Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), vol 12, special issue. 2024
http://dx.doi.org/

Chapter 5

Landslides disaster in India, mitigation and their impacts

Desastre por deslizamiento de tierra en la India, mitigación y sus efectos

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ABSTRACT

Landslides are natural disasters. This landslide disaster keeps on coming in India as well as in other countries. The main causes of this disaster are rifles, sunafal, earthworks, volcanic eruptions, mining, working, road cutting, construction of houses, and deforestation. Its types are Fall Landslides, Tappal Landslides, Slides, and Spreads. Many areas of India have been affected due to landslides, mainly in Assam, West Bengal, Uttarakhand, Maharashtra, Kerala, etc. From 1948 to 2020, many people have lost their lives. In 2020, Assam's landslides have claimed 80 lives and also caused economic losses. India's landslide zones are divided into five parts namely Very High Hazard, High Hazard, Moderate / Moderately High Hazard, Low Hazard, and Very the flame is a hazard. Landslides have killed ~500 in 1948, ~400 in 1998, 67 in 2000, 5700 in 2013, and 80 in 2020. In this review, the causes, types, damage, management, and mitigation of landslides, etc. have been discussed in detail.

Keywords: Landslides, causes, zones in India, impacts, management, and mitigation.

RESUMEN

Los deslizamientos de tierra son desastres naturales. Este desastre de deslizamiento de tierra sigue ocurriendo en la India, así como en otros países. Las principales causas de este desastre son los fusiles, los aserraderos, los terremotos, las erupciones volcánicas, la minería, el trabajo, el corte de caminos, la construcción de viviendas y la deforestación. Sus tipos son Fall Landslide, Tappal Landslide, Slides y Spreads. Muchas áreas de la India se han visto afectadas por deslizamientos de tierra, principalmente en Assam, Bengala Occidental, Uttarakhand, Maharashtra, Kerala, etc. Muchas personas han perdido la vida desde 1948 hasta 2020. En 2020, los deslizamientos de tierra en Assam se cobraron 80 vidas y también causaron pérdidas económicas. Las zonas de

deslizamientos de tierra de la India se dividen en cinco partes: peligro muy alto, peligro alto, peligro moderado/moderadamente alto, peligro bajo y peligro de llamas muy alto. Los deslizamientos de tierra han matado a 500 en 1948, 400 en 1998, 67 en 2000, 5700 en 2013 y 80 en 2020. Esta revisión analiza las causas, los tipos, los daños, el manejo y la mitigación de los deslizamientos de tierra. descripción.

PALABRAS CLAVE: Deslizamientos en India, causas, área, efectos, manejo y mitigación.

INTRODUCTION

Landslides, mass movements of rocks, debris, or earth along a slope are natural processes that have shaped much of the earth's landscape. However, with the increase of human settlements in unstable terrain, landslides pose a more serious threat to humans than ever, with an estimated 5,000 deaths per year [1]. Landslides occur when downward forces, including gravity, overcome the cohesive forces that hold the earth's mass together, and failure of the material that forms the slope occurs. Several factors contribute to the occurrence of landslides - geological factors such as weak, sensitive, and shear material, presence of cracks and joints, and contrasts of permeability or stiffness of the slope-forming material; morphological factors such as tectonic uplift, glacial rebound, and erosion of the slope or big toe; physical factors such as heavy rainfall, rapid snow melt and earthquakes; and anthropogenic factors such as mining, deforestation and the excavation of the hill or peak [2]. This information sheet describes and illustrates the various types of landslides and how one can recognize them and their related features in the field. Landslides are part of a more general erosion or surficial process known as mass wasting, which is simply the down slope movement of earth or surface materials due to gravity. They are classified into four main types: fall and toppling, slides (rotational and translational), flows, and creep [3]. Landslides are widespread, frequent, and sudden hazards that strike human lives, livestock, livelihood, living places, and the environment in an adverse manner leading to colossal losses and damages directly or indirectly in a cumulative way. The present paper is an attempt to compile the information related to the incidents and impacts of landslides in terms of their location, time of occurrence, and losses/damage caused to humans, habitations, and highways [4].

