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ROLE OF SPACE MEDIA IN ADDRESSING DISASTER: A CASE STUDY OF KOTRUPI LANDSLIDE ALONG THE DRANG AND GUMMA SALT MINES OF DHAULADHAR RANGE IN HIMACHAL HIMALAYA

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ABSTRACT

With the tropical climate and unstable landforms, coupled with high population density, poverty, illiteracy and lack of adequate infrastructure, India is one of the most vulnerable developing countries to suffer from various natural disasters, namely drought, flood, cyclone, earth quake, landslide, forest fire, hail storm, locust, cloud burst and volcanic eruption etc. which strike causing a devastating impact on human life, economy and environment. Though it is almost impossible to fully recoup the damage caused by the disasters, it is possible to (i) Minimize the potential risks by developing early warning strategies (ii) prepare and implement developmental plans to provide resilience to such disasters (iii) mobilize resources including communication and tele-medicinal services and (iv) to help in rehabilitation and post-disaster reconstruction. Space Technology plays a crucial role in efficient mitigation of disasters. While communication satellites help in disaster warning, relief mobilization and tele-medicinal support, earth observation satellite provide required database for pre-disaster preparedness programmes, disaster response, monitoring activities and post-disaster damage assessment and reconstruction, and rehabilitation. Himalaya ecosystem is harbor of natural resources and play critical role in the ecological and economic processes of the region. Deforestation, Landslides, land degradation, desertification and Glacier Lake Outbursts Flooding (GLOF) are the common environmental issues in the mountain regions. The major challenge currently faced by the mountain environment is the escalation of these issues through atmospheric as well as man induced changes. The term Disaster owes its origin to the French world "Disaster" Which is combination of two words "Des", meaning bad and "aster" meaning star. Thus, the term disaster refers to "Bad or evil star". Man has been facing hazards and disasters since the dawn of civilization. The Earth has been undergoing various changes; both slow and catastrophic from very beginning. Change that effects humans adversely are called hazard. A hazard comprises a dangerous condition or event, natural or manmade that could injury, loss of life or damage to property, live hood or environment. In other words, hazards are defined as "phenomena that create a threat to people, structures and economic assets and which may cause a disaster. They could be either man made or naturally occurring in our environment." A natural disaster pertains to a natural phenomenon which occurs in proximate and poses a threat to people, structures and economic assets caused by biological, geological, seismic hydrological or meteorological conditions or processes in the environment. Forty-six people had been died in landslide and mudflows disaster of Kotrupi village (adjacent to Urla) in Padhar sub-division, 35 km from Mandi town. During the field survey many photographs have been taken to prove the part of huge natural factors and anthropogenic causes have on the area. Landscapes of kotrupi have changed drastically due to the natural factors, quarrying practices and anthropogenic causes.

Keywords: Disaster, Landslide, Space Technology, Tele-Medicinal, Disaster Management and Hazard

INTRODUCTION: ROLE OF SPACE TECHNOLOGY IN DISASTER MANAGEMENT

Various disasters like earthquake, landslide, volcanic, fires, flood and cyclones are national hazards that kill thousands of people and destroy billions of dollars of habitat and property each year. The rapid growth of the world's population and its increased concentration often in hazardous environment has escalated both the frequency and natural disasters. With the tropical climate and unstable land forms, coupled with deforestation, unplanned growth production nonengineered constructions which make the disaster-prone areas mere vulnerable, delayed communication, poor or no budgetary allocation for disaster prevention, developing countries suffers more or less chronically by natural disaster. Asia tops the list of casualties due to natural disaster.

