



The Handbook of Landslides for Dewathang



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forewords

This Handbook is the outcome of Project Mapit, a five-month collaborative project implemented during the spring 2021. The handbook was implemented by a student team from Aalto University in Finland with the help of a student team from Jigme Namgyel Engineering College (JNEC) at Royal University of Bhutan.

A special thanks also goes to Ph.D. Philipp Schmidt-Thomé from the Geological Survey of Finland, who has kindly been helping us throughout the project by sharing his knowledge and ideas of communicating landslides with us, and providing us his valuable feedback on our project and especially on the drafts of this handbook.

The aim of this Handbook is to raise the awareness of landslides in the area of Dewathang Gewog in Bhutan. It is created for the students in the area, who can disseminate the information about landslides and raise the awareness and understanding of this serious natural hazard further in their home country.

Project Mapit was executed as a part of a cooperation project called Problem Based Learning (PBL) South Asia and as a part of Aalto University's Sustainable Global Technologies (SGT) Studio course.

With best regards,
Phuong Do, Pihla Bergholm and
Riikka Rossi.

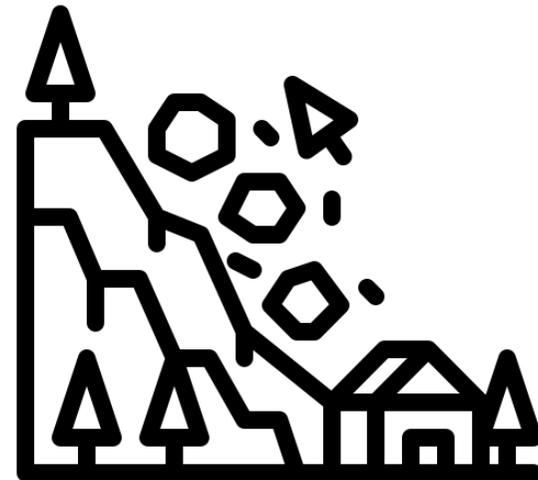
Helsinki, May 2021

what is a landslide?

A landslide is the gravitational movement of a mass of rock, earth or debris down a slope¹.

Bhutan is prone to landslides which cause loss of human life as well as property and damage to the natural environment.

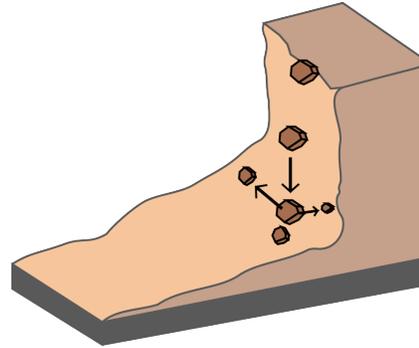
- Since the beginning of the present century, already **seven serious** landslides took place in Bhutan.
- A landslide in 2000 had severely damaged highways, e.g. between Phuentsholing and Thimphu, the lifeline of the country, with at least seven villages destroyed².



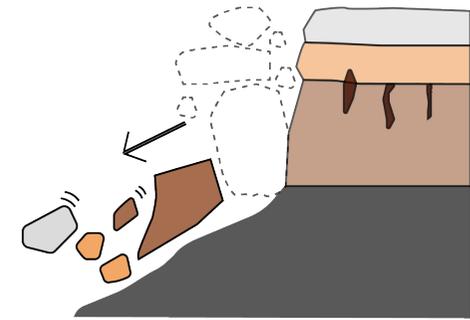
basic landslide types³

Landslides are usually classified on the basis of the geologic material involved (rock, debris, earth) and the type of slope movement (fall, topple, slide, spread, flow)⁴

