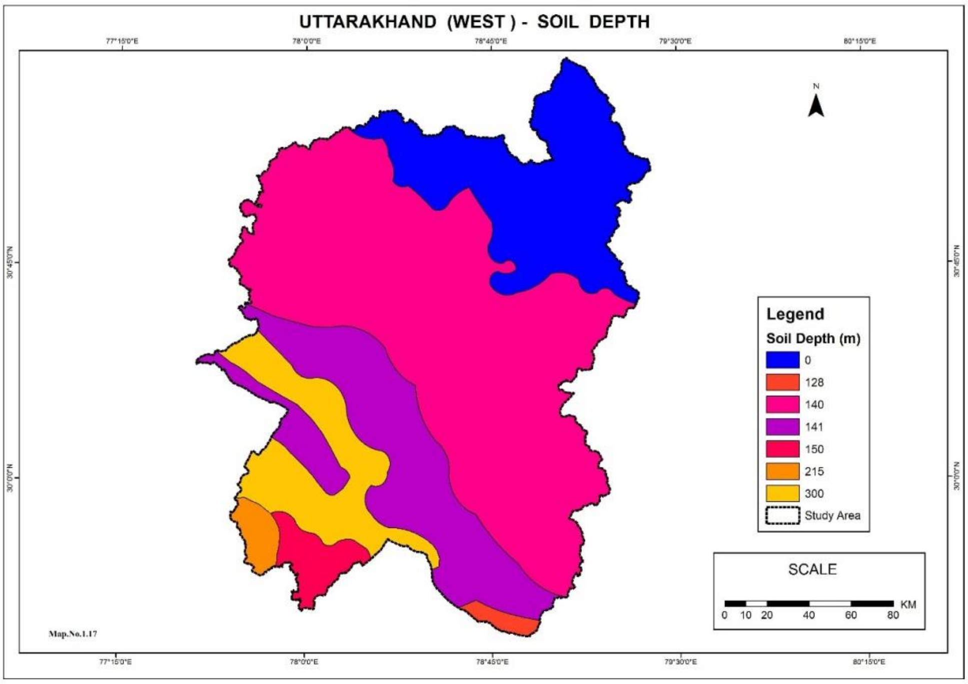
Lineament is defined as a line feature or pattern interpreted on a remote sensing image. The lineament reflects the geological structure such as faults or fractures. In this sense, the lineament extraction is very important for the application of remote sensing to geology. However, the real meaning of lineament is still unclear. It should be discriminated from other line features that are not due to geological structures. Lineament extraction is useful for geological analysis in oil exploration in which oil flow along faults, oil storage within faults, and the oil layer can be estimated. Lineament information can even allow analysis of the geological structure. The map shows the Structural lineaments fault it is represented in the blue color. Structural lineaments joint / fracture it is represented in the red color. And geomorphic lineaments / drainage parallel it is represented in the pink color.Map.No.1.16



ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

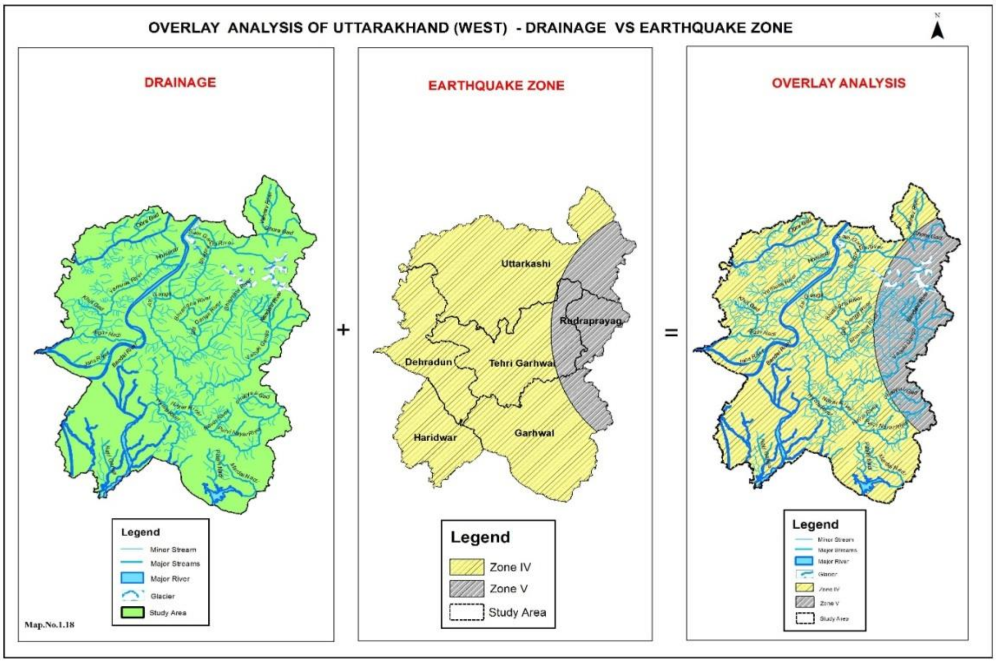
SOIL DEPTH MAP:

This map shows the detail of soil depth in meters. It classified into the intervals of 0,128,140,141,150,215,300. The highest soil depth are shown legend in meters with in brackets.Map.No.6.16



DRAINAGE AND EARTHQUAKE OVERLAY ANALYSIS

The Map No. 1.18 explains the adopted overlay techniques for the two different themes (Independent and dependent factors) of Drainage map and Earthquake map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the independent factor of Drainage. Influence to the Earthquake. This is a dependent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 independent and dependent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of drainage and Earthquake are negatively correlated to each other.



SEISMICITY:

Uttarkashi district has a long and devastating history of disasters, particularly earthquakes. The district falls in Zone IV and V of the Seismic Zoning Map of India and the area under investigations lies in Zone IV (Fig. 13).