Among various natural hazards, earthquakes, landslides, floods and cyclones are the majors disasters adversity affecting very large areas and population in the Indian sub-continent. These natural disasters are of (1) geophysical origin such as earthquakes, volcanic eruptions, landslides and (2) climate origin such as drought, flood, cyclone, locust, forest fire. Though it may not be feasible to control nature and to stop the development of natural phenomena but the efforts could be made to avoid disasters and alleviate their effects on human lives, Infrastructure and property. Rising frequency, amplitude and number of natural disasters and attendant problem coupled with loss of human lives prompted the General Assembly of the United National to proclaim 1990s as the International Decade for Natural Disaster Reduction (IDNDR) through a resolution 44/236 of December 22, 1989 to focus on all issues related to natural disaster reduction. In spite of INDER, There had been a string of major disaster throughout the decade. Nevertheless, by establishing the rich disaster management related traditions and by spreading public awareness the IDNDR provided required stimulus for disaster reduction. It is almost impossible to prevent the impact the occurrence of natural disaster and their damage however, it is possible to reduce the impact of disaster by adopting suitable disaster mitigation strategies. The disaster mitigation works mainly addressed the following.

minimize the potential risks by developing disaster early warning strategies,

prepare and implement developmental plans to provide resilience to such disasters,

mobilize sourcesincluding communication and tele-medicinal services and

To help in rehabilitation and post-disaster reduction. Disaster management on the other hand involves:

Pre-disaster planning, preparedness, monitoring including relief management capability.

Prediction and early warning.

Damage assessment and relief management. Disaster reduction is a systematic work which involves with different regions, different professions and different scientific fields, and had become an important measure for human, society and nature sustainable development.

ROLE OF SPACE TECHNOLOGY

Space systems from their vantages position have unambiguously demonstratedtheir capability in providing vital information and services for disaster management. The earth observation satellites provide comprehensive, synoptic and multi temporal coverage of large areas in real time and at frequent intervals and ‘thus’- have become valuable for continues monitoring of atmospheric as well as parameter related to natural disasters (table.1).

Geo-stationary satellites provide continues and synoptic observations over large areas on weather including cyclone – monitoring. Polar orbiting satellites have the advantage of providing much higher resolution imageries, even though at low temporal frequency, which could be used for detailed monitoring. Damage assessment and long-term relief management. The vast capabilities of communication satellites are available for timely dissemination of early warning and real-time coordination of relief operations. The advent for Very Small Aperture Terminals (VSAT) and Ultra Small Aperture Terminals (USAT) and phased-array antennae have enhanced the capability further by offering low cost, viable technological solution towards management and mitigation of disasters. Satellites communications capabilities-fixed and mobile are vital for effective communication, especially in data collection, distress alerting, position location and coordinating relief operations in the field. In addition, search and rescue satellites provide capabilities such as position determination facilities on board which could be useful in a variety of land, sea and air distress situations.

+Table 1: Applications of Space remote sensing in Disaster management

Normal - Operational or needs very little research

Underlined - Research and development required

Bold - Requires improved observation capability

Italics - Requires improved spatial or temporal resolution

Physical geography is one of the two major branches of geography. It is the integrated study of natural environment on or close to the earth surface. It represents the core of the geographical inquiries. It has been described not as a basic science but as an integration of a number of earth and life sciences, that gives insight into the nature of man’s

environment. (1) Physical geography, thus, studies the characteristics, origin and distribution of various physical attributes of the lithosphere (geomorphology), hydrosphere (oceanography), atmosphere (Climatology) and biosphere. Of the various branches of physical geography, geomorphology the study of landforms is an important one. The word geomorphology has been derived from three Greek root words viz, 'ge' meaning earth, 'morphos' meaning shape and 'logos' meaning reason. (3) Thus, in simple terms, geomorphology is the study of configuration of the earth's surface. The earth's crust is the core of study in geomorphology. The earth is a constantly changing system which is being shaped and reshaped by a large number of earth processes, grouped under two main headings viz, endogenetic forces and exogenetic forces. These forces and resultant movements are involved in the creation, destruction, recreation and maintenance of geomaterials and numerous types of relief features of varying magnitudes. These earth processes occur at different places, at different times with different intensities. The intensity of their occurrences sometimes is so high that they cause extraordinary changes both inside and outside the earth's crust and account for huge losses to vegetation, physical land, human lives and man-made structures. The geomorphic processes having such kinds of after effects are termed as natural hazards.

