VIDYASAGAR UNIVERSITY

Report On

Landslide and Its Causes, Consequennces & Management :
A Study in Some Parts of Sikkim Himalayas

B.SC HONOURS (GEOGRAPHY)
SEMESTER - VI

REG. NO :- 1520135 OF 2020 - 2021

ROLL NO :- 1126152 - 200009

SESSION :- 2022 - 2023

Phone: 9434023761 / 9732960309

SWARNAMOYEE JOGENDRANATH MAHAVIDYALAYA
Govt. Aided General Degree College | Estd.: 2014
P.O.: Amdabad, P.S.: Nandigram, Dist.: PurbaMedinipur, PIN 721650
www.amdabadcollege.in | Email: sjmahavidyalaya@gmail.com

Certificate

To whom it may concern

This is to certify that Paresh Senapati,
Roll 112612 No. 200009 Registration No. 1520135 of 2020-2021
student of B. Sc., Sem-VI, Geography Honours of Swarnamoyee Jogendranath Mahavidyalaya for the session 2022-23; submitted his/her project report entitled as Landslide and its causes, consequences and management : A Study in some Parts of Sikkim Himalayas.

for partial fulfilment of the syllabus prescribed by Vidyasagar University. The report has been prepared under the supervision of Miss Arpita Majumder and may be placed before examiner for evaluation.

Date: / /2023

		Supervisor
Samanta 09.08.23	Aparesh Mandal 8/8/23	Majumder 8/8/23
Dr. Ratan Kumar Samanta	**Mr. Aparesh Mandal**	**Miss Arpita Majumder**
Principal	Assistant Professor & Head	Assistant Professor
S.J. Mahavidyalaya	Dept. of Geography	Dept. of Geography
	S.J. Mahavidyalaya	S.J. Mahavidyalaya
Principal Swarnamoyee Jogendranath Mahavidyalaya Amdabad :: Purba Medinipur :: Pin-721650	Department of Geography S.J. Mahavidyalaya	Department of Geography S.J. Mahavidyalaya

:CONTENTS :-

ACKNOWLEDGEMENT

I would like to convey my deep appreciation to my teacher miss. Arpita Mojumder, Assistant professor Mr. Aparesh Mondal, Assistant professor and HOD; Mr. Narayan Chandra Bera, Guest teacher of the Department of Geography of Swarnamoyee Jogendranath Mahavidyalaya for their valuable suggestion's and encouragement in completion of my project work,

I would also like to express my sincere gratitude to our principal Dr. Ratan Kumar Samanta for providing all the required facilities to accomplish the report.

Finaly, I would like to thank my parents, friends, staff of college and the local residents of pelling in west Sikkim, without their support and help this assignment would not have been completed.

place: Amdabad

Date: 6.08.2023

Rajesh Senapati

Signature

LIST OF TABLE.

LIST OF FIGURES

List of photography

Introduction : Disaster and natural hazards are common and occur not only in India but over the world. India has been phone to natural disasters on account of geo-climatic conditions disaster such as floods, earthquakes, drought, cyclones and landslides have been major within the country. Hazards are of two kinds, natural and manmade natural hazards are the one that take place as a result of natural phenomena. these can be meteorological hydrological and geological such as cyclon, tsumanis earthquake, landslides floods, draught and volcanic eruption. on the other hand manmade hazards are the one that occur due to human negligence these are associated with industries, or energy generation power plants and include explosions explosions, leakage of toxic water pollution, dam failure, wars or civil strife or occurrence of fires. (Day & singh 2006).

Landslide is also called as semi or quasi natural hazards as it originate due to natural phenomen or also by human activities. landslide is the common disaster in different parts of sikkim. the high steep slope, making of the house or constructional work in the hilly slope etc. causes are responsible for landslide in sikkim In the present project paper it is discussed about the causes. effects management of landslide Disaster in west and south sikkim along with an overview of physical and socio-economic status of sikkim as landslide is also triggered by human activites along with natural phenomen.

Concept of Landslide : A Landslide is the movement of a mass of Rock debris or earth down a slope. Landslide is a type of mass wasting which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "Landslide" encompasses five modes of slope movement Falls. topples. slides Spreads and Flows. these are further subdivided by the type of geologic material (bedrock, debris or earth) A landslide is the movement down slope of a mass of Rock. debris earth or Soil. Landslide occurs when gravitational and other type of shear stresses can be built up with in a slope by a number of Proceses

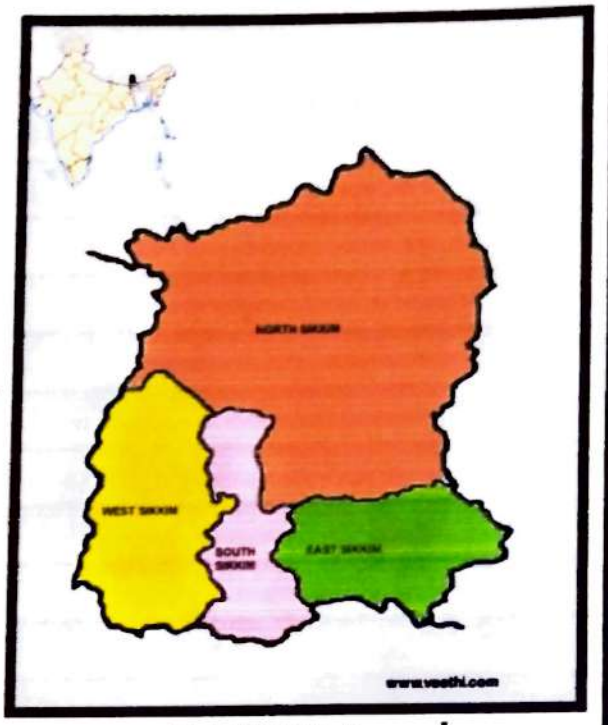
India has been divided into a number of zones on the basis of vunerability. very High and India has been divided vulnerability zone having highly unstable unstable. relatively young mountainous areas in the Himalayas. high rainfall regions with steep slopes,

Study Area :- Sikkim is a small extremely mountainous state in the Himalayas with sharply dedicend and extreme deep watershed. with :state is situate between 27°04'N to 28°07'N and 88°01'E to 27°06'E Ist is bounded by nepal in the west by the vast stretches of Tibetan plateau in the north and by Bhutan and Chumbi of west Bengal stretches along its southern boundary. The state has a total area of 7096 Sq.km. Sikkim is divided into four districts - East west. North and South.

