INFLUENCE OF LAND USE ON LANDSLIDES

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INTRODUCTION

Landslides denote downward and outward movement of slope forming materials composed of natural rock, soils, artificial fills or combination thereof, along surfaces of seperation by falling, sliding and flowing. Landslides are natural occurrences and is one of the land forming processes. Landslides are mass wasting processes and have to be distinguished from soil erosion which are surface wasting processes.

Although these are natural processes, landslides cause extreme public interest when damage to life and property are caused. Widespread landslides have occurred in Sri Lanka causing economic damage in 1947 in Kotmale, in 1984 in the Kalutara District and in 1986 in the Nuwara Eliya and Badulla Districts.

PREDISPOSING FACTORS

Steep slopes, unstable soils and geologic materials are contributory factors to landslides. Tsukamoto and Kusakabe (1984) have classified 4 slope types (Fig. 1) and roughly estimated the susceptibility to landslides.

Type A slopes:

In this type of slope there is a shallow soil layer overlying rock with no fissures. This slope is very unstable. Trees on this type of slope may even enhance the occurrence of landslides due to the additional weight. Lithosols and other shallow soils on dip slopes would represent this type of slope.

Type B Slopes:

A shallow soil layer overlies rock where fissures exist. Roots of trees can penetrate the fissures and provide anchorage thereby reducing landslides. Removal of forest cover will drastically decrease the stability of the land. Immature Brown Loam soils and the shallow phases of other soils specially on scarp slopes are similar to Type B slopes.

Type C Slopes:

The soils are somewhat deep but the soil becomes increasingly compact and of increasing shear strength with depth. Few tree roots penetrate the denser transition layer and stabilize the slope. Removal of trees and subsequent decay of tree roots destabilizes the land to a great extent. Lands with Reddish Brown Earths and the heavier Red Yellow Podsolic Soils on steep slopes are similar to Type C slopes.

Type D Slopes:

Deep soils with good structure on gentler slopes characterize Type D slopes. These slopes are generally stable. Medium textured Red Yellow Podsolic soils. Reddish Brown Earths, Non Calcic Brown Soils, Red Yellow Latosols and Reddish Brown Latosolic Soils on gentler slopes are similar to Type D slopes.

Removal of forest cover from extreme slopes with unstable soils is the long term causative factor for landslides. Under conditions of soil saturation upto 80% of the total shear strength of a soil is attributed to tree roots (O'Loughlin, 1974, O'Loughlin and Watson, 1979). Although retention of forests cannot guarantee total prevention of landslides, there

are a number of studies which report increase of landslides due to removal of forest cover e.g. O'Loughlin and Pearce (1976), Burrough and Thomas (1977).

The short term causes or "the trigger" to start landslides is saturation of the critical subsoil layers and increase of pure water pressure or vibrations due to earth tremors or explosions. Very heavy rainfall fell prior to the occurrence of the major landslides e.g., upto 750 mm on August 14 and 15th 1974 at Kotmale, upto 500 mm on 21st and 22nd May 1984 at Matugama and upto 1000 mm from 1st to 7th January 1986 at Maturata. Therefore saturation of the subsoil is undoubtedly the main cuase of landslides in Sri Lanka.

INFLUENCE OF LAND USE

Since it is presumed that saturation of the sub soil is the main cause of landslides, and also since it is estimated that upto 80% of the total shear strength of a saturated soil is attributed to tree roots, land use based on trees plays a very significant role in preventing landslides. Thus trees with very deep roots even penetrating into fissures in rocks are the most important. Forest trees standing for many generations would reach this state. Removal of forest cover and subsequent decay of roots will destabilize susceptible slopes.

Trees of younger age, vegetatively propagated trees without a strong tap root system, perennial grasses and annual crops will have progressively weaker root systems with respect to stabilising lands against landslides. Therefore, once forest cover is removed from susceptible sites, landslide occurrences are intensified with agricultural uses. A qualitative scale of susceptibility to landslides is shown in Figure 2.

Other land management practices are required to prevent excessive and concentrated seepage of water to the sub-soil. Well designed

mechanical soil conservation works such as drains on graded contour will dispose of excess water in a orderly fashion during high intensity rains.

In Sri Lanka,the land - man ratio is 0.3 ha per man. This is very small for a predominantly agricultural country. Thus,it is very necessary to make optimum use of all land. If susceptible lands are planted with trees to minimise landslides, thought must be given to utilization of products such as timber, fodder, fruits etc. Large scale logging can accelerate landslides.