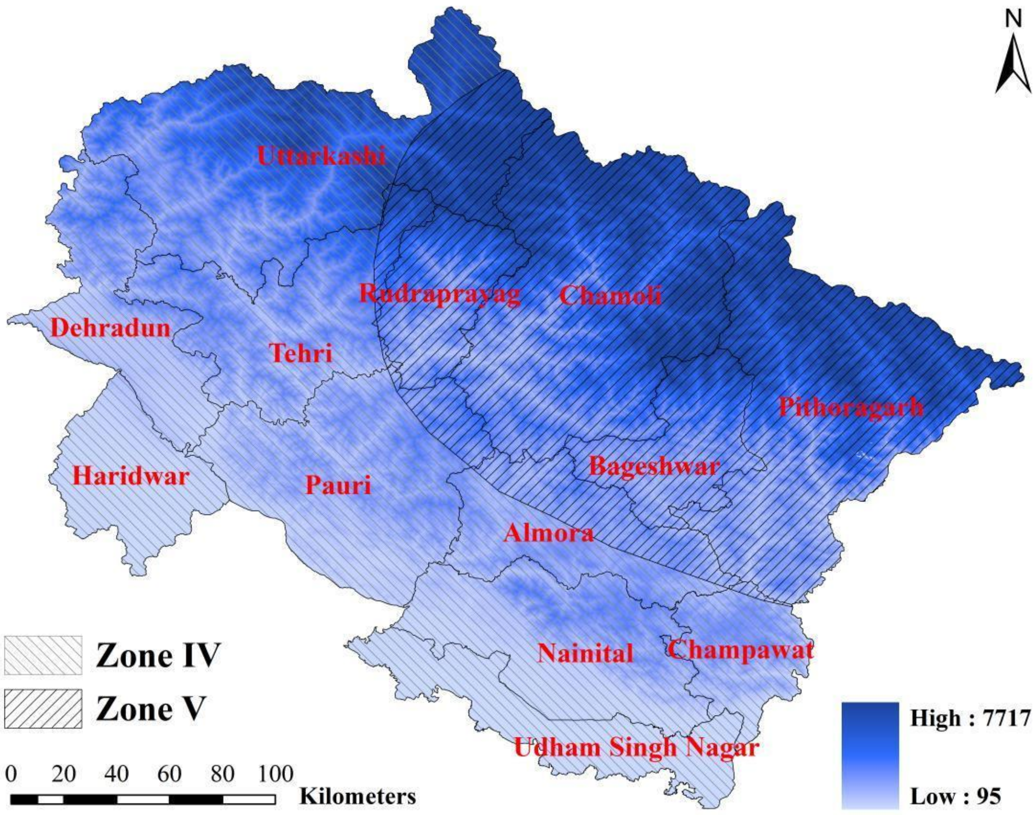


Fig 1.13:Earthquake zoning map of Uttarakhand.

20th October 1991 Uttarkashi Earthquake that has its epicenter at Agora that falls in the area under present focus took a toll of 768 human lives while 5,066 were injured in the event. The summary of the losses incurred by this earthquake is given in Table1. 4.

Table1.4: Details of the losses incurred by 1991 Uttarkashi Earthquake.

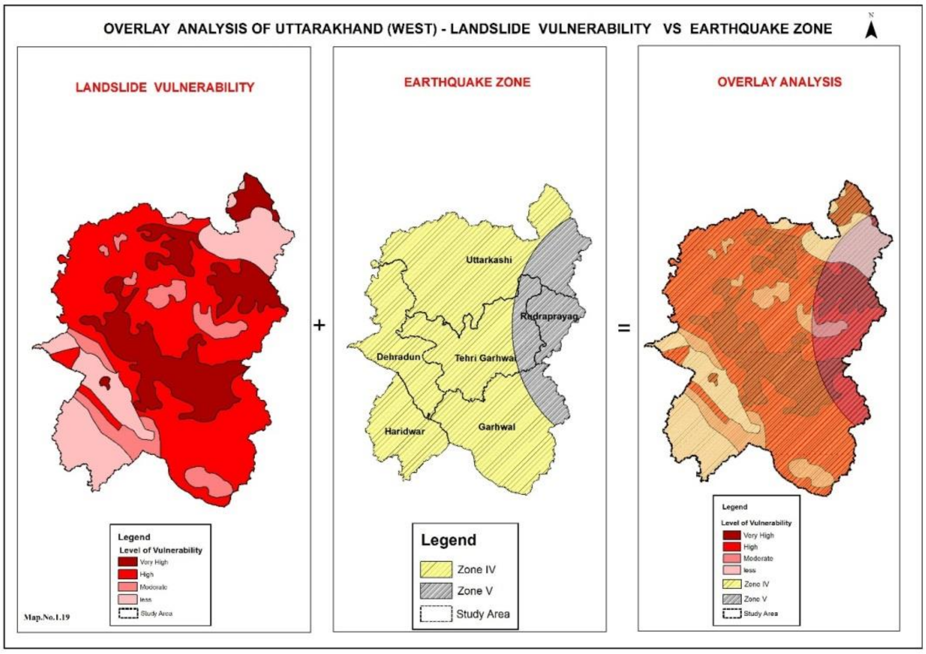
Head	Numbers
Human lives lost	768
Injured humans	5,066
Cattle lost	3,096
Houses damaged (full)	20,242
Houses damaged (partial)	74,714

Besides causing massive loss of infrastructure and property this earthquake triggered a number of rock slides. Large numbers of ground fissures were reported in the area. The earthquake also brought forth changes in spring discharge besides the chemistry of the hot springs in the region (GSI, 1992). This 6.6 magnitude earthquake had its epicenter at Agora, to the north of Uttarkashi town. The epicentral region thus falls under the area under present focus. The epicentral tract of 1991 earthquake occupying an area of 20 sq km around Maneri in Bhagirathi valley recorded an intensity of IX on MSK- 64 Scale. The main shock was followed by a series of over 2000 aftershocks in a period of two months.

ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

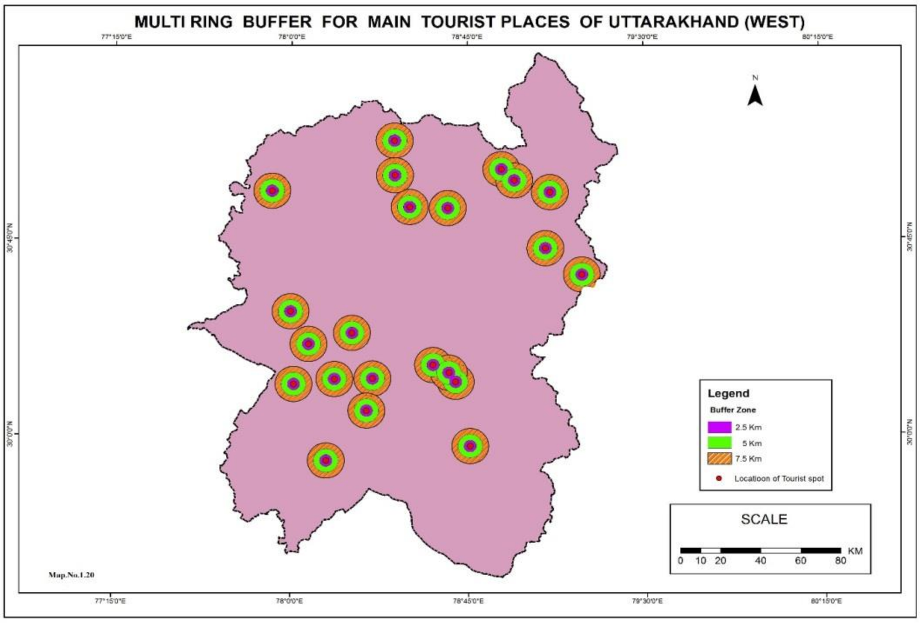
LANDSLIDE AND EARTHQUAKE OVERLAY MAP:

The Map No.1.19 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Landslide map and Earthquake map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of landslide influence to the Earthquake. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of landslide and earthquake are positively correlated to each other.



MULTI RING BUFFER MAP FOR MAIN MAP FOR TOURIST PLACES OF UTTRAKHAND:

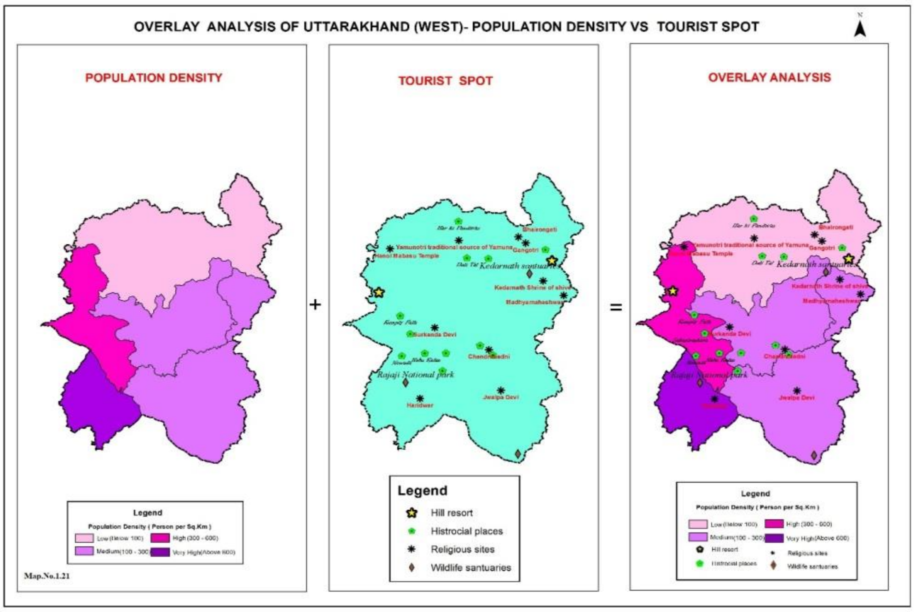
The map shows the influence of a tourist places. If a point is buffered, a circular zone is created may be analyzed by three different buffered zones. Highly affected zone it is represented in the blue color. Moderately affected zone it is represented in the green color. And less affected zone it is represented in the orange color. The location of tourist spot it is represented in the pink color.Map No.1.20.



ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 5, Issue 2, pp: (515-538), Month: April - June 2017, Available at: www.researchpublish.com

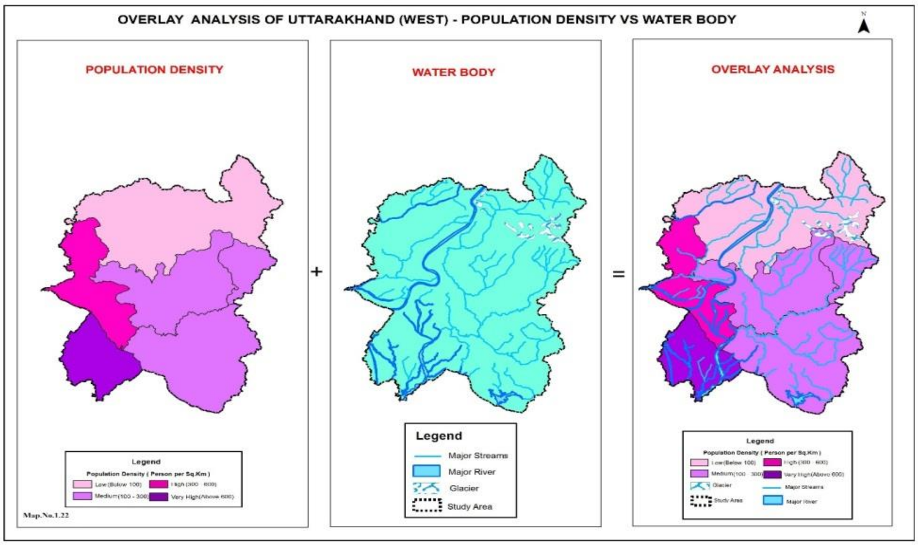
POPULATION DENSITY AND TOURIST SPOT OVERLAY MAP:

The Map No. 1.21 explains the adopted overlay techniques for the two different themes (Independent and dependent factors) of Population density map and Tourist spot map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the independent factor of Population density influence to the Tourist spot. This is a dependent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 independent and dependent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of Population density and Tourist spot are positively correlated to each other.



POPULATION DENSITY AND WATER BODY OVERLAY MAP:

The Map No.1.22 explains the adopted overlay techniques for the two different themes (Dependent and Independent factors) of Population density map and Water body map. Which arises a solution for decision making map for the above 2 different theme factors (variable) for finding the rescue point of view from the disaster happens. In this case the first map is the dependent factor of Population density influence to the Water body. This is an independent factor (variable) as a second map. By using GIS overlay analysis the third map. Has been arrived the decision making for the above mentioned 2 dependent and independent variables. Such as the area has been identified and made hierarchical classification of highest to lowest of potentiality of the study area. Hence the variable of Population density and Water body are positively correlated to each other.



III. CONCLUSION AND FUTURE STRATEGY

The fieldwork carried out in the area brings forth the fact that almost all the devastation has taken place in the proximity of the river bank and is caused primarily by abnormally high precipitation in the catchment of the streams. This is however no abnormal phenomenon and the river morphology in the area show evidences of occurrence of similar events in the past.