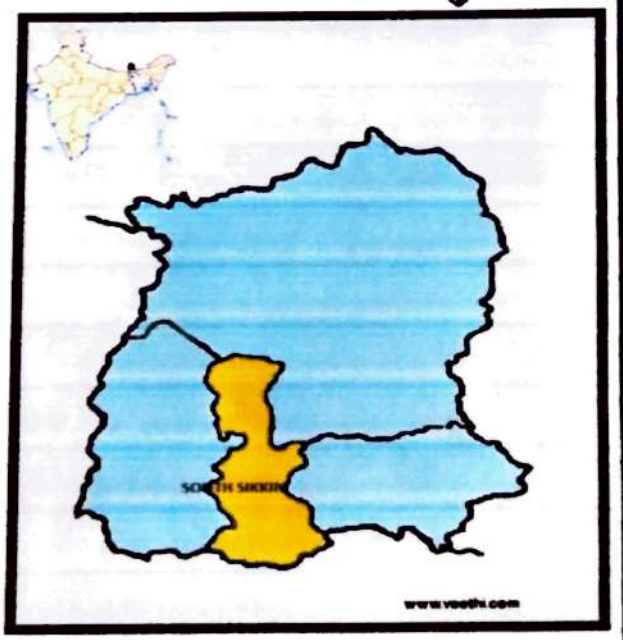
The state lies between very high and high landslide vulnerable Zone the basis of intensity of the controlling factors of landslide through north and east sikkim are in very risk zone of landslide. South and west districts of Sikkim are also in high risk zone of landslide prone areas. west and south District of Sikkim lies at an altitude of more less. 400 meters to 2500 meters with unique countryside escape of endless waves of agricultural field's and the terraced slopes etc. Causes are responsible for landslide in Sikkim In the present project paper it is discussed about the causes. effects and management of landslide Disaster in west and South sikkim along with an overview of physical and socio-economic status of Sikkim as landslide also triggered by human activities along with natural phenomena.

LOCATION MAP

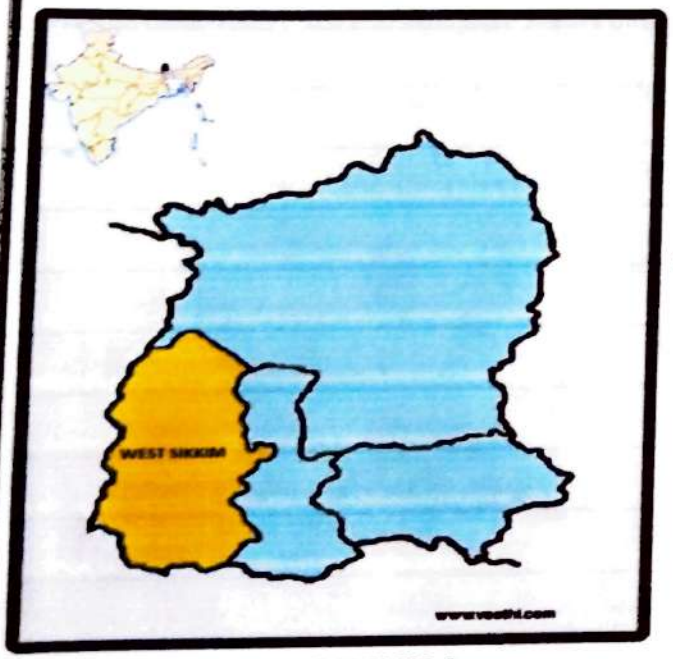
1. INDIA



2.SIKKIM



3.SOUTH SIKKIM



4.WEST SIKKIM

objectives :-

The present project paper on landslide has been initiated to fulfill some basic objectives which are as follows.

- To study the general overview physical and economic, socio-cultural environment of the study area as both very much related to landslide.
- To identify the major causes of landslide and its consequences in the study area specially in west and south sikkim.
- To asses the effective landslide management techniques and to give some sugestive measures to prevent landslide in the study area.

Research question :-

(i) what is the nature of landslide in west and south sikkim.

(ii) what are the main causes of landslid

(iii) what are the effects of landslid on the lives of the local people.

(iv) what measures have been taken to prevent landslid from government.

• Data base and methodology :-

→ The data has been collected from two sources - primary and secondary. The primary data has been collected from hotel manager, car driver, local people, and seller of souvenir hop. The secondary data were collected from various book articul. different link from wed site. Journal etc.

→ We collected data from hotel manager, car driver, local people and seller of Soveneir shop through interview method. and we gain an understanding of landslides through the observation method while travelling near landslide prone area.

→ Different cartographic techiques have been chosen to represent the data properly. We used to bar and line graph to show rain fall and temperature. to represent demography and literacy we have used pie and/bar diagram.

Limitation of the study :-

Due to the limited time period surveyor were not able to collect data properly. Besides this some other problem such as, poor financial condition, communication gap between respondent and surveyor due to different language etc. which was prevailed in that area. Hence the study was not dealt properly.

(4) A general overview on physical and socio-economic environment of Sikkim :-

As land slide is called as semi or quasi natural hazard it is originated by natural phenomena and triggered by human activities. Sikkim is one of the vulnerable state is India due to land slide. Geology relife structure, nature of slope, type of rock and its resistance power to erosion, soil, climatic nature, (specially rainfall) vegetation, cover etc. all are the controlling factors of landslide. Apart from those human activites such as economic activities developmental work also affect on land slide. on the othe hand, physical and socio-economic environment of the region can be devasted due to landslide.