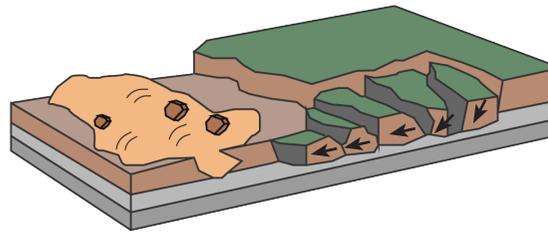
ROCKFALL



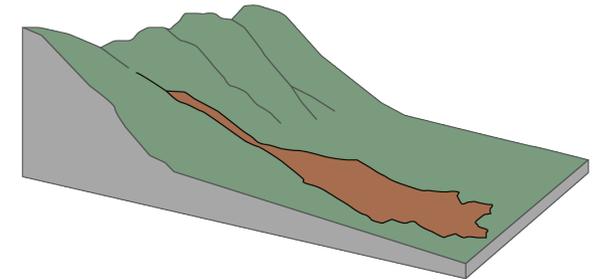
TOPPLE



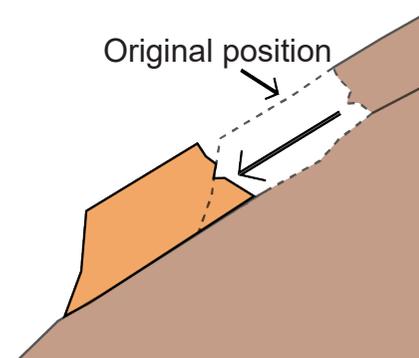
LATERAL SPREAD



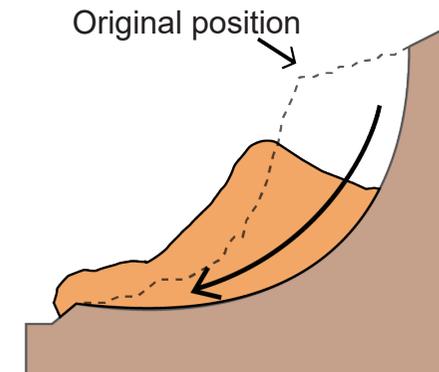
DEBRIS FLOW



TRANSLATIONAL LANDSLIDE



ROTATIONAL LANDSLIDE



natural causes of landslides

STEEP SLOPE & WEAK SOIL



- Fine soils and steep slopes are unstable^{5,6}
- Landslides can still occur in other conditions too: There are many geological and morphological factors affecting the process!^{3,5}

HEAVY RAINFALL



- Saturates the soil^{5,6}
- The wetter the soil is, the weaker it is⁵
- The main causative factor in Bhutan^{5,6}

LANDSLIDE

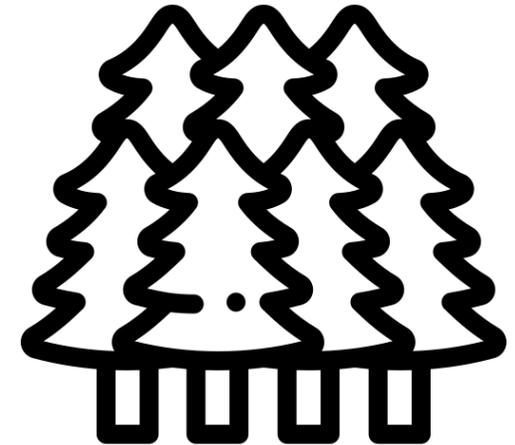


- Risks are also increased by:
- Earthquakes
 - Flood
 - Forest fires
 - Climate change^{3,7}