Figure: 1 The Photograph of Okhimath landslide which formed a lake in Madhyamaheshwar Ganga, Rudraprayag district.

Source: https://ndma.gov.in/Natural-Hazards/Landslide

CAUSES OF LANDSLIDES

The major causes of landslides are:

1. Rainfall and Snowfall: The occurrence of heavy or prolonged rainfall can lead to severe landslides in steeply sloping areas where highways and state roads have been built. The Nashri area between Batote Ramban-Ramsu and Banihal (Jammu and Kashmir) is often prone to landslides. Landslides in this region are particularly severe during the rainy and winter seasons when car traffic is interrupted for several days [6].
2. Earthquakes and Volcanic eruptions: Earthquakes are the main cause of landslides in folded mountain areas. In India, landslides are more common in folded Tertiary mountains, such as the Himalayas. In the Kashmir Valley, the 1905 earthquake caused landslides in the minor and major Himalayas, killing several thousand people. Volcanic eruptions also cause landslides in mountainous areas [6].
3. Mining, Quarrying, and Road Cutting: The continuous extraction of coal, minerals, and stones from mines and quarries and the development of roads by eroding the steep slopes of the folded mountains create favorable conditions for the occurrence of landslides ground. Such landslides can be observed throughout the Himalayas and in the Eastern and Western Ghats [6].
4. Loading by the construction of houses: The unplanned growth of towns and cities in the hilly areas without testing soil and rocks is also an important cause of landslides. The eastern slope of Nanital (Uttarakhand) is sinking because of the heavy load of hotels and residential structures [6].

5. Deforestation: Deforestation and other human activities also cause landslides. Most landslides are small with a few blocks to a few meters wide. But some are big enough to wreak havoc. They can bury roads, buildings and other structures. The negative impact of landslides can be reduced by controlling deforestation on mountain slopes, following building codes for such areas and avoiding the construction of buildings on steep slopes [6].

TYPES OF LANDSLIDES

They can occur for various reasons. We can classify them into four categories mentioned below:

1. Falls Landslides- It means falling of some material or debris or rocks etc., from a slope or a cliff which leads to a collection of this debris at the base of the slope [7].
2. Topple Landslides- These can occur due to some fractures between the rocks and the tilt of the rocks due to gravity without collapsing. Here we see the forward rotational movement of the material [7].
3. Slides- It is a kind of landslide when a piece of the rock slides downwards and gets separated from it [7].
4. Spread- It happens on flat terrain and gentle slopes and can occur because of softer material [7].

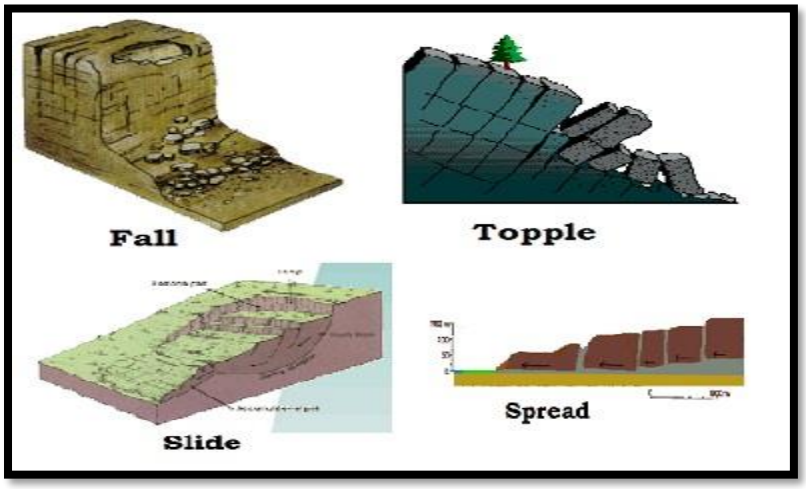

Figure: 2 Types of Landslides

Source: https://lotusarise.com/landslide-types-causes-impact-remedial-steps-upsc/