Hence a brief introduction on physical and socio-economic environment of Sikkim should in thought to know the causes and consequences of landslide in the study area.

physical Environment

2.1.1. physiography :

Situated in the Himalayan mountains the state of Sikkim is characterised by mountainous terrain. Almost the entire state is hill with an elevation ranging from >80 metres (920 ft) in the south at the border with west bengal to 8,586 m. (28,169 ft) in northern peaks near nepal and Tibet the summit of kanchenJunga, the world third highest peak is the state highest point situated on the border between Sikkim and nepal. For the most part, the land is unfit for agriculture because of the rocky precipitous slopes. However some hill slope have been converted into terrace farms.

2.1.2. Drainage :

Sikkim is drained by large number of perennial river, which merge in to two prominent rivers. the teesta and the Rangeet. Rest of other stream eventually joins are on the other Rangeet also joins the Teesta just near the boundary between Sikkim and west Bengal.

The Rangeet river and its tributaries originate in the tolung glacier in west Sikkim

and after flowing for about 60 km. Joins Teesta below malli near the bor of Sikkim with west bengal. River Rangeet is a major tributary of River Testa from the western Sikkim. major tributaries of Rangeet are Rimbi khalo, Rathangchhu. Kaleo khalo, Ramam khola and the little Rangeet.

2.1.3. Soil :-

The hill of Sikkim mainly consist of Gneiss and schist which weather to produce. generally shallow brown clay soils. The rock consists of phyllites and schists.

2.1.4 Climate :-

The state has five seasons. winter. Summer, Spring, autumn, and monsoon, season. Most of the inhabited regions of Sikkim experience a temprate climate, with temperatures seldom exceeding 28°C in summer the average annual temperature for most of Sikkim is around 18°C during the monsoon. heavey rains increase the risk of landslides. The record for the longes periode of continuous rain in Sikkim is 11 days. For affects many plants of the state during winter and the monsoon making transportation perilous temperatures in the mountain can drop to as low as -40°C in winter.

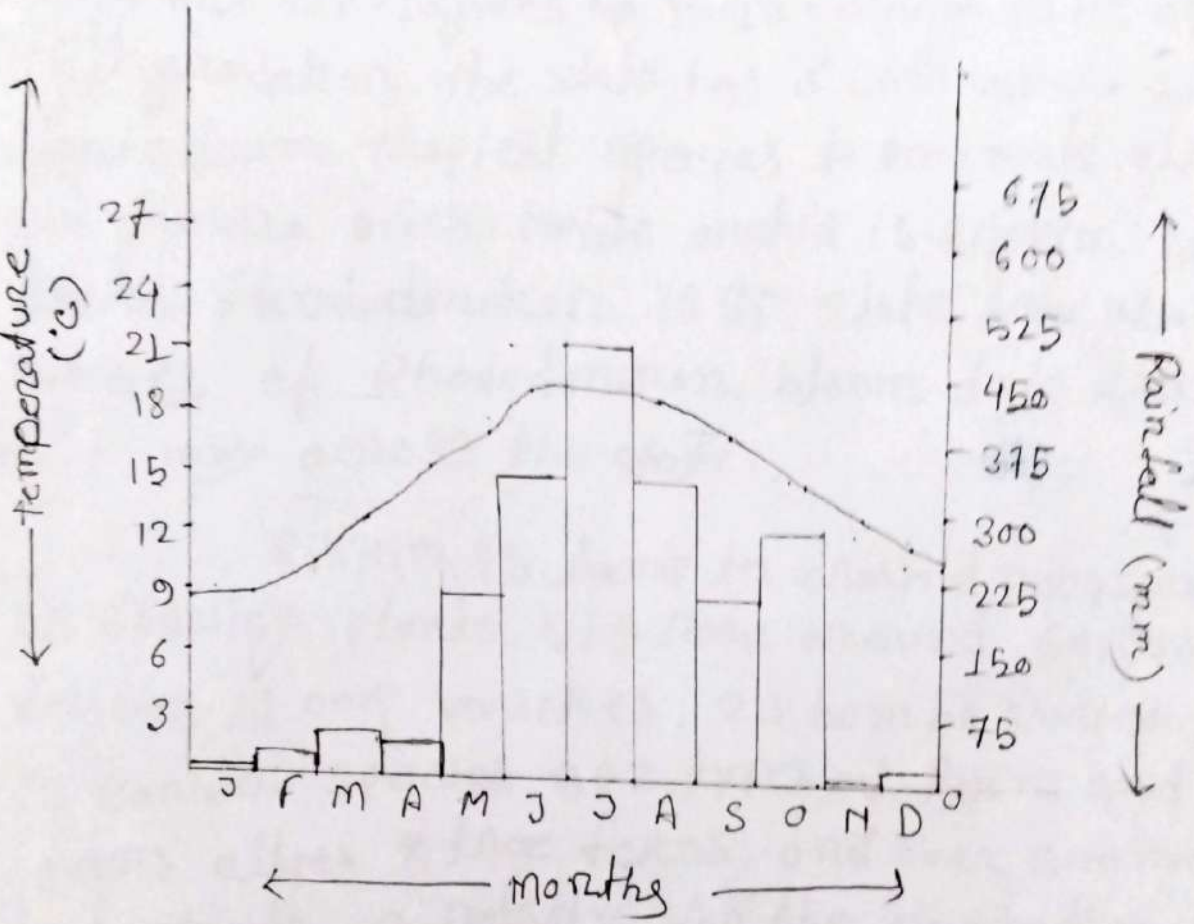
Table- 01

Temperature on rainfall data of Sikkim 2021

Month	Temperature (°c)	scale	temperature (cm)	Rain fall (mm)	scale	Rain fall (cm)
January	9.4	1cm = 3°c	3.13	6.1	1cm = 75 mm	0.08
February	10.9		3.63	21.9		0.29
March	13.7		4.56	57.0		0.76
April	16.6		5.53	45.5		0.60
may	18.7		6.23	266.4		3.55
Jun	20.3		6.76	554.6		5.25
July	20.3		6.76	394.0		7.38
August	20.4		6.8	401.3		5.35
September	19.6		6.53			3.41
October	17.3		5.76	334.9		4.46
November	13.9		4.63	3.9		0.052
December	11.1		3.7	22.7		0.30

SOURCE:- Hydrome Division, India Meteorological Department New Dilli

Temperature and Rainfall data of Sikkim 2011



2.1.5 Flora and fauna :-

Sikkim is situated in an ecological hotspot of the lower Himalayas one of only three among the eco-regions of India. owing to its altitudinal gradation. the state has a wide variety of plants from tropical species to temperate alpine and tundra ones. Noble orchid is Sikkim state flower Rhododendron is its state tree about 40 species of Rhododendron bloom late April-mid may across the state.