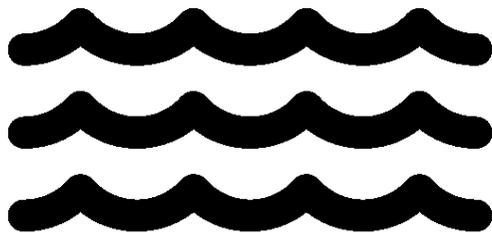
**human
actions
causing
landslides³**



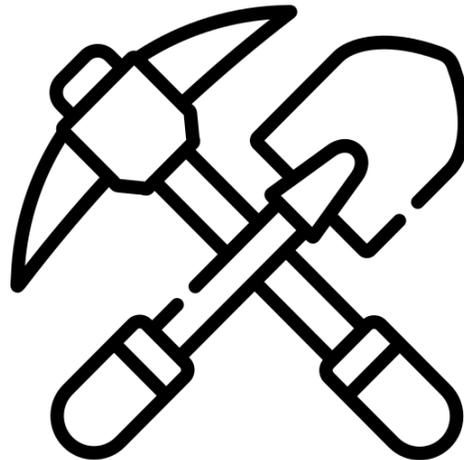
**EXCAVATION & LOADING
OF SLOPES**



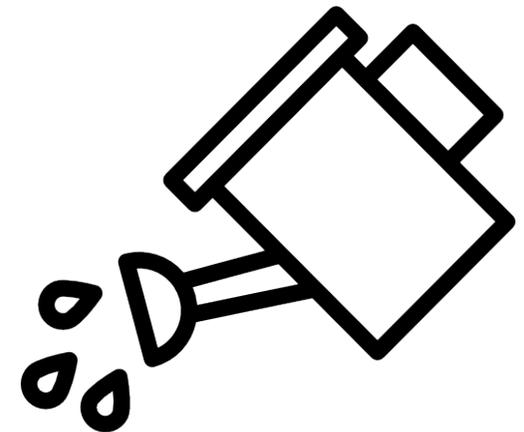
VEGETATION REMOVAL



CHANGING DRAINAGE



MINING



IRRIGATION

warning signs in...^{8,9}

WATER



Flowing water or saturated soil observed in new places



Suddenly increasing water levels in streams

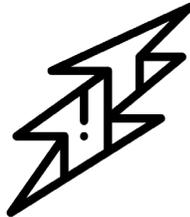


Suddenly decreasing stream water levels despite the rain

NATURE



Inclined trees

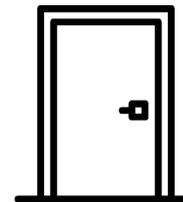


New cracks in the ground

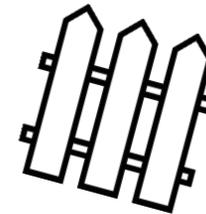


Unusual, rumbling noises

BUILT ENVIRONMENT



Stiff or stuck doors or windows



Inclined fences, walls, poles or terraces



Cracking floors, foundations or pavements

effects on...

PEOPLE



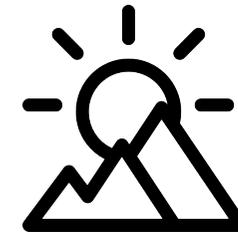
- Mortality
- Injury
- Illness
- Mental health issues (loss of family, property, livestock or crops)

BUILT ENVIRONMENT



- Damage to infrastructure (roads, railways, pipelines, artificial reservoirs, etc.)
- Property loss (buildings, agricultural land, etc.)

NATURAL ENVIRONMENT

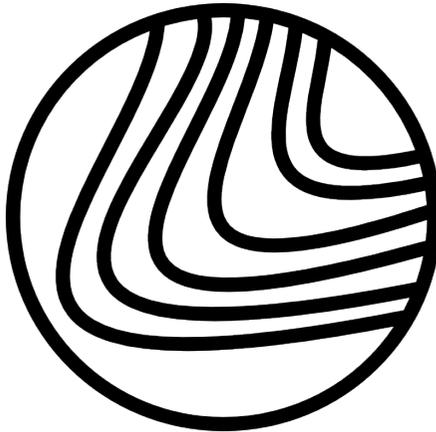


- Landslide dams blocking river courses that cause valley inundation upstream and generate flash floods or debris flows downstream
- Contaminating soils and surface and groundwater
- Soil erosion and sediment yield to valleys and rivers, and hence of reservoir silting
- Loss of natural resources

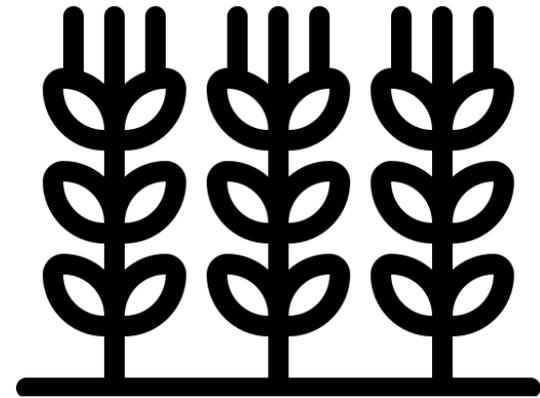


Between 1998-2017, landslides affected an estimated 4.8 million people and cause more than 18 000 deaths worldwide¹⁰

simple
mitigation
or
prevention
techni-
ques^{5,9,11}



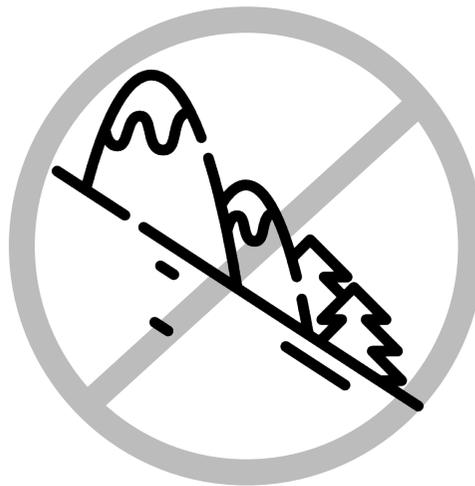
Map landslide prone areas and previous landslide events