CONSEQUENCES OF LANDSLIDES

The loss of irreplaceable human and animal lives is the most devastating effect of a landslide. There are now 14 verified deaths from the latest Kinnaur landslide. Movement is limited because mud, rocks, and debris sliding down the hill form a barrier on major traffic corridors such as highways and railway lines [8]. This restricts the movement of products and people. Damage to Infrastructure: When a landslide occurs, various houses,

buildings, roads, and other infrastructure are affected. Economic losses: A large amount of money is spent to rebuild infrastructure, rehabilitate the masses and provide assistance to those affected. Threatening Water Availability: When landslides occur on the slopes of a river valley, the sliding materials can reach the valley floor and partially or completely block the river channel. A landslide dam is a mound of avalanche debris that has accumulated and blocked a river. This can reduce the amount of water available to surrounding residents [8].

IN RECENT YEARS, INDIA HAS SOME SERIOUS AND DEADLY EARTH BUTS. HERE IS A LIST OF THE WORST COUNTRIES YOU NEED TO KNOW:

1. Guwahati landslide, Assam:The landslide occurred on September 18, 1948, due to heavy rains. More than 500 people died in the landslide and, according to reports, the landslide buried an entire village [9].

2. Landslide in Darjeeling, West Bengal: The landslide occurred around 4 October 1968. The landslide was caused by floods and the 60km highway was cut into 91 sections. Thousands of people died in the landslide, according to reports [9].

3. Landslide Malpa, Uttarakhand: Between 11 and 17 August 1998, successive landslides occurred in the village of Malpa, killing over 380 people when the entire village was swept away by the landslide. The landslide is one of the worst landslides in India [9].

4. Landslide in Mumbai, Maharashtra: The landslide was triggered in July 2000. The landslide occurred on the outskirts of Mumbai due to heavy rain followed by soil erosion. According to reports, around 67 people died and local trains were also hit [9].

5. Amboori landslide, Kerala: The landslide was known as the worst landslide in the history of Kerala. The landslide occurred on November 9, 2001, due to heavy rains and about 40 people died in the accident [9].

6. Kedarnath landslide, Uttarakhand: The landslide occurred on June 16, 2013, and was the result of flooding in Uttarakhand. More than 5,700 deaths have been reported and more than 4,200 villages have been affected by floods and landslides following the floods [9].

7. Malin landslide, Maharashtra: The landslide occurred on July 30, 2014, in a village in Malin. The landslide happened due to heavy rains and about 151 people died and 100 people went missing after the disaster [9].

Table: 1 Data on socio-economically significant landslides between the years 2020 and 1948.

S. No.	Location	Month / Year	Damage
1.	Pettimudi, Kerela	6 August 2020	80 people died, and many casualties occurred
2.	Kuwari, Uttarakhand	10 March 2018	Kuwari landslide in Uttarakhand
3.	Kotrupi, Himachal Pradesh	13 August 2017	More than 50 people died, 40 were missing, and there were severe casualties
4.	Karimgang, Hilakandi, Assam	18 May 2016	More than 50 people died and caused severe damage to agricultural land, cattle, and properties.
5.	Malin, Maharashtra	30 July 2014	151 people died, and more than 100 were missing
6.	Kedarnath, Uttarakhand	16 July 2013	5700 people died, and 42,00 villages were affected
7.	Daur Gaon, Narendranagar block, Tehri district	11 Sept 2011	6 members of a family were killed and 4 houses collapsed
8.	Tamenglong, Manipur	6 July 2011	6 killed 7 injured, and NH-53 closed
9.	Chamoli	30 June 2011	10 killed, Rishikesh-Badrinath closed
10.	Khurong Kewa Dara along Peling Dentam road, 15 km away from Geyzing, Tikjuk, and lower Pelling, West Sikkim	23 June 2011	16 persons have been killed in multiple slides due to torrential rains b/n 8:30 pm and 11 pm, collapsing the entire connectivity, power, and water supply
11.	Upper Siang Distt, Arunachal	4 Oct 2010	10 dead (8 dead in the collapse of a house in the village of Moïse), houses buried
12.	Almora	19 Sept. 2010	31 died and 7 injured