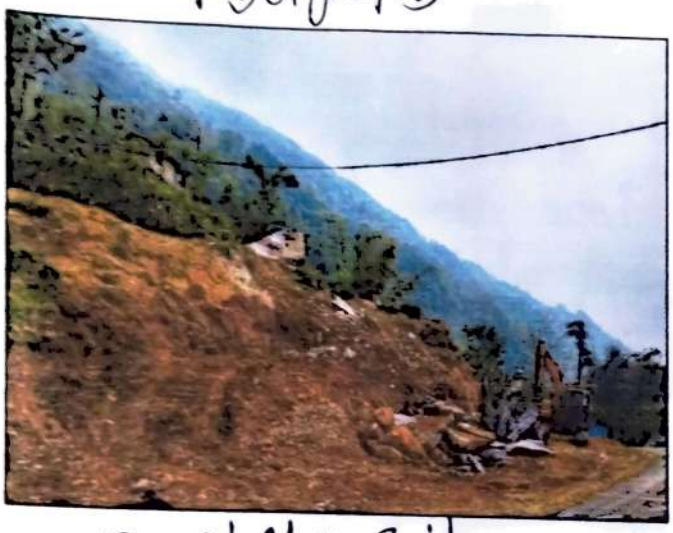
Sikkim is home to around 5000 species of flowing plants, 515 rare around 60 Primula species 11 oak varieties, 23 bembo varieties 16 Conifer species 362 types of ferns and ferns allies 8 tree ferns, and over 900 medicinal plants. A relative for the poinsettia locally known as 'christ may flower" can be found in abundance in the mountainous state.

The fauna of sikkim include the Snowleopard, musk deer, Himalayan, tahr, red panda, Himaya marmot Himalayan serow, Himalayan gaural, muntjac common longur, Asian black bear clouded leopard marble. cat. leopard. cat shale. Tibetan wolf hog. Badger, binturong and. Himalayan Jungle. cat.

Among the animals more commonly found in the alpine zone, are yaks, mainly reared for their milk, meat and as abeast of bov. Sikkim has more than 550 species of birds. Some of which have been declared endangered. The redpanda is the state animal of sikkim.

Physiography

Drainage System (Ponjeet)



Ground Clay Soil

Rhododendron Plant

National Animal Red Panda

Socio. economic Environment

2.2.1 Demography :-

As per census of india. 2011 total population of Sikkim was 6.11 Lakhs. Sikkim is the least populated state of india male 52.87% and Female 47.05%

2.2.2 Literacy :-

Literacy rate in sikkim stood way at 81.42% where male literacy rate was at 86.55% and Female literacy rate 76.04%
census of india. 2011

2.2.3. culture :-

In Sikkim the leading communities are the lepchas Bhutias and Nepalese. the official languages of the state are. English, Nepal, Sikkimes and lepcha. the sikkimese are highly devout people and religion play major role in Sikkim there are major two religions Buddhism and Hinduism, and Sikkim is multi, lingual state where people of many communities reside harmoniously.

2.2.4. Health :-

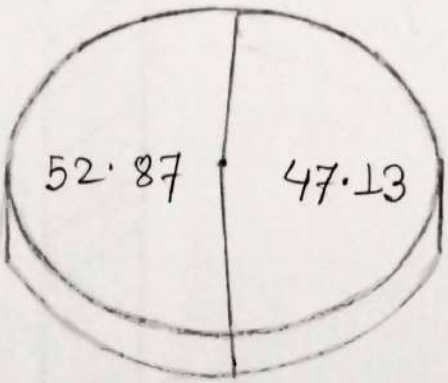
There are few hospitals, health Centers clinics and health facilities across the state of sikkim. these medical facilities

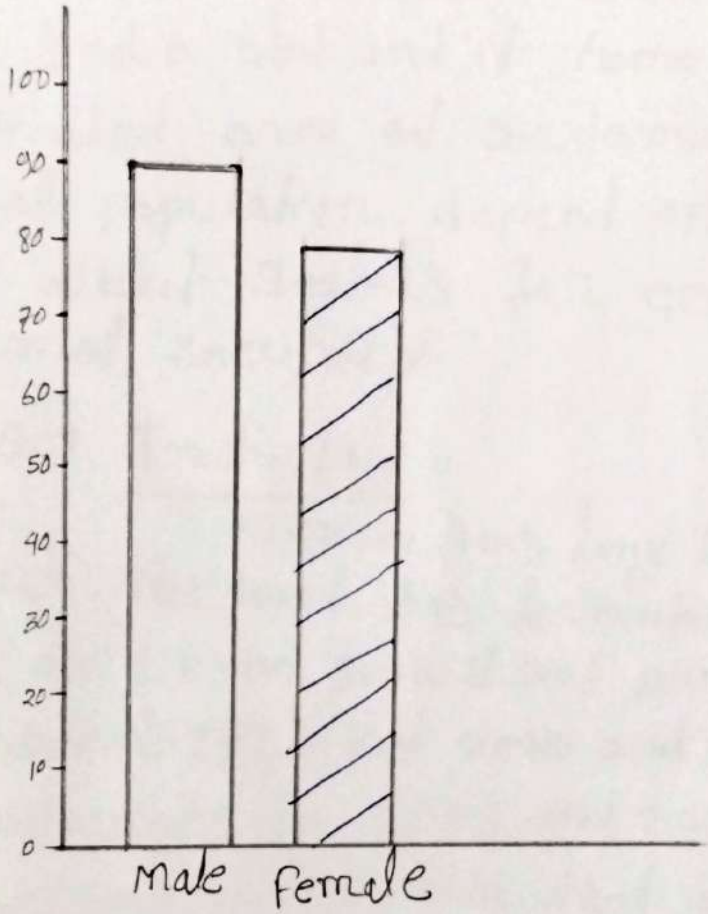
Population composition of Sikkim 2011

Sex	percentage of population	total population	population (c)
male	53.87	100	$\frac{53.87}{100} \times 360° = 190°$
femal	47.05		$\frac{47.05}{100} \times 360° = 169°$