Promote sustainable farming techniques on hilly environment



Do not build in areas prone to landslides

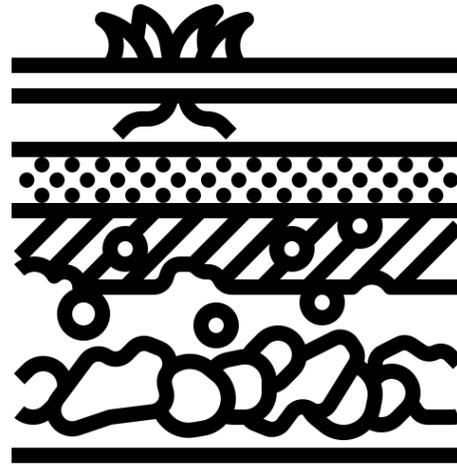


Avoid making cuts in steep slopes

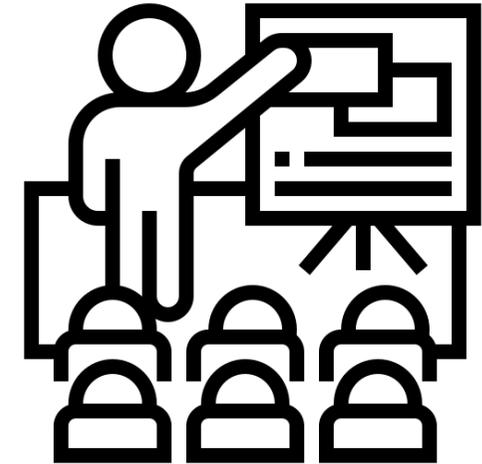


Avoid deforestation

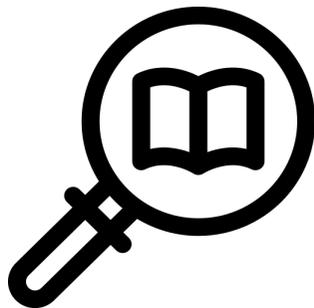
how to prepare for a landslide?



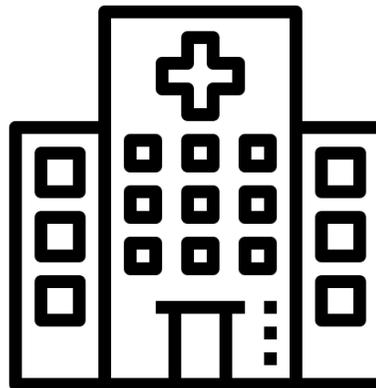
Understand your area's
ground conditions



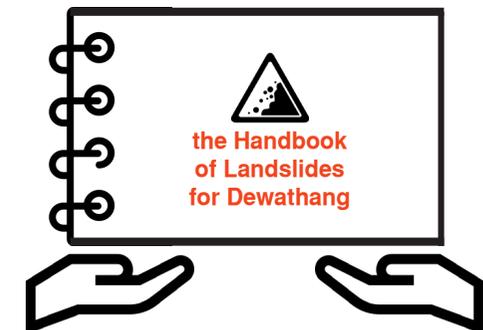
Capacity building for locals



Prepare knowledge regarding
landslides. Learn about the
emergency-response and
evacuation plans for your area
& develop your own emergency
plan



Know where **safe places** are
(e.g. hospital, school, etc.)



Disseminate this material **to
others**

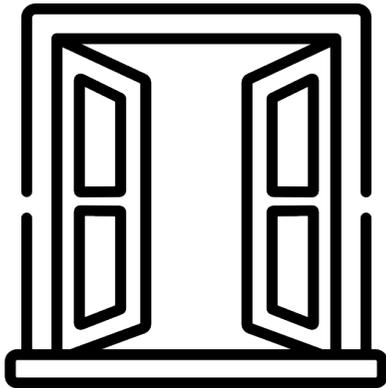
what to do
in case
of a
landslide?^{8,9}