13.	Nainital	18 Sept 2010	8 killed
14.	Avalbagh block, Almora district	18 Sept 2010	6 killed 14 injured
15.	Leh Distt, J&K	5/6 Aug 2010	145 killed, hundreds missing, village washed away, >25,000 people affected and became homeless
16.	Ratnagiri, Maharashtra	19 Jun 2010	8 killed, and 2 houses damaged
17.	Dibang valley, Arunachal	22 Apr 2010	12 killed, and communication lines were cut off
18.	Gulmarg, J&K	8 Feb 2010	17 killed in an avalanche
19.	Udhagamandalam (Ooty), TN	10 Nov. 2009	43 killed, 600 houses destroyed, 1100 people homeless
20.	Madibagh of Kadwad in Karwar taluk, Uttara Kannda distt, Karnataka	2 Oct 2009	24 killed, 9 houses collapsed, and NH-17 was blocked. In total 21landslide occurred on that day in the Karwar hills
21.	Kurseong, Darjeeling	16 Aug 2009	9 killed 2 injured 500 houses damaged
22.	Nachni, Pithoragarh	8 Aug 2009	43 killed, and 3 Villages Nachni, La, and Jhekla were completely buried under landslides
23.	Kurseong, Darjeeling	28 May 2009	27 killed, 500 houses damaged
24.	Kurseong, Darjeeling	26 May 2009	10 killed 23 injured
25.	Itanagar	30 Oct 2008	12 killed 150 houses were damaged, and rail and road links damaged
26.	Shimla, HP	21 Sept 2008	42 killed, 13 houses collapsed and the road caved in
27.	Himachal Pradesh	15 June 2008	16 killed and 6 injured
28.	Itanagar, Arunachal	14 June 2008	14 killed 30 injured, and road links blocked
29.	Market Colony, Zunheboto	2008	52 houses were destroyed in 5 locations
30.	Nehrukund, Manali	18 Mar 2008	25 Killed, Manali-Leh highway blocked
31.	Jammu Srinagar NH	8 Feb 2008	25 killed in an avalanche
32.	Uri, J&K	10 Jan 2008	15 killed due to avalanche
33.	Dharla village, Shimla	30 Sept 2007	53 killed

34.	Tehri district	23 Sept 2007	19 killed 20 injured
35.	Kalimpong, Darjeeling	7 Sept 2007	8 killed, 44 houses and 80 dwelling units damaged
36.	Pitthoragarh district, UK	6 Sept 2007	14 killed
37.	Sangla-Chittkul, Tangling-Purnavi near Recong Peo in Kinnaur and Ghanvi-Ladana-Sudana and Ghanvi-Pancha in Rampur sub-division of Shimla district	15 Aug 2007	65 killed, 14 houses destroyed and 13 damaged
38.	Shimla, HP	15 Aug 2007	Several were killed (~100), 96km Kalka-Shimla rail route damaged
39.	Kerala	18 July 2007	22 killed, 4500 homeless
40.	Devpuri village, Chamoli distt, UK	12 July 2007	8 killed
41.	Calcutta, West Bengal	3 July 2007	8 killed
42.	Kollam, Kottayam, Kannur, Ernakulum & Kazhikode distts., Kerala	24 June 2007	13 killed
43.	Wayanad, Kerala	15 June 2007	5 killed, 2 injuries/missing, 265 houses and crops lost amounting to an economic loss of Rs.8.5 Lakh and 6.5 Crore
44.	Manning slide, South Sikkim	24 Sep 2005	7 killed and 28 families evacuated
45.	Maligaon Petrol Pump, Nilachal Hill, Assam	24/25 Aug 2005	12 persons died, injured many, and caused heavy damage to buildings and huts
46.	Govindghat, Joshimath	Aug 2005	11 killed
47.	Vijaynagar, Rudraprayag	22 July 2005	9 killed
48.	Dragon slide, Raigad district, Maharashtra	26 July 2005	190 killed
49.	Mokokchung Debris Avalanche	26 May 2005	14 persons were killed, 50 injured, 4 houses destroyed and 35 damaged
50.			11 people were killed, 5 houses destroyed