Literacy Rate of Sikkim, 2011

sex	percentage of literacy	scale	Literacy Rate (cm)
Male	86.55	1 cm = 20	4.32
female	76.04		3.80


52·87
47·13



LEGIEND	
male	
female	

2.2.5.1. Agriculture.

Economy of sikkim is largely agrarian bases on the terraced farming of rice and the cultivation of crops such as maize milled wheat. barely, oranges tea and cardamom Sikkim produces more cardamon than any othe India Stat and it home to the largest cultivated area of cardamom (88%). It is rural population depend on agriculture and allied sectors for economic food national security.

2.2.5.2. Industry :-

Sikkim has long been agro-based society. the Govt. has formulated certain policies such as Sikkim Industrial promation and Incentive (SIPI) Act 2000 and its subsequent amendments in 2003 and 2007. Some of the Industries of Sikkim that deserves a special mention in this content are : pharmaceutials Cosmetics. Food processing. Breweries. Mettress corrugated Boxes. Tea Processing etc.

2.2.5.3. Eco-Tourism :-

In January 2016 - Sikkim because India's first '100 present organic, 'state the Directorate of Ecotowrism under the forest Environment and wildlife management Depar-

-tment has identified and demarcated 11 areas in Sikkim as ecotourism. Eco-tourism in Sikkim started in the year 1995-96 with trainings awareness, changes in regulations to adapt to the mountinous terrain and entry of foreign tourists in many of restricted and protected areas

protected parks and santuaries for eco-tourism activies:- Kanchedzong National park. Singba Rhododendron Senctuary, Pamzong, Lho wildlife. santuary Kyongnosla Alpine, Santuary. maenam wildlife, santuary varsey Rhododendron santuary.

2.2.6 Transport:-

National Highway 10 (NH10) formerly NH 31A) links silguri to Gangtk. Sikkim nationalised transport runs bus and track services, oparate, throughout sikkim and also connect it to siliguri. A branch of the highway from mello connects western sikkim. Towns in estern, southern, and western sikkim are connected to the hill stations of Kalimpong and Darjeeling in northern west Bengal. The state is

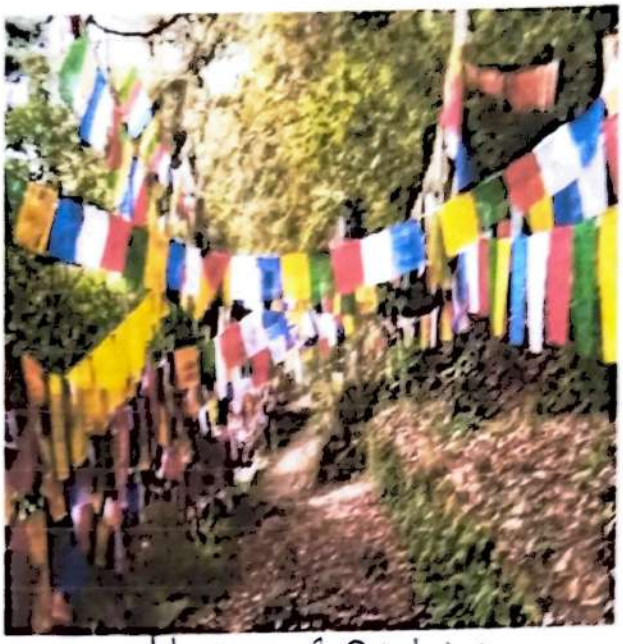
provied treatment both to the local patients and other patients from nyhe bowsing place as well.

SL NO	HEALTH INSTITUTION	EAST	NORTH	SOUTH	SOUTH	SIKKIM
1.	State Referral Sikkim Hospital	1	.	.	.	1
2.	District Hospital	1	1	1	1	4
3.	Community Health Centre	1	.	.	1	2
4.	primary Health Centre	6	7	5	6	24
5.	primary Health sub-centre.	48	41	18	39	146
6.	District tubercu-losis centre Namchi	.	.	.	1	1
7.	Centre Referral Hospital manipal tadong	1	.	.	.	1
8.	total	58	49	24	48	179

2.2.5 Economy :-

The economy of sikkim is mainly bases on agricultural and animal husbandry and tourism. Sikkims nominal stat gross domestic product (GDP) was estimated at US$ 4.6 billion in 2019 with GDP per capita being $ 7,530 (₹5,5000) thus constituting the third -smallest GDP among India's 28 States.

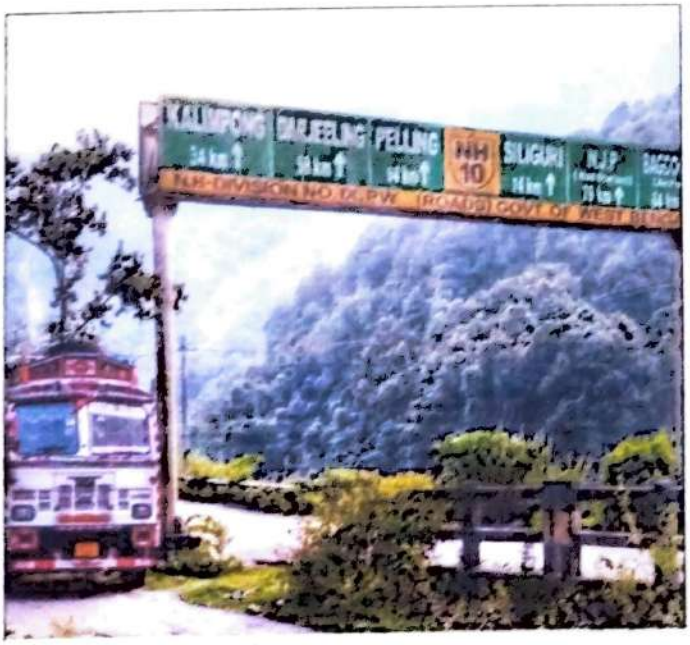
Culture of Sikkim



Culture of Sikkim

primary Helth centre in Denthom

Cardamom cultivation



NH10

Landslide in study Area

The frequent occurrence of landsled is a very common phenomena in Sikkim Himalays And one that causes the most damage to property and connectivity in the causes the most land locked stat and also loss of the live of the lives and property. Apart from this recent unplanned development activites, particularly road construction and ill planned settlements have further aggravated the incidence of the landslide and subsidenc.

