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Landslide occurring during large storms are generally considered to be triggered by the impact of rainfall on slope stability. Yet, (2009) Schulz et have al. demonstrated that atmospheric pressure changes can also affect the stability of slow moving landslides. Here, we investigate the impact of atmospheric pressure change and rainfall on the stability of slopes.

2. Model

The hillslope is modelled as a tilted 1D homogenous infinite half-space following a Mohr-Coulomb friction law. Both rainfall infiltration and atmospheric pressure changes have an impact on pore pressure. It is computed using an impulse response function based on an existing model (Iverson, 2000).



| Model parameters | | |
|------------------------|------------|--|
| slope angle | α | 30° |
| friction angle | arphi | 25° |
| cohesion | С | 20 kPa |
| hydraulic conductivity | K_{z} | 10 ⁻⁶ m ² .s ⁻¹ |
| Hydraulic diffusivity | D | 10 ⁻⁵ m ² .s ⁻¹ |
| Saturated unit weight | γ_s | 20 kPa.m ⁻¹ |
| Water table depth | h | 2 m |

3. Rainfall effect

The rainfall effect is delayed in time and the maximum pore pressure is reached hours to days after the end of the main event. This delay is increasing and maximum amplitude decreasing as depth increases.

4. Atmospheric effect

The effect of the atmospheric pressure is instantaneous and always equals the inverse of the pressure change – if under the water table level. The below depth, the surface, only modifies the speed at which the pore pressure decays back towards zero.

5. Comparative effect

rainfall Both infiltration and atmospheric pressure changes modify pore However, pressure. their respective impact on the safety factor depends on the intensity of the storm event and the model.

The impact of atmospheric pressure change and rainfall for triggering landslides during weather events

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6. Results

China

The model has been applied to a real data set corresponding to typhoon Morakot which struck Taiwan in August 2009. In only 4 days the cumulated rainfall reached 3000 mm, and the atmospheric pressure dropped by 3.5 kPa.

The effect of rainfall and atmospheric changes are magnitude. in similar However the drop in safety factor occurs earlier when considering the atmospheric pressure.



7. Model improvements

Taiwan Central Weather Bureau

(http://www.cwb.gov.tw)

Medium-strength typhoon (Vmax 32.7-50.9 m/s) (Vmax 17.2-32.6 m/s) (Vmax<17.2 m/s)

Our 1D model is not very representative of the complexity of landslides and leads to overestimating the delay of response due to rainfall. A 2D model would improve the accuracy – especially concerning slope-parallel fluid flow – and allow for a spatial evaluation of the atmospheric effect over the entire hillslope.

8. Take-home message

- Rapid changes in atmospheric pressure have a short term impact over slope stability.

- The deeper the slip surface the higher the effect.
- The effect can lead to an early failure during the occurrence of the storm.

References

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