	Darjeeling, West Bengal	July 2003	and 6 people were missing, when heavy rains lashed the eastern Indian hill station of Darjeeling on July 8, 2003
51.	Budhakedar and Khetgaon Landslide, Bal Ganga Valley, Tehri	10 Aug 2002	29 people killed
52.	Amboori village	9 Nov. 2001	38 people died and 4 houses were destroyed, damaged rubber plantation
53.	Mumbai, Maharashtra	10 July 2000	67 people died
54.	Photo and Byung Gad Landslides, Chamoli	17 July 2001	21 dead and several houses damaged
55.	Ukhimath, Rudraprayag	16 July 2001	28 persons killed
56.	Barua Bhenti slide UK	19 Sept. 1998	15 people died, and several livestock were killed about 8 km north of Okhimath along the left bank of the Madhmaheshwar river
57.	Madhya Maheshwar, Rudraprayag	17 Aug 1998	40 persons were killed and 10 livestock lost
58.	Malpa Landslide, Kali River	17/18 Aug 1998	Destroyed village of Malpa with more than 210 dead
59.	Ukhimath Landslide blocked the Madhyamaheshwar river (a tributary of Mandakini)	12 August, 1998	109 deaths and 1908 families from 29 villages were affected and 820 houses damaged
60.	Gangtok and its suburbs, Chandbari< tathangchen, Zero point, Gangtok Bhusuk Road	8 June 1997	50 people were killed and damaged a large number of houses were. Killed a constable on duty and destroyed the institute of cottage industries and numerous vehicles. About 20 minor and major landslides occurred. In Changey Tar Busty, 1 died and several houses and other properties destroyed
61.	Ratauri, Pithoragarh	July 1996	16 killed
62.	Lugar Bhatti slide,	12	65 people died about 2km north of Kullu

	Kullu, Himachal Pradesh	September 1995	along the left bank of the Beas river
63.	Deorali, Gangtok	1995	30 people were killed and huge damages to properties
64.	Aizwal, Mizoram	May 1995	25 deaths and roads damaged
65.	Varundh Ghat, Konkan Coast	June 1994	20 killed, breaching of Ghat road up to 1km at several places
66.	Kohima, Nagaland	August 1993	500 people died, Several were injured and about 200 houses were destroyed; about 5km road stretch was damaged
67.	Kalimpong, West Bengal	August 1993	40 deaths and heavy loss of property
68.	Hlimen Slide, Aizawl	9 Aug 1992	66 killed and 17 houses destroyed
69.	Gopeshwar, Chamoli	16 Aug 1991	36 killed and 26 livestock lost in 6 villages
70.	Assam	July 1991	300 deaths, damage to roads and buildings worth millions of rupees
71.	Nilgiris	October 1990	36 deaths and several injured. Buildings, roads damaged and communication disrupted
72.	Syari and Deorali, Gangtok	1990	25 dead and considerable loss of property, especially in the army staff
73.	Soldan Khad slide HP	1988	Flashflood in Soldan that killed 32 persons and 35 cattle, 200m road damaged on NH-22
74.	Kapkot, Bageshwar	Aug 1984	9 killed
75.	Ukhimath Landslide	1979	39 persons killed
76.	Tuensang slide, Nagaland	1973	10 persons killed
77.	Dobata, Dharchula	19 July 1971	12 killed, and 37 buildings damaged
78.	Chamoli district	20 July 1970	A landslide formed an artificial lake in the upper Alaknanda River watershed; 101 villages were affected, >100 people were killed and 142 animals perished; about 36 vehicles drowned by flash floods; Chamoli

			district headquarters were vandalized then moved to Gopeshwar
79.	Darjeeling and West Bengal	1968	More than 1000 people died, and a 60km highway was broken into 91 parts
80.	North District, Sikkim	1967	65 GREF workers killed
81.	Guwahati Assam	18 September 1948	500 people died, and an entire village was buried under it

Source: [4, 10]

LANDSLIDE ZONES IN INDIA

Landslide zones in India are divided into the following areas: -

Moderate-Low Vulnerable Landslide Zones: Trans Himalayan region, Spiti of Himachal Pradesh, Aravalli Mountains, Deccan Plateau, Chhattisgarh, Jharkhand, and Odisha [10].

