3.3.4 Indonesia

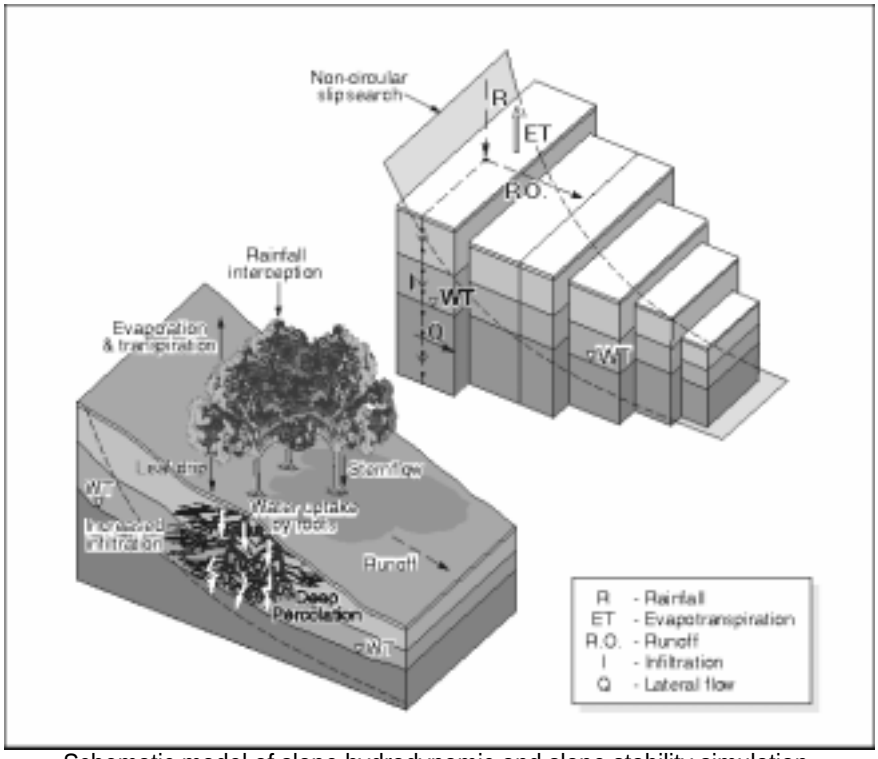
Indonesia

Development of Eco-Bio-Engineering Mitigation System: An Eco-Geological Approach towards Community-Based Prevention of Rain-Induced Landslides in Java

The mountains that cover about 70 % of the island of Java, geological conditions and high precipitation make Java highly susceptible to landslides. Their occurrence, however, has dramatically increased within the last three years mainly as the result of urbanization and deforestation.

Integrated Approach for Landslide Mitigation
Most of the vulnerable areas in Indonesia are rural area. Consequently, a low-cost, simple system is required in the light of the socio-economic conditions of these areas. An eco-geological approach with respect to a community-based system of slope management is therefore preferred.

a. Role of vegetation
Some previous investigations show that vegetation on slopes can effectively control the slope hydrology and stability. The vegetation cover on slopes significantly affects the rate of rain infiltration and rise in the groundwater table as well as improvement of soil/rock shear strength on slopes. Wilkinson et al. (1988) and Wilkinson (2000) found that in hydrological terms, vegetation affects the slope hydrology and slope stability through three mechanisms depending on the type of vegetation, as illustrated below. Dense stands of trees can significantly reduce the effective rainfall infiltration owing to interception, evapo-transpiration and root water uptake. Accordingly, the capacity of free water both as runoff on the slope surface as well as infiltrated water in the soil pores can be reduced, and thus the occurrence of floods and landslides can both be minimized.
Meanwhile in mechanical terms, both root reinforcement and vegetation surcharge significantly affect slope stability (Wilkinson, 2000). Deep penetration of root stands into hard rocks beneath the loose soil provides crucial additional support to the soil cohesion, and thus increases the soil shear strength against sliding.



Schematic model of slope hydrodynamic and slope stability simulation.

b. Proposed bioengineering management
The suggested type of vegetation for both controlling hydrological conditions and maintaining slope stability is local trees, which are not too heavy but have quite deep roots. The pattern and space of tree plantations should also be arranged to reduce excessive weight that may also drive soil movement. At least a 10-m distance between tree stands is suggested. Grass or low vegetation can therefore be planted between trees.
A numerical approach is very useful in analyzing complex slope-stability problems in hydrologically sensitive areas with respect to the design of vegetation plantation. Such analysis, applying the Combined Hydrological and Stability Model (CHASM) developed by Wilkinson et al. (1998), is currently being undertaken to develop the most appropriate design for several models of slopes in Central Java.

c. Role of social management
All the bioengineering designs proposed above may not be effectively implemented in areas subject to landslides in the absence of a rigorous assessment of the social conditions of the community in vulnerable areas and their surroundings. Improving the willingness of community to protect its own susceptible area is necessary. Most communities consist of farmers or people living in an agricultural environment. Introducing vegetative measures to maintain the sustainability of hydrological regimes in their environment is therefore highly appropriate.

Conclusion

Considering the socio-economical conditions of landslide susceptible areas in Indonesia, a low-cost but effective and simple system is required to minimize the occurrence of landslides. Integrated water-resource management with respect to community -based slope management is accordingly proposed. The communities' understanding on the importance of vegetation for environmental protection against landslides is crucial for indirectly reducing the rate of deforestation and thus in empowering the community to minimize landslide disasters.

- **Background**
The mountains that cover about 70 % of the island of Java, geological conditions and high precipitation make Java highly susceptible to landslides. Their occurrence, however, has dramatically increased within the last three years mainly as the result of urbanization and deforestation.

- **Objective**
To prevent or minimize the occurrence of landslides by developing an appropriate management system and to reduce serious socio-economic damage.

- **Term/Time Frame**
The project is now in progress.

- **Activities Undertaken**
Analysis of complex slope stability problems in hydrologically sensitive areas is currently being undertaken by applying the Combined Hydrological and Stability Model (CHASM).

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