3.1. Causes :-

The frequent occurrence of landslides is very common phenomena in Sikkim Himalay. In the Sikkim region can be caused by a veriety of factors including geological, environmental and human related. Here some common causes that contribute to landslide —

Ⓐ Geological causes :- Sikkim a stat in north eastern India is located in a seismically active region and experiences various geological process that can contribu to landslids.

① slope stability :-

steep slopes and unstabl geological formation can contribute to landslides.

the Sikkim region is characterized by rugged terrain with steep slopes, especially in the Himalayan mountain range. the presence of weak rock formation and loose soil can make these slopes prone to landslide.

① Geological formation :-

the geological formation of Sikkim consists of complex and varied rock types including schists, gneisses, phyllites and quartzites. Some of these rocks have inherent weakness and discontinuities, such as bedding plans, joints and faults which can act as potential sliding surfaces.

B. Environmental causes :-

Sikkim state is prone to landslide. due to its rugged terrain and high rainfall. several environmental causes contribute to landslide.

② Heavy Rainfall :-

Intense or prolonged rainfall can saturate the soil. increasing its weight and reducing its stability. Sikkim experiences heavy and monsoon rains. particularly during the months of June to September. the excess water can infiltrate the ground leading to landslide. 6th August 2020 Jorethang landslide in West Sikkim.

(ii) Earthquakes :- Sikkim falls in a seismically active region due to its proximity to the Himalayan tectonic plate boundary. Earthquakes can generate ground shaking, which and disturb the balance of slopes and trigger landslide 2011 sikkem earthquay, with a magnitude of 6.9 causes signif. icant landslide in the region resulting in loss of life and infrastructure damage.

(iii) Erosion :- Natural erosion process such as river erosion undercut sloped and weaken them stability continous erosion removes support from the base of slopes making them prone to landslides.

(iv) Human Related causes :- Human activities can also contribute to the occurrence or exacerbation of landslide. Here are some man-made causes of landslide.

(i) Deforestation :- Clearing large areas of forest for agriculture logging or urbanization reduces the stability of slopes. Tree roots help bind soil and prevent erosion, so their removal can make slopes more prone to landslide.

(iii) Construction and Excavation :-

poor construction practices, improper grading of slopes and excessiv excavation can alter the natural stability of the. land Building roads, highways or structures on steep slopes without appropriate engineering measures can increase the risk of landslide.

(iii) Defective Drainge systems :-

Inadequate or poorly designed drainage systems can lead to the accumulation of water in the soil, increasing pore pressure and reducing the shear strength of slopes. This can result in slope failures and landslides.

(iv) surface modification :-

Altering the natural drainge patterns by modifying rivers streams or water channels can cause increased water flow and erosion. which can weaken slopes and trigger landslides.

(v) Irrigation and water leakage :-

Improper irrigation practices, such as excessive water application. or inadequte drainage systems can saturate slopes and increases their susceptibity to landslide water leakage for pipes or sewers can infiltrate the soil leading to instability.

cons in the valleys facing steep hill slopes etc are damaged and sometimes village are completely destroyed by the thick debris of rocks muds and other meterials dislodged from the hill caused by landslide of various south triggered by earthquakes or heavey rainfall or human activities.

② Economic Effect

Loss of agricultural farms and crops:-

At the very outset it may be pointed out that majority of settlements are built on the hill slopes and foothills in mountai nous areas. and thus agriculture is also practiced on hill slopes and in the valleyes. Generally, terraced cultivation is in practice. In the event of massive landslide the terrace farms are completely destroyed be falling debris of rocks, the debris is dumped in the valleyes and henee farms and crops on the valley floors are also buried under thick debris cover.

① Environmental Effect:-

Damming of rivers and flash floods:-

Huge volume of debris produced by landslide of various sorts coming into the rivers forms temporary dams across the river.

and thus blocks the river flow. In such situation substantial volume of water is impounded behind the temporary dams and some lakes are also formed. when the impounded water overtops the debris dams. such landslide-dam generated flash floods wash out everything coming in their way including human settlements domestic animals. inhabitants and there belongings resulting in the downstream section of the rivers.

(f) Effect on Ecosystem :

(a) Impact on water : when landslide occur, they can seriously damage or destroy ecosystem sometimes the effects can last for thousands of years. they can pollute streams and water bodies. this invariable has severe repercussions on water quality and marine life.

(b) wipe out forest land :-

what's more, these hazards can wipe out large tracts of forests wildlife habitats and remove productive soils from slopes.

(c) Dam up or flood streams :-

Also they can dam up rivers and streams. In so doing water flow is restricted. marine and terrestrial organisms the depand on the water flow may eventually die. conversely. that depend on the water flow may eventually outburst floods can introduce a tremendous amount of new sediment into streams or they can submerge, and kill vegetation in the flooded region. In Sikkim flash flood killed 22 people, triggered a series of landslides and washed away nearly 30km of highway in north Sikkim amid torrential rain.