High Vulnerable Zones: Northeastern region, Eastern Ghats, Konkan Hills, and Nilgiris [10].

Very High Vulnerable Zones: Andaman and Nicobar Island, Western Ghats, Darjeeling, Sikkim, and Uttarakhand [10].

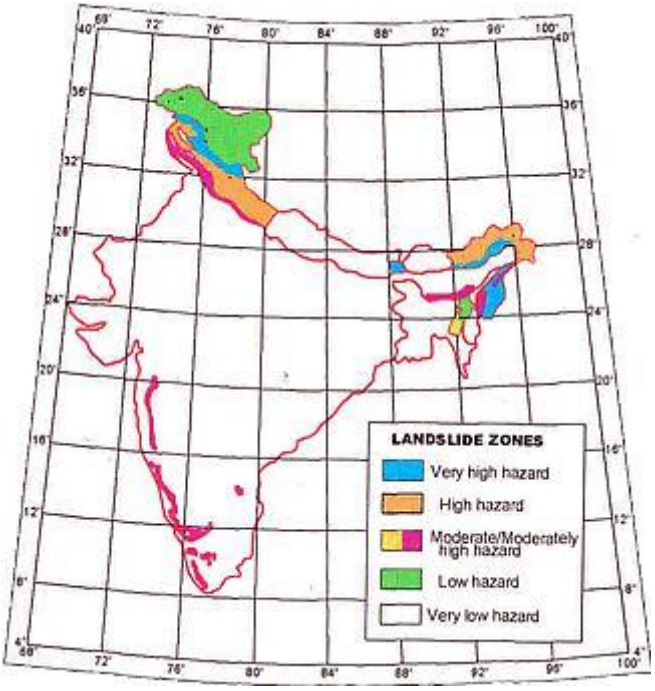

Figure: 3 landslide zones in India

Source: https://ndma.gov.in/Natural-Hazards/Landslide

MEASURES REQUIRED TO PREVENT LANDSLIDES

Take the following necessary steps to control landslides in India:

- Increased forest cover is a must on community land to reduce the risk of landslides.
- People must store excess water in catchment areas.
- It will reduce the effect of flash floods and also restore groundwater levels.
- People should limit the grazing of their animals.
- Also, reduce urbanization activities such as dam construction or other commercial projects.
- There is a need to implement public awareness of landslide prevention measures and other risk management methods [10].

IMPACTS OF LANDSLIDES

Huge losses of life and property

a) Guwahati Landslide (1948)- 500 deaths
b) Malpa Landslide (Uttarakhand, 1998)- around 400 deaths
c) Mumbai Landslide (2000)- 67 deaths
d) Kedarnath (2013) - over 5700 reported deaths and 4200 villages were affected [11].

The decimation of infrastructure: The forced flow of mud, debris, and rock from a landslide can cause severe property damage. Infrastructure such as roads, railways, recreational destinations, buildings, and communication systems are often decimated by a single landslide [11].

Impact on river systems: Materials that slide down can enter rivers and block their natural flow. Realistic river fish can die due to disruption of natural water flow. Communities that depend on river water for household chores and irrigation will suffer when the water flow is blocked [11].

Landscape beauty is affected: The erosion left behind by landslides leaves behind rugged landscapes that are unsightly. The pile of material that comes downhill can cover land utilized by the community for agricultural or social purposes [11].

LAND MANAGEMENT IN INDIA

- Landslide management in India has been very ad hoc with solutions to site-specific problems and the implementation of immediate corrective actions, including debris removal and dumping of debris on a slope or river.

- The NDMA 2009 has published the guidelines for the management of landslides. Consequently, the key components of landslide management are:
- Following the Malpa accident, the government set up a landslide hazard zone (LHZ) task force, geotechnical survey, and land use zoning and regulation.
- The Geological Survey of India (GSI) has received the responsibility of a focal point for LHZ and the Ministry of Science and Technology (DST) and the Ministry of Environment, Forests and Climate Change (MoEFCC) have been identified as two task forces respectively as focal points for the rest.
- The GSI is the leading body for monitoring and mitigation of landslides.
- • Landslide Hazard Atlas of India with Small Scale Maps was published in 2004 jointly by Building Materials and Technology Promotion Council (BMTPC) and Anna University.
- Since 2014-2015, GSI has initiated and implemented a national landslide sensitivity mapping program at the macro scale (1:50,000) National Landslide Sensitivity Mapping (NLSM) to cover the 0.42 million square kilometers of landslide-prone areas [11].