A hazard is an unforeseen accident. It is an important process of hill slope modification. A hazard becomes a disaster when is upsets the feeling of security associated with a place, because of human, animal and property losses. A disaster becomes a catastrophe when it causes huge losses in terms of human life, property and natural setting. The geographical aspect of a disaster or a catastrophe lies within the destruction of settlements, habitats and disintegration of spatial order that a disaster causes. Geographical disasters take various forms including destruction of a place, a race, habitat, culture and enforced displacement.

A hazard may be caused either by natural or by anthropogenic processes. It may also be caused by the interaction between these two processes. A natural hazard occurs due to change in intensity of a natural process. Floods, cyclones, mass movements, earthquakes and volcanic eruptions are the examples of natural hazards. On the other hand, anthropogenic hazards are caused by human actions. These hazards may be either technological or social. Acidic rain, wars, nuclear hazards, diseases, subsidence and landslides are the examples of anthropogenic hazards.

LANDSLIDE AS HAZARD

Landslide is a name given for a group of particular type of rapid mass movements. A mass movement is a down slope movement is a down slope movement of soil and rock material under the influence of gravity. Mass movement comprises all gravity-included movements such as landslides, creep, avalanches, earth flows and mudflows. These are accelerated by the presence of water, ice and air. Humid regions with high relief and shattered rocks experience greatest frequencies of mass movements. They are the most important geomorphic processes of hill slope modification and comprise one of the major categories of natural hazards that have caused humanity to suffer for millennia. The velocity of mass movements may range from very rapid to very slow, as slow as imperceptible to human eyes. The slow mass movements such as creep are quite capable of producing great damages such as cracked road surfaces and building foundation, broken water mains, bending of tree trunks and telephone poles. However, it is landslides and availanches, the very rapid forms of mass movements, which are capable of sweeping away everything in their path. They occur suddenly and unexpectedly and cause huge destruction to human life and property, Because of such type of nature of landslides, they are usually known as landslides hazards.

REVIEW OF LITERATURE

Kalvoda carried out studies on the lower Himalaya of Himachal Pradesh, Garhwal and Kumaon. He concluded that the degree and extent of landslides are closely related to the causes of tectonic activity of individual massifs, complicated folding, nappe structure and quantity and duration of precipitation. Saxena while studying landslides in Himalaya, concluded that unscientific quarrying and blasting for road and dam construction along with overgrazing, over fallowing, over ploughing and deforestation are the prevailing unrationalized human interferences which cause major landslides, rock slips and debris slides.

Sahani studied the environmental challenge in the Himachal Himalaya are concluded that construction of unimaginatively planned and cruelly executed roads are the biggest factors for causing destructive landslides, which destroy forest, plants and croplands.

Verma discussed two types of landslides in Himalayan region, those affecting the bedrocks and those affecting the overburden. He suggested a Czechoslovak, which produce noise due to movement along the planes of failure and pinpoint the source.

Pal and Shah discussed the role of mass movement in land degradation and stated that the trusts and faults are still active in the Himalaya.

STATEMENT OF PROBLEM

Landslides are amongst the major problems of the Himalayan environment since times immeroial. Ugly looking repulsive wounds caused by landslide scars are seen in many parts of the Himalayan chain. Such phenomena are more frequent and hazardous along the Himalayan roads. These are incurring loss of hundreds of cores of rupees each year. They not only disrupt the transportation flow but also degrade the physical land and vegetation, damage human settlements and lead to the loss of human and animal lives.

This monography epitomizes the fact regarding the occurrences of landslides.

HYPOTHESIS

The Himalayas are extremely sensitive and active environments with landsliding a major process of hill slopes. Once disturbed, the Himalayan slopes are hard to retain. In addiction, it is arduous to identify and rank specific causes of landslides in terms of their relative importance.

