

# IoT based landslide prediction and prevention

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## Problem Statement Understanding

### 1.Landslides:

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are 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). Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.

### Causes of Landslides:

Landslides occur when the slope (or a portion of it) undergoes some processes that change its condition from stable to unstable. This is essentially due to a decrease in the shear strength of the slope material, an increase in the shear stress borne by the material, or a combination of the two. A change in the stability of a slope can be caused by a number of factors, acting together or alone. Natural causes of landslides include:

- saturation by rain water infiltration, snow melting, or glaciers melting.
- rising of groundwater or increase of pore water pressure (e.g. due to aquifer recharge in rainy seasons, or by rain water infiltration).
- increase of hydrostatic pressure in cracks and fractures.
- loss or absence of vertical vegetative structure, soil nutrients, and soil structure (e.g. after a wildfire – a fire in forests lasting for 3–4 days).
- erosion of the toe of a slope by rivers or sea waves.
- physical and chemical weathering (e.g. by repeated freezing and thawing, heating and cooling, salt leaking in the groundwater or mineral dissolution).

- ground shaking caused by earthquakes, which can destabilize the slope directly (e.g., by inducing soil liquefaction) or weaken the material and cause cracks that will eventually produce a landslide.
- volcanic eruptions.

**Landslides are aggravated by human activities, such as:**

- deforestation, cultivation and construction.
- vibrations from machinery or traffic.
- blasting and mining.
- earthwork (e.g. by altering the shape of a slope, or imposing new loads);
- in shallow soils, the removal of deep-rooted vegetation that binds colluvium to bedrock;
- agricultural or forestry activities (logging), and urbanization, which change the amount of water infiltrating the soil.
- temporal variation in land use and land cover (LULC): it includes the human abandonment of farming areas, e.g. due to the economic and social transformations which occurred in Europe after the Second World War. Land degradation and extreme rainfall can increase the frequency of erosion and landslide phenomena.

## **Impact of landslides:**

### **Landslides harm agriculture**

One of the most damaging effects of landslides is the destruction of agricultural land. Debris spread over farms, cultivation and pastures, covering important agricultural land. They destroy seeds, plants, food stocks and grazing land. These lands can remain inaccessible for years ultimately impacting on farmers' livelihoods. In Guatemala as an example, watersheds collapsed in 2005 due to landslides associated with Tropical Storm Stan. Consequently, farmers were severely affected by this event.

### **Damage built infrastructure**

Landslides can cause serious damage to the built infrastructure. They can destroy and/or damage houses, buildings and infrastructure close to hills and mountains. They block roads, railroads and shipping lanes. In 1980, a debris flow from Mount St Helens volcano filled the Columbia River with more than 34 million m<sup>3</sup> of sediment. Cargo ships could not reach Oregon until the sediment was dredged.

### **Economic losses**

As it currently stands, economic losses due to these hazards have been increasing during the past decades. This is mostly linked to increasing development and investment in landslide-prone regions. Basically, landslide costs include both direct and indirect losses.

Direct losses refer to costs of repair, replacement or maintenance of properties and assets affected by landslides. All other costs like loss of agricultural productivity, effects on water quality and reduced real estate values are indirect losses. The devastating 1983 Thistle landslide in Utah, United States, had direct and indirect economic losses on the order of \$688 million.

### **Loss of lives and social disruption**

Landslides are responsible for a number of deaths, injury to people, damage to housing, infrastructure and agricultural lands. In the United States alone, some 25-50 people are killed by landslides each year. In Italy, more than 10,000 people died in 840 landslides during the period 1279 to 1999. More often than not, the disasters happen without warning giving people no time to escape.

Sometimes, such events can impact on the mental health of people also; children and youngsters especially at more at risk. Moreover, victims of landslides can develop crush injuries or crush syndrome after they have been rescued from the debris.

## Software and Hardware requirements

### Hardware:

#### Arduino microcontroller:

The Arduino microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the "Arduino language". In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool (arduino-cli) developed in Go.

#### Soil Moisture Sensor:

**Soil moisture sensors** measure the volumetric water content in soil. Since the gravimetric measurement of free soil moisture requires removing, drying, and sample, soil moisture sensors measure the volumetric water content indirectly other property of the soil, such as electrical resistance, dielectric constant, or neutrons, as a proxy for the moisture content. direct weighing of a by using some interaction with

#### Vibration Sensor:

A **vibration sensor** is a device that measures the amount and frequency of **vibration** in system, machine, or piece of equipment. Those measurements can be used to detect imbalances or other issues in the asset and predict future breakdowns. (1Hz-300kHz) a given

#### ATMEGA 328 Microcontroller:

The **ATmega328** is a single-chip **microcontroller** created by **Atmel** in the megaAVR family (later Microchip Technology acquired **Atmel** in 2016). It has a modified Harvard architecture 8-bit RISC processor core. **Atmega328 microcontroller** is used in basic Arduino boards i.e Arduino UNO, Arduino Pro Mini and Arduino Nano.

#### MEMS Accelerometer:

MEMS accelerometers are used wherever there is a need to measure linear motion, either movement, shock or vibration but without a fixed reference. They measure the linear acceleration of whatever they are attached to. Acceleration is measured in  $m/s^2$ , but the convention for accelerometers is in 'g', or units of gravity, 1g being  $9.81m/s^2$ .()

#### ESP8266 wifi:

The **ESP8266** is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability.

### Software:

## Proteus:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

## Arduino IDE:

It is an open-source software tool used to write and compile code in Arduino Module. It runs on OS such as Windows, MAC, Linux etc.

## Python:

Python is an interpreted high-level general-purpose programming language. Python's philosophy emphasizes code readability with its notable use of significant indentation. design

## Additions and Updates

1. All the sensors should run on solar energy, so if there is a power cut due to any reason, still charging will be done because it will no longer need electricity from the power line.

## Applications, Advantages, Challenges

### Applications:

### Advantages:

1. Helps to prevent life and property.
2. Implementation of this kind of network is quite reliable.

### Challenges:

### Conclusion:

Real time monitoring of landslides is one of the challenging research areas available nowadays within the field of geophysical research. The event of an actual field deployment of a wireless device network primarily based landslide detection system. This system uses wireless sensor nodes, ESP8266 wifi for efficient delivery of real time data to the system for monitoring and provide warnings and risk assessments to the inhabitants of the area. This network will be used for understanding the capability and usability of wireless sensor network for critical and emergency application.

## References:

1. *What Is a Landslide and What Causes One?*, [www.usgs.gov/faqs/what-a-landslide-and-what-causes-one?qt-news\\_science\\_products=0](http://www.usgs.gov/faqs/what-a-landslide-and-what-causes-one?qt-news_science_products=0).
2. “Effects of Landslides: Positive, Negative, Examples.” *Yo Nature*, 18 Aug. 2020, [www.yonature.com/effects-landslides-positive-negative-examples/](http://www.yonature.com/effects-landslides-positive-negative-examples/).