THE ISSUES IN LANDSLIDE MANAGEMENT IN INDIA

- The CAG reported the lack of communication systems during the Uttarakhand landslides, which exacerbated the problems.
- The question of coordination and management at different levels remains.
- Proper interpretation of weather forecasts is still lacking.
- The improper development of the hill area, including the unscientific construction of roads, tunnels, and hydroelectric projects, seriously undermines the natural balance of the structures.
- Illegal interventions in watercourses are still not contained by appropriate measures.
- The tourism economy weighs far above sustainable development in decision making.
- A weak environmental impact assessment regime is partly responsible for increasing problems.
- Lack of resources for mitigation and prevention measures is another concern.
- Whenever a major disaster occurs, the first few hours are lost by calling the NDRF.
- The local and provincial SDRF is not sufficiently formed to face major disasters.
- There is a lack of scientific analysis of landslide events and inventory data analysis, resulting in recurring errors [11].

MITIGATION STRATEGY

In addition to monitoring and early warning systems at selected locations, danger zones need to be identified and species slides stabilized and managed. Hazard mapping should be carried out to locate areas often prone to

landslides. It is always advisable to take area-specific measures to combat landslides. Restriction of construction and other development activities such as roads and dams, confinement of agriculture to valleys and areas with moderate slopes, and control of large-scale settlement development in areas with a high risk must be applied. NDMA Landslide Guidelines - Landslide Hazard, Vulnerability and Hazard Assessment Conceptualizing Multiple Hazards Landslide Remediation Practice Research and Development, Monitoring and Early Warning Networking and Knowledge Management Capacity building and training Public awareness and education Emergency preparedness and response Regulation and enforcement [6].

CONCLUSION

A landslide is a natural disaster. This landslide disaster keeps on coming in India as well as in other countries. Many areas of India have been affected by landslides, mainly in Assam, West Bengal, Uttarakhand, Maharashtra, Kerala, etc. Many people have lost their lives from 1948 to 2020. Landslides killed 500 people in 1948, 400 in 1998, and 67 in 1998. 2000. 5700 in 2013 and 80 in 2020. The government should monitor landslides. Awareness is essential to avoid landslides. To make people aware of the use of landslide avoidance. Rescue operations should be carried out immediately in case of landslides so that there is no loss of life and property.

REFERENCES

1. Petley, D. N., Dunning, S. A., & Rosser, N. J. (2005). The analysis of global landslide risk through the creation of a database of worldwide landslide fatalities. In *Landslide risk management* (pp. 377-384). CRC Press.
2. Cruden, D. M., & Varnes, J. D. (1996). Landslide types and processes. Landslides: investigation and mitigation, transportation research board (National Research Council).
3. Ministry of lands and mineral resources,https://www.mrd.gov.fj/images/Brochures/Types_of_Landslide.pdf
4. Parkash, S. (2011). Historical records of socio-economically significant landslides in India. *Journal of South Asia Disaster Studies*, *4*(2), 177-204.
5. https://ndma.gov.in/Natural-Hazards/Landslide
6. Lotus Arise, (2021). https://lotusarise.com/landslide-types-causes-impact-remedial-steps-upsc/
7. Vedantu, https://www.vedantu.com/geography/landslide
8. https://prepp.in/news/e-492-landslides-in-india-impacts-and-management-explained-pointwise
9. https://www.indiatoday.in/education-today/gk-current-affairs/story/landslides-india-283441-2015-07-20
10. https://www.godigit.com/guides/natural-disasters/landslide-prone-areas-in-india
11. https://www.iasexpress.net/landslides-in-india/

Received: 11th November 2022; Accepted: 20th April 2023; First distribution: 25th April 2023