The hypothesis is that landslides are physical and man-mad phenomena caused by natural and anthropogenic factors reacting to fragile physical conditions. Man and his developmental activities increase the sensitivity of the Himalayan slopes, which in turn, enhances the frequency and magnitude of landsliding processes. Man acts more like a catalyst as in a chemical reaction. In fact, natural processes virtually obscure the effects of human intervention in the Himalayan environments. Nevertheless, man's role in the process of landslides cannot be denied.

AIMS AND OBJECTIVE

Following are the aims and objectives of this monograph: -

To study the role of space technology media in addressing the disasters specially in context of Kotrupi landslide in Mandi district of Himachal Pradesh.

An attempt with also be identified the various types of landslides.

Identification of various landslide affected places along the Drang and Gumma Salt Mines of Dhauladhar Range in Himalaya.

The study of different climatic, geological and anthropogenic factors responsible for the occurrence of landslides.

COLLECTION OF DATA

Both primary and secondary data have been used for the present study. The area under study was frequently visited to study landslides occurred in the recent past. Photographs were taken and analyzed. The following field observations were made along the study highway.

Types of landslides.

Probable causes of landslides.

General Litho logic and vegetation qualities of the area.

Human development activities along the road.

Preventive measures taken.

Potential landslides sites.

A great deal of information about landslides were collected by interviewing the local residents, labourers and Engineers of Public works Department, stone crushers and glaziers at different places along the highway. Researcher consult experts report regarding kotrupi landslides in Himachal Himalaya.

Geologists, earth google map and remote sensing cell were consulted to know the geological characteristics along the highway. Along the Drang and Gumma Salt Mines of Dhauladhar Range in Himalaya.

THE STUDY AREA

Himachal Pradesh (30º 22′ 40′′ N to 33º 12′ 40′′ and 75º 47′ 55′′E to 79º 04′20′′E) is a mountainous state in the north-west India. It is known for its pristine natural beauty that includes gurgling streams, forested slopes and snow bound peaks. It has an area of about 55,673 square kilometers and a population of about 68,56,509. The state has twelve administrative districts. It is bounded by Utrakhand (a newly created hill state) in the south-east, Tibet in the north-east, Jammu and Kashmir in the north, Punjab in the west and south-west and by Haryana in the south. The entire state is mountainous with attitudes ranging from 450 meters to 7000 meters.

The state is a constituent part of the Himalyas and it entirely lies in the Western Himalayas, between river Indus in the west and river Kali in the east. The Western Himalayas comprise the states of Jammu and Kashmir (Kashmir Himalayas), Himachal Pradesh (Himachal Himalayas) and Utrakhand (Kumaon Himalayas). The Himachal Pradesh covers 17% area of the total 3,29,032 square kilometers area under the western Himalayas. Physiographically, the Himachal Himalayas have been divided into the following four sections;

The outer Himalayas or Siwaliks The
Middle or Lesser Himalayas

The Great Himalayas (also known as Himadri, Inner or Central Himalayas or Central Crystalline) The
Trans-Himalayas

CAUSES OF LANDSLIDES

Landslides are the most catastrophic geomorphic events in the mountainous areas throughout the word. However, these are natural events, but human use and interest in mountainous environments has increased the intensity and magnitude or their occurrences. Landslide debris blocks mountain roads, chokes the streams and rivers , destroys human settlements, uproots the trees and plants, deteriorates the physical land, causes siltation of river channels and reservoirs and accounts for the loss of human and animal lives. Landslides may occur at places of geological weaknesses, over steepening slopes and seismically sensitive areas but these are particularly frequent along the artificial cliffs created by the construction of roads in mountainous terrain.

The process of a landslide is complex, in which many factors, over the time, work in combination to generate landslides. The natural slope instability factors are of two types namely passive factors and active factors. Passive factors make a slope gradually more susceptible to mass movements over the time whereas active factors temporally either reduce the shear strength or increase the shear stress of slope materials, below the critical angle of repose. Thus, over steepening slopes, weakness in slope materials, absence of vegetation, undercutting by streams or rivers, weathering and cutting of hill slopes for various purposes are passive factors and strong vibrations due to earthquakes, heavy precipitation in the forms of rain and flash floods are the active factors responsible for slope failures.