From the above considerations it is seen that more aspects than specifying a crop is involved in discussing land use with respect to landslides. According to the Framework for Land Evaluation (FAO, 1976) land use described in terms of the crop and management aspects are termed Land Utilization Types. Thus for lands with varying degrees of landslide hazards particular land utilization types involving appropriate mix of crops and trees with soil conservation measures will have to be specified.

Stabilization of scars and debris of landslides that have already occurred is also urgently necessary to minimize siltation of reservoirs, damage at neighbouring streams and lands. Vegetation,especially tree vegetation plays a major role in slope stabilization through reduction of soil water through evapotranspiration, consolidation of the soil mass by root systems and anchoring of the regolith to the bedrock in areas where the rock is partly weathered or fractured. Since establishment of trees will take a long time, grasses which are shallow rooting should be established to bind the mass of soil together.

RESEARCH REQUIREMENTS

No investigations have been done in Sri Lanka on appropirate land use to minimise land-slides. For obvious reasons, research on landslides has to be a very long term task.

Firstly, landslide hazard maps showing the degree of hazard as well as the different types of slopes should be prepared. It is necessary to categorize slopes in more detail than done by Tsukamoto and Kusakabe.

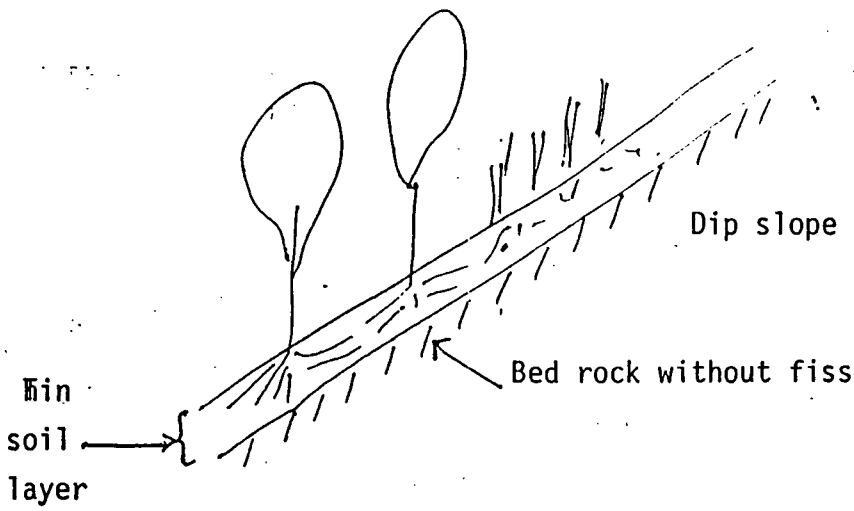
The mix of trees and crops required for the different types of hazardous slopes will have to be tested. The rooting capability of different tree species will have to be estimated. The strength of roots of the species too has to be studied.

Using the data from the above studies, appropriate land utilization types for hazardous areas will have to be done.