(d) Loss of lives and social disruption :-

Landslide are responsible for a number of death, injury to people damage to, housing, infrastructure and agriculture lands. In Sikkim on sunday 18 september 2011 at 6:11 pm. (local time) a mw 6.9 earthquake with an epicenter located near the Sikkim region (27.723°N, 88.064°E) killed 77 people. including 16 at the Teesta stage III Hydroelectric power project site injured 719 left thousands homeless and temporarily displaced many and also caused substantial loss to livestock.

(4) Socio. Economic effects of landslide:-

Socio · economic effects include adverse impacts, as enumerated above on people, there homes and properties, industri and factories, agricultural land and crops. timber life lines such as roads and highway institutions etc. It is significant to note that socio economic problems caused by mass movement of rock waste and landslides. due to slope failures are many fold and are assuming larger proportion due to expansion of built enviornment in environment. fragile and vulnerable mountainous areas,

Contourbunding:-

Earthen embankment was contourbunding at intervals across the slope and along the contour line of the many landslide in Sikkim A series of such band is very useful in dividing the area into strips and ate as barrier to the flow of water.

Bench terracing:-

Relatively steeps land was tranformed into a series of level or nearly level strips or steeps running across the slope of many landslides in South Sikkim.

Rock slope Netting:-

Rock Netting is used to cover an entire area of unstable rock. the slope netting can be either draped or bolted in each corner of each panel. Rock netting is used where the unstable rock is big and blocky. It is a new technique of land slide control which is used for landslide control of Sikkim.

Contour trenching:-

Series of deep pit or trenches across the slope at convenient distance was built with in the landslide of South Sikkim. The soil excavated from the trenches was deposited on the lower edge of trenches where forest trees were planted

Sausage wall:

predenence was given to sausages wall among the mechanical method in every landslide of sikkim and every landslide was nearly checked by applying sausage wall.

SOME OTHERS PHOTOGRAPHS RELATED TO LANDSLIDE

Landslide Prone area upstande. Settlement

heavy Rainfall

Uprooted plant

Land subsidence.

Rock Slope Netting

Bench Terracing

Some instances of

2007, 19th July:

Heavy rain triggered a landslide in Rabangla, South Sikkim, the Singtam, Rabangla road has been as many as 11 landslide while the Namchi - Rabangal route via Damthang has been closed because of an uprooted tree.

2011, 23rd June:

A torrential spell of rain from 7.30 pm. to little past midnight on the 23rd Jun 2011 triggered numerous small landslide on Pelling where 14 people perished on the Pelling - Dentam road in west Sikkim.

2011, 18th September:

on September 18, 2011, a 6.9 magnitude earthquake struck the india, napal border region. According to news reports, impacts of the earthquake included landslides in the northern india stat of Sikkim between Napal and Bhutan.

2020, 21th Jun:- A landslide occured in Tafopain at 6 PM. on friday. the road constructed across a steep terrain near Tafopani remains vulnerable to landslid especially during rain season and recent

back cutting initiated for the road expension has added to risk landslide during on going monsoon season. Legship - Nayabazar road was blocked near to tapain. due to the landslid. the commuters travelling from Jorethang to Geyzing. Yuksan and toshiding were compelled to take Reshi - Rinchenpong route via Legship to reach their destination.

2020, 27th June :- A landslid occured at national Hydropower project of corporation (NHPC) Teesta Stage-v dam on the left bank of the river in Dikchu. According to the local people of Jong and Apodar the landslid was occured due to the neglige of NHPC. and it could have been avoided with proper preventive work on time. the landslid has severely damaged the 55 meter high dam of the 510 mw Teesta Hydropower project of NHPC.

2020 6th August :-

A massive landslid occured in Jorethong in South Sikkim. A Road in Jorethang was also washed off due to heavy rainfall in the region. the IPAC laboratory in Mazhitar Jorethang was badly damaged in the landslide. the house was also completely was head away. due to the landslide triggered by heavy rain fall in the area.

2022, 5th February :-

A landslide occured to Pettling village in Namchi district due to heavy rain fall 60 houses were demaged in this landslide.

2023, 18th June :-

multiple landslide induceed by heavy rainfall have damaged over a hundred houses in west Sikkim district. the incessant rain has caused extensive damage to infrastructure. and property in the state.

Managment :-

Guidelines by the National Disaster management Authority (NDMA) on managment of landslide. seduce the ominous. destructive potential of landslide. and minimize the consequential losses by institutionalizing the landslide hazard mitigation efforts. preventive and corrective measures. to lessen the impacts of landslide it may be mentioned that landslide cannot be stopped. But number. fae quency, occurrence. and severity can be minimized. Some preventive measures have been taken to manage landslide in the study area -

Some Instances of Landslide in the study area

A landslide occured at Pathing village in namchi district due to landslide.

The IPCA laboratory was bodly effected due to landslide.

Tee Ste Stage-v dam was broken due to landslide.

Landslide allover Sikkim due to earthquake.

14 People died in Pathing due to landslide.

Leg ship- Nayabazar road was due to landslide.

Namchi Rabangla Road was closed due to landslide

SUGGESTIVE MEASUER

Along with the managment system of landslide in sikkim himalaya some other measure should be taken.

(i) During pursuing of any disruptive project in the high risk zone like sikkim should be proceed with prudence

(ii) Environmental Impact Assesment standers should be followed before mining or dam building.

(iii) Landslide microzoning method should be implemented in the extremely vulenarable areas.

(iv) to strengther hazard reduction and public awarness effort. locality available trained people should be consisted.

(v) To strenghter disaster managment potential more funding should be given to landslide planning and metigation agencies.

(vi) mitigation techniques such as confining agriculture to villeys and place with moderate slopes, fostering large scale afforestation initiative and building water bunds should be encaraged.

(vii) Encouraged fuel use of effective landslide rehabilate on and mitigation techniques.