Causes of landslides may group under two heads namely external causes and internal causes. Traditionally, according to the source of origin, the causes of landslides are grouped under two heading viz, natural factors and anthropogenic factors.

NATURAL FACTORS

Natural factors refer to the natural processes producing landslides by racing with natural conditions. Following are the important natural causes of landslide occurrences:-

GRAVITY

Gravity literally means weight or heaviness. Scientifically, it is the force of attraction (gravitational force) between the earth and a body on the earth's surface or in the earth's gravitational field. According to the law of gravitation, any two pieces of matter attract one another with a force that is directly proportional to the product of their masses and inversely proportional to the square of distance between them. This force, therefore, decreases with increasing distance from the earth. It is the gravitational pull by virtue of which things are attracted towards the earth.

All the mass movements are primarily the result of gravity. As discussed earlier, two opposing groups of forces are responsible for the occurrences of landslides. These are the shear strength of hill slope materials and the down slope force. The shear strength of slope material is determined by three factors namely, the normal stress, cohesion and internal friction and is a measure of their ability to resist down slope movements. Contrary to it acts a single force, which tends to move slope materials downward. This force is the down slope force or driving force that is caused by the component of gravity. The force of gravity acts parallel to the slope. This force becomes greater as slope angle increases. By definition, the increase in weight of slope materials also increases the force of gravity. Thus, other factors being conducive, landslides are caused either by the increases in angle of slopes or by the increase in weight of slope materials.

NATURE OF SLOPE

The angle of slope plays a vital role in the stability of hill slopes. Generally, steeper a slope, less stable it will be. It means that magnitude and frequency of landslides will be more on steep slopes than on the gentle slopes. Steepness of slope, in fact, controls the impact of down slope force caused by gravity. The steepest angle that can be maintained on any given slope without failure of the slope material is called the angle of repose. The angle of repose depends on the type, amount, and condition of slope materials and therefore varies from place to place. As the angle of slope increases, the thickness of unconsolidated material over slopes decreases. The processes that generate landslides by oversteepening the slopes are stream erosion, under cutting and excavation for road construction and mining activity. The steepness of slopes also decided the type of landslide. Thus, rock falls, debris falls, earth falls, topple and avalanches are associated with very steep slopes, almost vertical to vertical, whereas rock slides and debris slides occur on relatively moderate slopes.

GEOLOGY

The geological setting has three components: lithology, stratigraphy and structure. Essentially, the geomorphology of any area is created by the interplay of these three components. Lithology and stratigraphy are intimately related to each other. Lithology of an area directly influences the magnitude and frequency of landslides. The weakness of slope materials is greatly responsible for the occurrences of landslides. As a rule, loose or weak slope materials are much more prone to landslides than the consolidated hard rock . Steep or even vertical cliffs can be maintained in a relatively stable condition in massive, solid rock such as granite, limestone or basalt while poorly consolidated rocks such as shale and many types of sandstone are unable to maintain steep slopes. In general terms, rocks comprising largely of clay materials are more prone to landsliding than rocks having predominance of quartz.

It is not only lithology but geological structure also, which determines the stability and instability of slopes. Geological structure means the arrangement and disposition of the rocks in the earth‘s crust because of earth movements. Steeply inclined bedding planes, presence of joints, fissures and other zones of weakness can generate landslides even in massive hard rocks such granite or basalt. The presence of hard rock over weaker rock may cause landslide due to rapid erosion of the underlying weak rock.

VEGETATION

Vegetation is a function, of climate, soil type and topography of an area. It is intimately related to landslides. Generally, the intensity and magnitude of landslides occurrence is more in areas of less vegetation. However, sometimes, slope failures are also produced by the presence of vegetation.