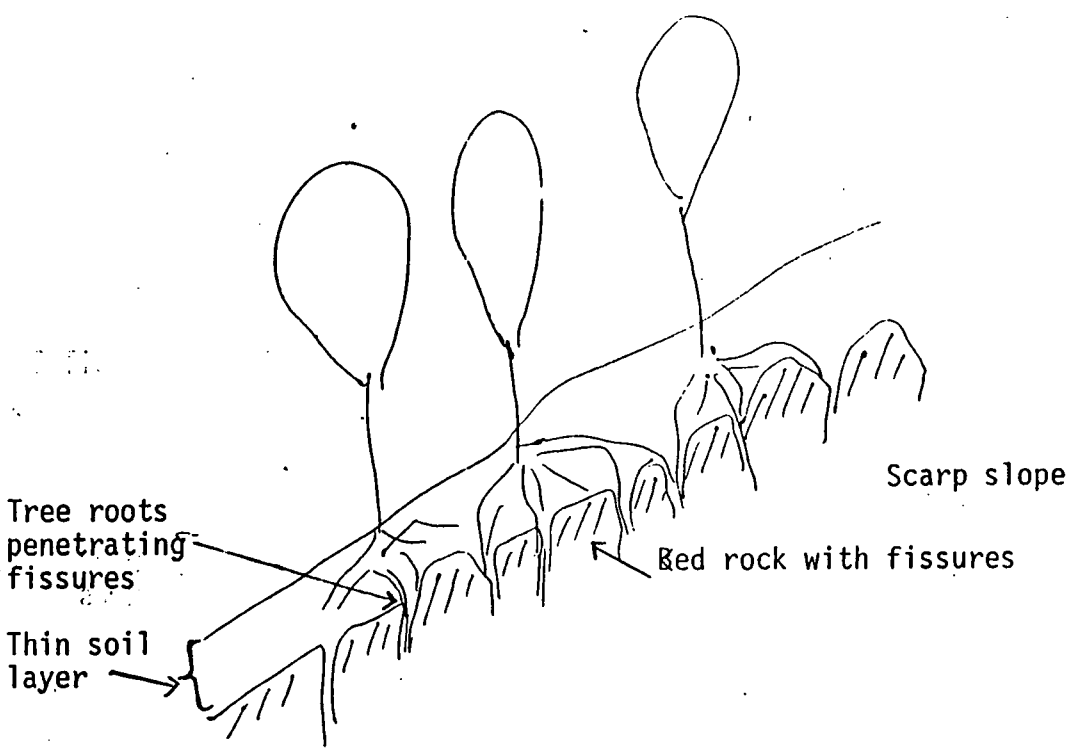
CONCLUSION

Damage to land and people by landslides could be greatly minimised by proper land use planning. Money spent on this activity should be far less than the cost of landslides damage and the possibility exists to even earn better incomes from appropriate land use enterprises than from presently practised marginal enterprises.

Figure.1. Classification of Slopes According to Landslide Hazard.

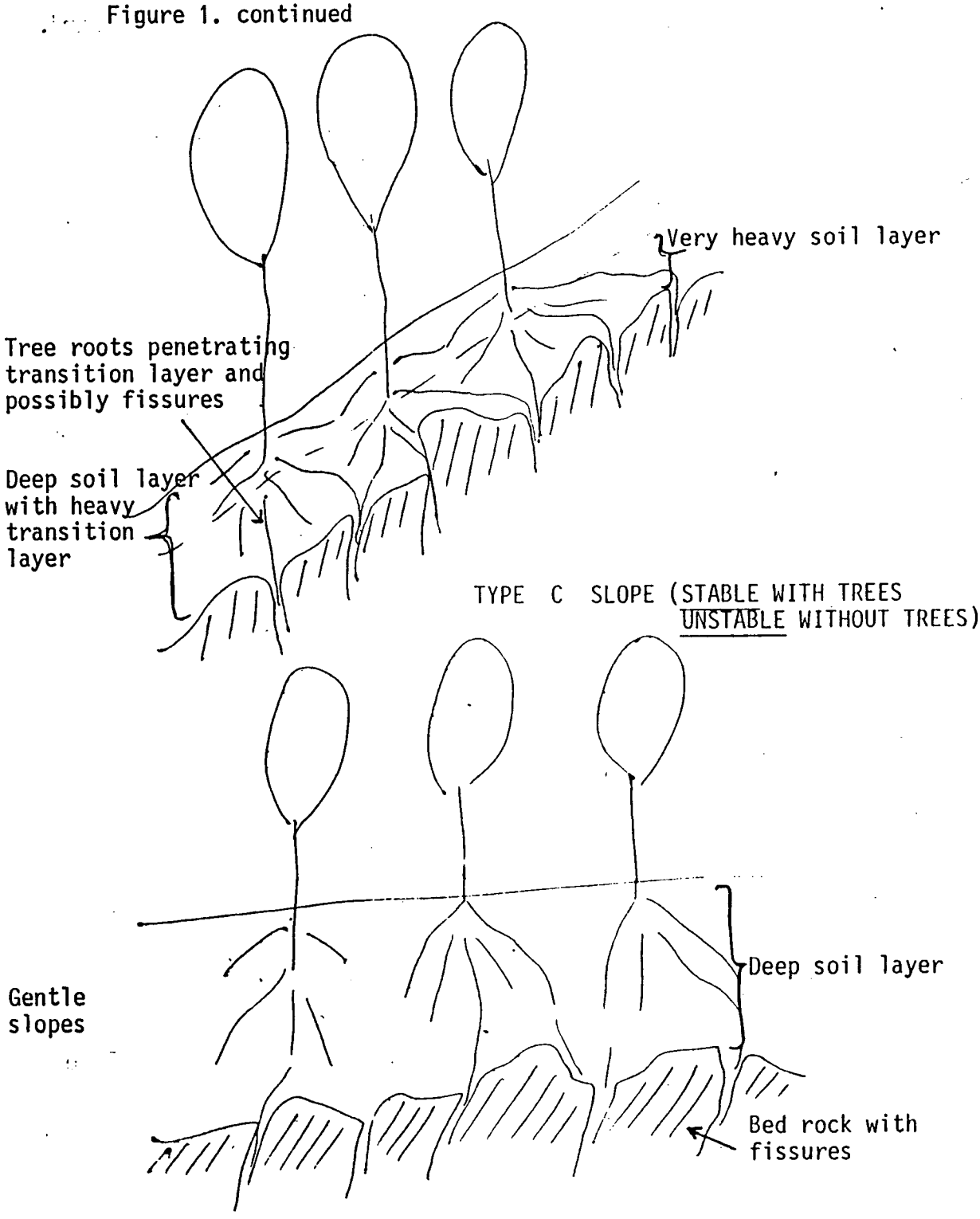


TYPE A SLOPE (VERY UNSTABLE)



