INDIA – URBAN CLIMATE CHANGE FACT SHEETS

Landslides

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Introduction

The term Landslide describes a wide variety of processes that result in the downward and outward movement of slope forming materials including rock, soil, artificial fill or combination of these. The material may move by falling, toppling, spreading or flowing[1].

Landslides occur due to a number of complex factors. However, researchers believe that heavy rains are one of the major causal factors for landslide. The climate scientists and IPCC Working Group I reports that more extreme weather with heavy rainfall is expected in future. This implies that climate change will increase the number of landslide incidents.

Landslides rank third in terms of number of deaths due to natural disasters. Himalayan landslides kill 1person/100 Km^2/ year and average losses due to Himalayan landslides cost more than ₹ 550 crores/year and cause more than 200 deaths. The hazard of Himalayan landslides affects over 0.49 million Km^2 (~15 %) of our country's area[2] .

The Himalayas and Western Ghats are the two regions that are most vulnerable to landslides. The Himalayan mountain belt is vulnerable due to the tectonic instability of younger geological formations that comprise it which are subject to sever seismic activity. The vulnerability of Western Ghats and Nilgiris is due to uplifted plateau margins influenced by neo-tectonic activity.

Impacts

Landslides impact:

- Total Environment – these include impacts on
- Human life
- Homes, property and possessions
- Farms and livestock
- Industrial establishments
- Telecommunication
- Natural environment
- Morphology of the Earth's surface, particularly that of mountain and valley systems
- Forests and grasslands
- Native wildlife that exist in the area
- The character and quality of rivers and streams and groundwater flow

The landslides negatively impact the economy of the area with massive loss to life and property. These also result in loss of fertile top soil. Landslides adversely affect a variety of resources e.g. water supplies, fisheries, forests, dams etc.

Nearly 20 states of India fall under different landslide hazard categories. Sikkim and Mizoram come under high to sever hazard classes. High to very high landslide hazard classes cover the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Nagaland and Manipur. Low to moderate hazard zones of landslide cover the parts of Indian peninsula including hilly tracts of states like Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Goa, Madhya Pradesh and Kerala.

Causes

A number of factors are responsible for causing landslides including slope angle, climate, weathering, water content, vegetation, overloading, slope stability and geology. Causes could be natural or anthropogenic.

Natural factors could be elevation of pore water pressure by saturation of slope material from intense or prolonged rainfall and seepage (dominant particularly during monsoon period from July to September and post snowfall from January to March); vibrations caused by earthquakes (prominently in regions with unstable slopes); undercutting of cliffs and banks by waves or river erosion; and volcanic eruptions.

Removal of vegetation, interference with, or changes to, natural drainage, leaking pipes such as water and sewer reticulation, modification of slopes by construction of roads, railways, buildings, etc., overloading slopes, mining and quarrying activities, vibrations from heavy traffic, blasting, etc., and excavation or displacement of rocks are some of the anthropogenic causes of landslides.

The causal factors for landslides could be morphological (such as volcanic or tectonic ground uplift, wind and/ or water erosion, deposition loading in slope crest, and vegetation removal due to natural reasons such as forest fires); or physical (prolonged precipitation, rapid draw-down, earthquake, volcanic eruption, thawing, shrink and swell, and artesian pressure) or a combination of the two.

Solutions

1. Evaluation of slope stability and any landslide threat is crucial during development assessments which could help in implementation of timely and effective remedial measures.
2. Slump and slide risks can be reduced through suitable profile modifications such as that of soil and/or rock.
3. Improved drainage for runoff of accumulated water to avoid saturation of water
4. Stabilisation of soils by vegetation could substantially increase the cohesiveness of subsurface material, preventing surface erosion and shallow mass failures.
5. Construction of restraining structures, and permeable walls could help impede rock and soil movement and increasing the shear strength.
6. Stabilising the mobile parts of the affected parts through piles could help minimize the damage.
7. Ground anchors supporting mobile mass could help in preventing further movement.
8. Other measures could be electro-osmosis (for drainage in less permeable soils), and thermic treatment of soil for hardening.
9. Preparing landslide hazard/susceptibility zonation and management maps on 1:25,000 scale based on integration of geological, geo-structural, slope, geomorphological, land use/land cover and other terrain characteristics derived from satellite, topographic and other collateral data.

[1] United States Geological Survey
[2] http://www.imd.gov.in/ims/pdf/plenary/SMV.pdf

CASES

Jammu & Kashmir

08-10-2005

Ten people were killed and some others went missing after a house collapsed due to landslide in Rajouri district of Jammu and Kashmir on 8th October.

Sikkim

21-09-2012

Several landslides were triggered due to excessive rainfall on 21-Sept-2012. This event has caused 21 deaths. Damage to the buildings and roads in the Lachen river valley was observed.

23-06-2011

Heavy rainfall in Pelling and surrounding regions. Landslides hence triggered at various places caused damage to property and killed 16 people.

Himachal Pradesh

12-02-2014

The continuous moisture in soil due to melting of snow triggered landslides in Kullu district, washing away roads and terraced fields.

08-08-2011

Landslides triggered by incessant rains in Mandi district blocked national highways for many hours at many places, disrupting traffic flow.

Uttarakhand

16-08-2014

Seven persons were killed after a landslide led to the collapse of three houses at Kathbangla locality in Dehradun. The rescue team had to work hard to break the concrete pucca ceiling of the collapsed houses to rescue people.

12-07-2013

Six people were killed in a landslide in Nainital. The landslide came after a heavy spell of rain in the area on the previous day.

15-06-2013

Heavy rainfall on 15th – 17th June in Uttarakhand caused devastating floods and landslides. As per reports on 17th June, around 5,700 people lost their lives in three days. Kaidarnath, Gaurikund, and market town of Rambada were completely washed away by floods and debris in Mandakini river. It turned to be the country's biggest disaster after tsunami in 2004.

Maharashtra

30-07-2014

The landslide struck and wiped out the village of Malin, near Pune. Nearly 44 houses were buried and around 134 people died. One of the reasons was changing agricultural practices –shift from cultivation of rice and finger millet to wheat. This required levelling of steep areas, contributing to instability of the hills. Also the construction of the nearby dam was considered as a possible reason. The instability of the hillsides was also due to the construction activities, and stone quarrying.

Sources of cover page photographs (from left to right):
Photo 1: Image of landslide on Mumbai-Pune Expressway, *source – NMTV*
Photo 2: Image of landslide during floods of Uttarakhand, *source - Samachar*
Photo 3: Image of landslide in Mumbai's suburb (June 2010), *source – America Pink*