As plants grow, their roots spread. The spreading of tree roots in rock fractures and fissures cause the physical weathering of rocks. The weathered material so produced acts as susceptible material to slope failures. Some types of vegetation take –up large quantities of water and add weight to steep slopes. Conifer trees, as compared to deciduous trees, have low rate of transpiration and are less capable in reducing the impact of raindrops on slope. Slopes with predominance of grass and shrubs are more sensitive to slides than slopes with large trees. The presence of grass and shrubs tremendously increases the amount and rate of infiltration of water, which adds weight to slope materials. This weight is sufficient on their shallow roots to hold them back.

A bare land, in very few cases, may reduce the frequency of occurrences of landslides but, on the other hand, it will increase grain-by –grain erosion of topsoil layer. In short, it can be said that vegetation may also help in generating landslides.

EAETHQUAKE TREMORS

The natural shaking of Vibration of the earth caused by sudden adjustments in the crust of earth is called an earthquake. During an earthquake, a series of waves spread outward from the epicenter, the point on earth's surface that is perpendicular to the focus of earthquake. An earthquake is caused by various processes such as folding or faulting in the earth's crust, eruption of a volcano, gaseous expansion and contraction within the earth, hydrostatic pressure or man – made water bodies like reservoirs or lakes and plate movements.

Landslides due to earthquake tremors are very common in hilly areas. The mountainous areas, composed of weaker lithologies, are tectonically sensitive. Even slight tremor of an earthquake is capable of producing huge landslides and consequent damages in these areas. The earthquake vibrations reduce the cohesive strength of rocks and earth materials. The reduction is so rapid and considerable that rocks or earth materials at once get detached from their parent body and move downward rapidly, thereby generating landslides. The joints, fractures, fissures and faults are the zones of weaknesses along which separation of rocks take place.

CLIMATE

Climate is the average weather conditions of an area, based on many years of observations. Climate determines the extent and type of precipitation and moisture content of slope materials. Climate also influences the type of landslide. For example, avalanches are common in snow-dominated areas whereas landslides, mudflow and earth flows are more common in areas of high rainfall. Other climatic variables such as temperature and humidity determine the rate of weathering. Weathered material provides potential material for the occurrence of many types of mass movements. Water from rain or receding of glaciers causes saturation of earth materials. The pore water pressure is developed in the materials that decreases shear strength and increases the weight of slope materials. The net effect is the occurrence of landslides.

RIVER EROSION

It is continuous process by which river water erodes and thereby steepens the toe of a slope. It removes the underlying support of slope materials. As a result, the shear strength of slope decreases which results into slope failures in the form of landslides.

FLASH FLOODS

Flash floods are resulted from heavy rain in the catchment area of a river. The high velocity moving water during flash floods generates landslides in two ways.

Firstly, it erodes riverbanks extensively. AS a result of it, slopes become steeper and slope materials are left unsupported. It leads to the storage of riverbanks. After flash floods, when water level suddenly drops, the water stored in banks is left unsupported.

Secondly, it leads to the storage of riverbanks. After flash floods, when water level suddenly drops, the water stored in banks is left unsupported. This stored water on the hand enhances the down slope forces and on the other hand reduces the shear strength by developing an abnormal pore water pressure. These two phenomena produce landslides in the form of bank failures.

ANTHROPOGENIC CAUSES

A number of landslides have been caused by the artificial changes made by man in adverse geologic conditions and weak slope materials. It is essentially man's action that upsets the natural balance along the highways and leads to land sliding. The following human activities are responsible for the occurrences of landslides:

CONSTRUCTIONAL ACTIVITIES

Man, through his developmental activities such as construction of buildings, dams and roads have changed the mountain environments enormously. This interference by man with the natural setting has generated many landslides, especially along the highways.

Any constructional activity in a hilly terrain either require deep back cutting or down cutting of hill slopes. The cutting in areas of hard rock is done with the help of explosives, which produce an internal disintegration in the rock body. It also reactivates the older geological faults and widens the joints and fissures present in the rock strata. The construction

on slopes also leads to the cutting of vegetation. The disturbance in the natural setting of slopes, supported by climatic agents such as precipitation and temperature, produce landslides.