TYPE B SLOPE (STABLE WITH FOREST TREES, UNSTABLE WITHOUT TREES)

Figure 1. continued



TYPE D SLOPE (VERY STABLE)

Figure 2. Landslide Hazard Rating of Land Uses

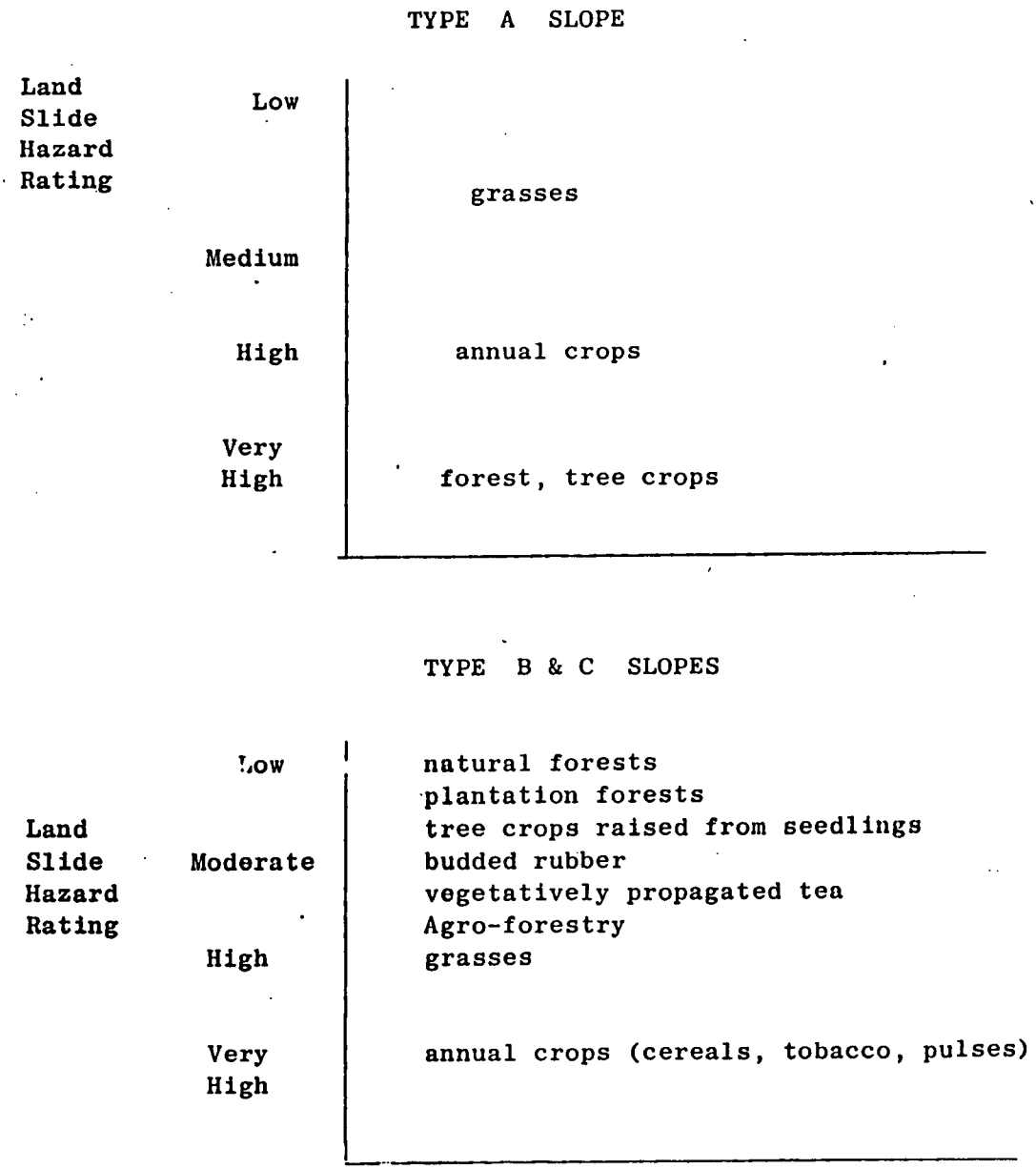


Figure 2. continued.

TYPE D SLOPE