CONCLUSION

physiography, climate and other natural phenomen of Sikkim Himalayas make it hazardous with frequent landslide. Human activities play the role as positive catalyst for this calamity. there are spatio-temporal variation in frequency of land slide occur basically due to heavy rain fall along with some associated factor. many times it creates massive and unwarranted loss of life and property therefore, there should be efficient manage ment of landslide hazard, there are necessities of the development of industutional capality. It may be mentioned that landslide can not be stopped. but there number, frequency, recurrence and severity measure to lisser the impact of landslide which will help to preven water entering the hill slopes through joints and cracks. decrea sea water pressure in the rocks, through shallow and sub-shallow drainge. Place drainage place drainge trenches in order to reduce water pressure in the vicinity of hill slopes. the inhabitants of this area should be sensitized through awarness programs. mock drills, poster and so and on the landslide prone areas of Sikkim requier special attention and vigilance. to cope up with this calamity.

Bibliography

Agriculture. (2022) Retrieved from http://sikenvis.nic.in/Database/Agriculture_777.aspx

Ahuja, R. (2018). Research Methods. Rawat Publications, Satyam Apts, Sector-3, Jawhar Nagar, Jaipur-302004(India).

Biodiversity(n.d.). Retrieved from https://sikkim.gov.in/departments/forest-environment-and-wildlife department/biodiversity#:~:text=Species%20wise%2C%20the%20State%20harbors,Fishes%20and%20over%20600%20Butterflies

Bhattacharya, A. Bhowal, S. (2022). Report On Aquifer Mapping Studies & Management Plan In Parts Of West Sikkim District, Sikkim. *Central Groundwater Board Eastern Region, Kolkata Ministry of Jal Shakti Department of Water Resources, River Development & Ganga Rejuvenation Government of India*.

Chakraborty , N. (2022). Duryog O Biparjay Byabosthapana. Nabodaya Publication, 61-Surya Sen Street, Kolkata- 700009

Culture and Tradition of Sikkim(n.d.) Retrieved from https://www.tourmyindia.com/states/sikkim/people-and-culture.html

DNA Web Team(2020). Massive landslide hits Sikkim's Jorethang ,IPCA laboratory damaged [Blog post] Retrieved from https://www.dnaindia.com/india/photo-gallery-massive-landslide-hits-sikkim-s-jorethang-see-pics-2836274

Gaunia, G.(2022). Landslide and Management: A Study on Gangtok, Sikkim, *India.International Journal Of Multidisciplinary Educational Research. Vol.11,* Issue7(6), *pp. 20-29,ISSN: 2277-788* DOI: http://ijmer.in.doi./2022/11.07.95

https://en.m.wikipedia.org/wiki/Sikkim

https://www.mapsofindia.com/maps/sikkim/districts/southdistrict.htm

https://gyalshing.nic.in/economy/

https://india.fandom.com/wiki/Economy_of_Sikkim/About#:~:text=Sikkim's%20economy%20is%20largely%20agrarian,%2C%20apples%2C%20tea%20and%20orchids

https://ssdma.nic.in/Home/ContentFor?MenuID=3&ContentFor=Content_SubMenu

https://www.slideshare.net/pramodgpramod/disaster-management-landslide

Kothari, C,R, Garg, G. (2019). Research Methodology- Methods and Techniques . New Age International (P) Limited, Publishers, New Delhi- 110002. ISBN- 978-93-86649-22-5

Landslides, (2022). Retrieved from https://odpm.gov.tt/node/17

Landslide on NHPC's Teesta V hydropower project in Sikkim damages the 55-metre high dam(2020) . Retrieved from https://en.gaonconnection.com/landslide-on-nhpcs-teesta-v-project-in-sikkim-damages-the-dam/

Lachungpa, C.(2009). Report On Treatment Of Land Slide And Erosion Control Project Under Tdet - South Sikkim 2004-05 To 2007-08. *Envis Centre Sikkim On Status Of Environment & Its Related Issues. Forests, Env. & Wildlife Management Department Government of Sikkim.*

Management of landslides and snow avalanches - National disaster management guidelines by National Disaster Management Authority. (2011) National Disaster Management Authority.Retrieved from https://www.indiawaterportal.org/articles/management-landslides-and-snow-avalanches-national-disaster-management-guidelines-national

Nag, C. (2022). Research Methodology & Field Survey in Geography. Nadia Publishers, Kolkata-13

Ongmu, D. (2019). Landslides hit West Sikkim, CM PS Golay visits affected areas. Retrieved from https://www.eastmojo.com/sikkim/2019/09/20/landslides-hit-west-sikkim-cm-ps-golay-visits-affected-areas/

Rai D, Singhal, V, Mondal, G, Parool, N, Pradhan, T ,Mitra, K. (2012). The M 6.9 Sikkim (India–Nepal Border) earthquake of 18 September 2011.*Current Science Association.Vol. 102,* No. 10 , pp. 1437-1446 .Retrived from https://www.jstor.org/stable/24107802

Roy, T, Mondal, B, Maity, M, Bandyopadhay , C , Bishal, P.(2021) Geographical Research Methods and Field Survey. Kalyani Publishers, Diamond Agencies Pvt. Ltd., B-125, Sec. 63, Noida. ISBN: 978-93-90522-21-7

Sarkar, A. (2008) Practical Geography- A Systematic ApproachOrient Black Swan Private Limited, Kolkata- 700072. ISBN: 81-250-3529-X

Shil, A. (2021). Research Methodology with Geographical Field Survey. The Himalayan Books, 39 B Sri Gopal Mallik Lane, Kolkata-700012. ISBN: 978-81-926509-8-2

Sikkim's ecotourism evolution(2018). Retrieved from https://www.greeneconomycoalition.org/news-and-resources/sikkims-eco-tourism-evolution

South Sikkim District - Population 2011-2023 Retrieved from https://www.census2011.co.in/census/district/463-south sikkim.html#:~:text=Out%20of%20the%20total%20South,as%20per%202011%20census%20data

Sikkim Culture (n.d.).Retrieved from https://www.bharatonline.com/sikkim/culture/index.html

Sikkim Economy ,(2018). Retrieved from https://www.globalsecurity.org/military/world/india/sikkim-economy.htm

Taneja, S.(2017). Sikkim is 100% organic ! Take a second look. Retrieved from https://www.downtoearth.org.in/news/agriculture/organic-trial-57517

EXAMINED

10/08/23

Department of Geography
S.J. Mahavidyalaya