Construction of roads, multi-storied buildings and dams to produce hydroelectricity or to store water for irrigation, are important constructional activities of man that are generating landslides in hilly areas. Explosives are extensively used during such activities. Most of the time, it becomes imperative to cut down vegetation.

The construction of roads is the most important cause of landslides in hilly terrain. The deep back and vertical cutting is carried out to construction a road. Sometimes, the cutting is made against the geological structure of the area. The cutting done through the natural alignment of rocks render them unsupported and result in landslides. The construction of multi-storeyed buildings and dams create stress on slope materials by increasing the weight on soil or rock strata.

This increased stress may generate landslides and can cause failure of the dam or destruction of the building.

MINING AND QUARRYING

The deep excavation in the earth by underground workings, in order to extract minerals is termed as mining whereas quarrying is an open excavation on the surface of earth to extract rocks and other nonmetallic minerals. Mining produces hollows in earth's interior. Quarrying involves the removal of vegetation and topsoil layer. The use of explosive is made on large scale in both of these processes. The hollowness created by the mining of minerals leads to the topple of overlying materials. In addition, the cutting made through the steeply dipping rocks, produce landslides.

THE REMOVAL OF VEGETATION

The roots of trees and shrubs from a web-like structure or network. This network of roots holds the slope materials together by providing cohesion to slope materials. The extra amount of water present in slope materials is transpirated by vegetation. It also retards the grain-by-grain erosion of the soil by reducing the impact of falling rain.

The cutting of vegetation reduces the rate of transpiration. It increases soil moisture and adds weight to slope materials. In the absence of vegetation, rain directly falls on the surface. It breaks the soil structure and causes soil erosion. The erosion of soil leads to siltation of streams and river beds. Many a times temporary lakes or reservoirs are formed along the course of stream or river. The out break of these temporary reservoirs causes flash floods downstream, which are largely responsible for failure of river and stream banks. In addition, the roots of denuded trees decay with time. Their decay lessens the strength and cohesion of soils and slope-failures are caused.

AGRICULTURAL PRACTICES

Agricultural practices include all activities related to cultivating the soil and rearing or livestock. Man prepares terraced fields by leveling the hilly terrain in order to grow cereals, vegetables and other crops. It disturbs the natural slope setting. The repeated ploughing in terraced fields loosens the soil structure. Consequently, more and more water percolates through the pores of the soil. This percolated water produces landslides either by adding weight to the slope materials or by contributing to the process of weathering of underlying rock strata. Animals graze and damage the seedling and saplings of plants and grasses. They also damage soil structure. It reduces the percolation capacity of soils. The surface run-off increases, which washes away the topsoil layer. As a result, bedrock is exposed to the direct action of weathering agents. These weathered strata provide potential material for landsliding. Also, lopping of trees and shrubs for fuel, fodder and small timber reduces vegetation cover and thereby the cohesion of slope materials.

To conclude, landslides are very rapid forms of mass movements in which displacement of slop materials takes place primarily by falling or sliding. The sensitivity of a slope to slope failure is determined by the strength of two opposing groups of forces acting on it. In general, landslides are triggered by active factors. Landsliding is a natural process but human interference in the natural environment has increased its frequency and magnitude of occurrence.

ROLE OF SPACE MEDIA IN LANDSLIDES

Aerial photographs and large scale satellite images have been used to locate the areas which incidence of landslide. Higher spatial resolution and stereo imaging capability of IRS=IC and ID enable further refining the location and monitoring of landslides. A number of studies have been carried out in India using satellite data and aerial photographs to develop appropriate methodologies for terrain classification and preparation of maps showing landslide hazards in the Garhwal Himalayan region, Nilagiri hills in south India and in Sikkim forest area. Such studies have been carried

out using mostly aerial photographs because of their high resolution enabling contour mapping with intervals of better than 2m in height. The availability of 1 m resolution data from the future IRS missin may help generating contour maps at 2m intervals making thereby space remote sensing a highly cost effective tool in landslide zonation.