Warn others in danger



Stay calm but alert and
act quickly



Move away from windows or
other open areas where debris
flow could enter



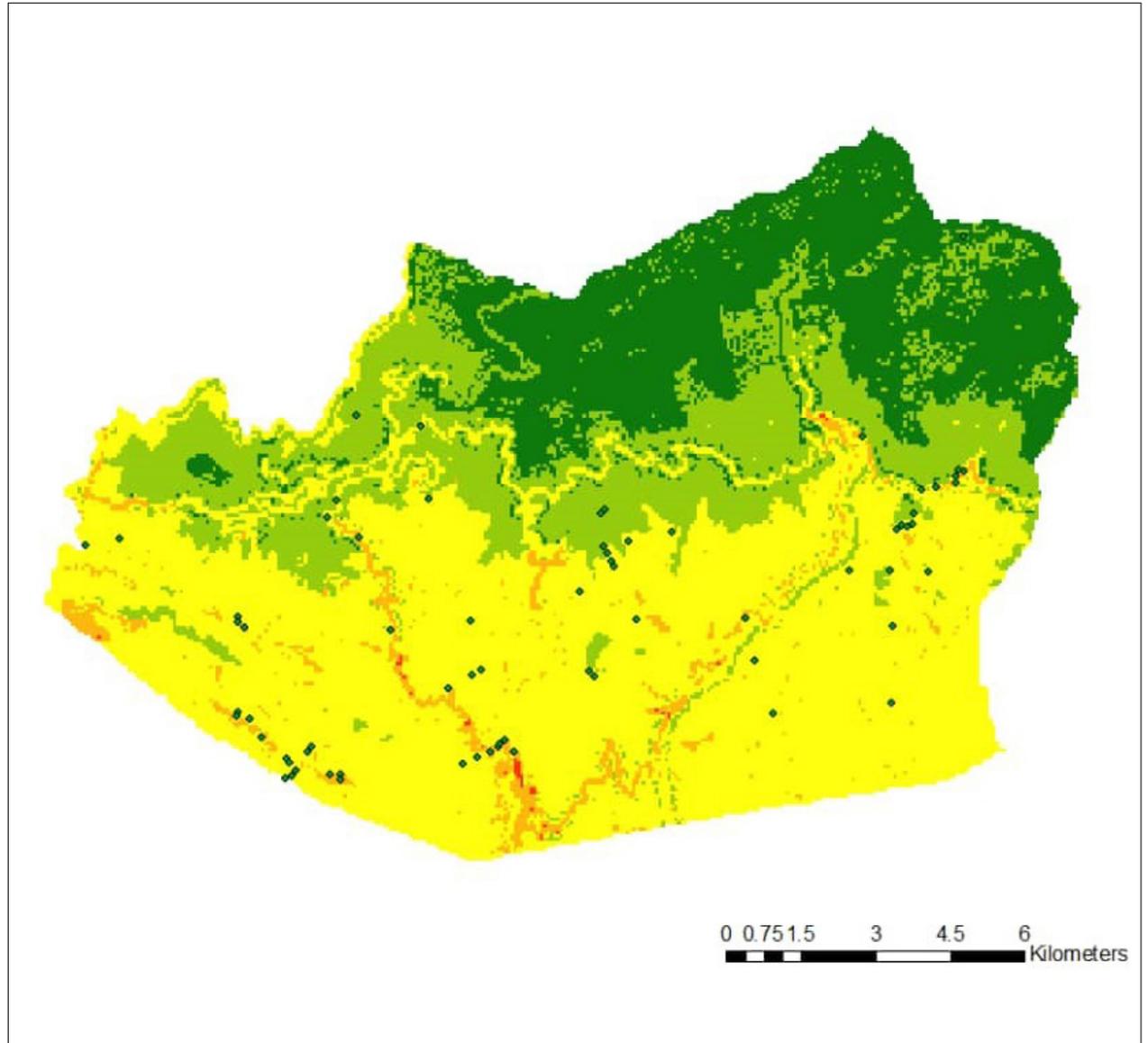
Evacuate to a safe space and
stay away from slopes or river
banks



In need - **contact emergency
personnel - 999 or 219**

landslide susceptibility map for Dewathang

- Landslides
- Very low chance
- Low chance
- Moderate
- High chance
- Very high chance



pictures of past landslides in Dewathang

Photos by
Deewash Mishra, 2021



references and further reading material

Pictures:

Cover photo by Tanay Dedhia/Unsplash
Icons by Flaticon

p. 4 Riikka Rossi & Highland, L.M., and Bobrowsky, Peter, 2008. The landslide handbook - A guide to understanding landslides: Reston, Virginia, U.S. Geological Survey Circular 1325, 129 p. Available at: https://pubs.usgs.gov/circ/1325/pdf/C1325_508.pdf. Referred: 3.6.2021

p. 12 Landslide susceptibility map for Dewathang by Deewash Mishra, Deki Chomo, Jigme Tenzin, San Man Subba, Yadi Raj Acharja, 2021

p. 13 Deewash Mishra, 2021

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**contact
details in
case of a
landslide**

**Regional Office
Samdrup Jongkhar**

Road Safety and Transport
Authority (RSTA)

- kwangchuk@rsta.gov.bt
- 07251459

Department of Road (DOR)

- dorsjro@gmail.com
- 07251055
- www.mowhs.gov.bt

**Disaster
communication
helpline: 999**

**National
Disaster: 219**