Influence of orientation and vegetation cover on soil thermo-hydraulic behaviour: a monitored embankment study

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ABSTRACT

Slope mass-wasting (SMW) such as erosion and slope failures is currently one of the most important environmental problems affecting society and biodiversity. The effects of SMW are extensive and include loss of forests and agriculture land, reduction of reservoir capacity, damage to infrastructures, fatalities, among others. Recent research forecasts an increase of SMW triggering factors as a consequence of global warming, such as extreme precipitation events and prolonged droughts [1].

Soil-vegetation-atmosphere (SVA) interactions play an important role in the stability and erosion of natural and man-made slopes due to their influence on the slope thermo-hydro-mechanical conditions [2]. The comprehension of SVA interactions is important to reduce SMW mechanisms and a correct land-use planning. The use of vegetation to reduce slope erosional processes is environmental friendly and relative low cost, when compared to traditional engineering measures. Nevertheless, vegetation effects on slope stability and surficial erosion must be studied in order to apply possible SMW mitigation strategies.

A full-scale monitored embankment with different orientations (South and North) and slope covers (bare and vegetated) is presented. The main goal is to understand the effect of both orientation and slope cover on SVA interactions and the influence on the soil thermo-hydraulic behaviour. This work presents results on rainfall infiltration, drying rates, temperature and heat flux data. Monitoring is crucial for a better understanding of the physical mechanisms related to SVA interactions. Furthermore, it is necessary for the calibration and validation of models.

The results show that vegetation can have positive and negative implications regarding slope stability and surficial erosion. Vegetation enhances rainfall infiltration and hence decreases runoff, which reduces surficial erosion and slope stability. Moreover, plant transpiration develops higher and faster suctions, which increment slope stability. Nevertheless, it has to be verified that the decrease of slope stability due to higher infiltration rates is compensated by the faster suction recovery and by root mechanical reinforcement. In terms of orientation, daily temperature changes and heat flux are higher at South oriented slopes. As a result higher evaporation rates are expected on South-facing slopes. Vegetation cover strongly reduces sun radiation incidence on South-facing slopes and consequently heat flux decreases roughly by 75%. This effect is reduced on North oriented slopes. However, the effect of vegetation transpiration in the development of dryer soil conditions is more important than the orientation effect. This can be stated by the higher drying rates and conditions at the North vegetated slope compared to the South bare slope.

REFERENCES

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