Analysis:

Event id: 4-LS-2017-Himachal Pradesh

Version-2 (15 Aug 2017)

KOTROPI LANDSLIDE, MANDI DISTRICT, HIMACHAL PRADESH

(A Preliminary report)

National Remote Sensing Centre/ISRO, Hyderabad

Date of occurrence: 13 August 2017

Background: A massive landslide occurred near the village of Kotropi, (near Kotropi Bus Stop), in Mandi District of Himachal Pradesh, on Sunday, 13th of August, 2017. The landslide occurred on National Highway 154, the road between Mandi and Pathankot (figure 1). Media reports suggest that a section of the slope collapsed totally and two buses of Himachal State Transport along with few other vehicles were buried under the debris. As of now, news reports suggest that there have been 47 fatalities from the incident. Around 300 m of the highway has been completely buried under debris, thus cutting of communication on a very important road.

. Figure 1: Kotropi landslide (Source: News World India)

Geological Assessment: Geologically the area is in a thrusted contact (Main Boundary thrust) between the Siwaliks and the Shali Group of rocks consisting mainly of dolomites, brick red shale, micaceous sandstones, purple clay and mudstones (source: GSI, 50k Geological Map). The hardness of these rocks are in general less and further they have been subjected to deformation by the thurst in the area, making them highly prone to landslides. Lineaments were mapped from the satellite image. Deep incision of the tributaries suggests that some of the lineaments could be neotectonically active since there are near to the main boundary thrust that separated Siwalik groups from lesser

Himalayan rocks

. Satellite-based landslide disaster assessment: Pre-event LISS IV data (dated 24 March 2017) of the area shows the presence of two existing landslide scars on slope (figure 3). This indicates that the slope was unstable and was prone to a failure. Post-event satellite data over the landslide affected area were acquired by ISRO on 15 August 2017 through emergency payload programming of Resourcesat-2 satellite. Analysis of Resourcesat-2 LISS-IV FMx (5.8 m) shows the occurrence of a large landslide in the area where old landslide was observed in the pre-event satellite data. The landslide is a 'debris flow' type. It has a long runout which clearly suggest the heavy rainfall is the main cause of its occurrence. The width of the landslide is 190 m and the run out length is 1155 m.

Figure 3: 3D perspective view of the Kotropi landslide. LISS-IV FMx image is draped over 10m CartoDEM

CONCLUSION

Apart from loss of human lives, disasters inflict severe damage to ecology and economy of a region. Space technology has made significant contribution in all the three phase, i.e. preparedness, prevention and relief of disaster management. With a constellation of both INSAT and IRS series of Satellities, India has developed on operational mechanism for diaster warning especially cyclone and drought, and their montoring and mitigation. However, predication of certain

events likes earthquake, volcanic eruption and flood is still at experimental level. Develoments in space-based earth observation and weather watch capabilities in future may help refining existing models/ approaches for prediction of such events and their management.

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DisasterPreventionPreparedness (Warning)Relief

EarthquakesMapping geological lineaments land useGeodynamic measurements of strain accumulationLocate stricken areas, map damage

Volcanic eruptionsTopographic and land use mapsDetection/measurement of gaseous emissionsMapping lava flows, ash falls and lahars, map damage

LandslidesTopographic and land use mapsRainfall,slope stabilityMapping slide area

Flash floodsLand use mapsLocal rainfall measurementsMap flood damage

Major floodsFlood plain maps; land use mapsRegional rainfall;evapotranspirationMap extent of floods

Storm surgeLand use and land cover mapsSea state;ocean surface wind velocitiesMap extent of damage

Hurricanes Synoptic weather forecastsMap extent of damage

Tornadoes Nowcasts; local weather Local weather observationsMap amount, extent of damage Drought
Long ranged climate modelsMonitoring vegetative biomass;