One can therefore deduce that the infrastructure and other facilities that got destroyed in the event were located at wrong place and due consideration was not given to the possibility of high floods in the adjoining rivers and streams. This can be attributed to long recurrence interval of such events and short disaster related memory of the masses. Construction of a number of structures on the river ward side of the embankment built on the aftermath of 1978 floods in Uttarkashi gives strength to this assertion.

It needs to be understood that it is not possible to erect embankments at all places and embankments only provide a temporary solution to such problems. Moreover water would always find its path to flow past to lower grounds and erosion of banks is a natural process.

It is a general practice in the hills to align roads along rivers and streams. Apart from convenience and comfort, ever increasing economic opportunities in the vicinity of the roads encourages people to settle down in the proximity of the roads even if it implies being exposed to disaster risk. Increasing tourist and pilgrim traffic further promotes this tendency.

Terrain characteristics limit the availability of agricultural land in the hills and therefore terraces with relatively high productivity were traditionally utilized for agricultural pursuits rather than for the construction of residences. Commercial interests in the recent times, particularly in the vicinity of the roads however led to construction of commercial and other establishments in the land available in the proximity of the roads and rivers.

All these changes are responsible for enhanced flash flood risk in the area.

It is therefore highly important to strictly regulate developmental initiatives in close vicinity of streams and rivers. Appropriate legislative interventions would be required for formulating a policy in this regard and firm executive action in accordance with letter and spirit of this policy would be required to ensure compliance of the same.

The suggestions for mitigative measures have been included in this report, along with the site specific surface geological-geotechnical information. In order to be effective, these mitigative measures must be designed in detail by adequately qualified and experienced geotechnical / civil engineer, with due respect to the ground conditions and details of the specific sites. Peoples increased awareness will lead to better perception, which will enhance community preparedness and thereby make necessary adjustment to bring down the loss due to floods in the area. This should become a part of flood protection policies to reduce the loss. The present study also demonstrates the utility of GIS in the Disaster Management Studies.

REFERENCES

[1] Disater mitigation and management center, (2012), investigations in Asi Ganga Valley on the aftermath of flas flood/ landslide incidence in August, 2012, Department of Disaster Management, Uttarakhand Secretariat, Dehradun-248001, October, 2012.

[2] ALFIER,"Global ensemble stream flow fore casting" 2 November 2012.

[3] MAGRID," Climate change, atmospheric rivers, and floods in California-A multilevel analysis of storm frequency and magnitude change" 1June, 2018

[4] N.V, DUNG 1, 3, "Managing disasters, anthropology, and society" published kilaso.books, 2010.

[5] C.PENNING, ," Flood management in Canada at the cross roads" May 2008

[6] GLENIS, ," Flood management in Canada at the cross roads" May 20"Disaster wet and dry, rivers, floods and droughts in world history 13

[7] H.J. SHIVA PRASAD," Flood management in Canada at the cross roads "JULY 2005.

[8] DANIEL, "Disaster wet and dry, rivers, floods and droughts in world history 2008

[9] BRETT, , "Industrial desperation v/s climate disruption flash flood and planning flows in lokandar metropolises journals of the A.N.M, university of technology OCT-2013

[10] RICHART,"GIS- Based analysis of flood disaster risk in LECZ of China and population exposure", 2007.

[11] JOHNCANNON," "Economically efficient flood protection standards for the netherland"-21 January 2007.

[12] DAVID, ""Even destructive cascade dam break floods".2010.

[13] L.ALFIER," Analysis and modeling of flood risk assessment using information diffusion and artificial natural network" School of mathematics and Physics University of china, 2012- NOV.

[14] MIKE AHERN," Flood risk assessment in Fujian province china, 20O5.

[15] P.C.D. MILLY,"The Environmental Effects of flood disaster in anambra state", 2001.

[16] Approaches for the restoration of the environment in Kushiro wetland contributing to flood risk control, 2012.