WATERSHED AFFORESTATION FOR PREVENTION OF SOIL EROSION AND LAND SLIDES

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INTRODUCTION

Some of the mountainous Watersheds of Sri Lanka are very thickly populated due to their favourable climatic conditions for cultivation and good living. Practices of mis-use of land in these watersheds have caused very serious degradation and already large areas have been identified as being in most critical need of stabilization. These areas require immediate soil erosion control and stabiliztion by establishment of permanent vegetative cover. This is extremely important because the mountainous areas provide catchment and storage for the bulk of the country's water supply. The upper Mahaweli watershed degradation has caused decline in river levels during the dry period of the year and promotes the occurrences of landslides and flash floods which result in loss of lives and substantial losses for the country's national economy. The Government is making massive investments in irrigation works and in hydro-electric power of the Mahaweli river. Non-availability of irrigation water in the quantities needed and the under utilization of power station capacity resulting from the reduced dry season water flow and erosion causing siltation of reservoirs will seriously undermine the viability of such an important project. Therefore, proper land management of such a critical watershed has a vital importance for the whole nation.

OBJECTIVES OF WATERSHED AFFORESTATION

Primary objectives of watershed afforestation could be identified as follows:

(a) To protect and preserve the soil resources as the basis of upland's productivity.

(b) To protect down-slope arable lands from becoming choked with sediment.

(c) To minimize the sediment loads of rivers which will ultimately reduce the storage capacity of reservoirs and the operating efficiency of hydro electric power plants.

(d) To regulate the stream flow, so that flooding will be minimized in the wet season and stream flows will be maximized in the dry season.

(e) To protect lives and propertieis from landslides by stabilization of unstable slopes.

AFFORESTATION FOR CONTROL OF SOIL EROSION

The control of soil erosion is the primary objective of afforestation programs in critical watershed areas. The importance of tree planting for this purpose has long been recognized. A forest cover with a good canopy and well developed litter on the forest floor can reduce soil erosion to virtually nil even on long steep slopes of erodible soil in regions of intense rain fall. In doing this, the forest floor is probably more important than the canopy. Water dripping from tall trees would have nearly the same erosive power as direct rainfall. The understory vegetation and leaf litter on the soil surface absorb the energy of the rain drop impact and thus protect the soil from the detachment process with which erosion begins.

EFFECTS OF FOREST VEGETATION AGAINST EROSION COULD BE IDENTIFIED AS FOLLOWS

(a) The protective canopy, which breaks the impact of raindrops and protects against splash erosion.

(b) The mat of litter, which further protects against raindrop splash

and also slows surface runoff.

(c) The channels of decayed roots in the soil which increase infiltration.

(d) Transportation of soil is reduced due to physical binding of the soil with roots.

(e) The improvement of soil structure and its water absorbing capacity through the addition of organic matter.

(f) Transpiration will increase water storage capacity of the soil This extends the period of infiltration and reduces surface runoff during small storms.

It has been well documented that, due to these reasons the forest cover is the most efficient means of soil erosion control in critical watershed areas. Therefore, steep slopes which are not suitable for other uses should be kept under permanent forest cover.

EFFECT OF AFFORESTATION ON LANDSLIDES

There are six environmental factors that should be carefully considered when judging stability of natural slopes against landslides. They are:

(a) Landform features
(b) Soil characteristics
(c) Bedrock lithology and structure
(d) Vegetative cover
(e) Hydrologic characteristics of site
(f) Climate

Each of these factors encompasses a group of factors which control stability of the slope and determine the typesof landslides which are most likely to occur. Discussions of effects of all these factors on occurrence of landslides are beyond the scope of this paper, and only the vegetative cover factor is discussed.

EFFECT OF TREE (VEGETATIVE) COVER ON STABILITY OF NATURAL SLOPES

(a) Reduction of soil moisture by interception and evapotranspiration:

Vegetative cover generally helps to control the amount of water reaching the soil and the amount held in the soil as stored water against gravity, largely through a combination of interception and evapotranspiration. As indicated earlier, under forest conditions interception take place in two stages, first by the multi-storied canopy and then on the soil surface by forest floor. The direct effect of interception on the soil water budget is probably not large in areas of high total rainfall or high intensity rainfall, but it has a significant influence in low intensity rainfall areas such as Nuwara Eliya. Evapotranspiration is more pronounced in low rainfall areas than in high rainfall areas. However, in areas characterized by warm weather, evapotranspiration significantly reduces the soil moisture content from various levels of sub soil. This may lead to substantial recharge requirements in order to satisfy soil water deficits, reducing the possibility of saturated soil conditions necessary for slide producing events.

(b) Anchoring action of the root system:

Root system of trees and other vegetation may increase shear strength in unstable soils by anchoring through the soil mass into fractures in bedrock. Pinus caribaea, the common species planted

in the Upper Mahaweli watershed has a wide spreading deep penetrating and strong root system. Generally the Taproot system of 15 years Pinus caribaea tree grows upto a depth of 8 - 10 feet.

(c) Binding effect of fibrous lateral root system:

Lateral root system of tree species and other vegetation may provide continuous long fibrous binder within the soil mass, and tying the slope together across zones of weakness. A very good example for this effect is bamboo species planted in the up-country watershed. The most important features of bamboo species are its fast growth rate and interlocking fibrous root system which binds the soil moss together.

SELECTION OF TREE SPECIES FOR CONTROL OF SOIL EROSION AND LAND SLIDES

For erosion control the choice of vegetation is wide, generally all plants are capable of providing some degree of protection, whether herbaceous plants, shrubs or trees. But trees provide the best, long-term protection against soil erosion as well as landslides. In selection of species for control of soil erosion and landslides, special consideration should be given to tree species which produce abundant litter. Where tree species are chosen which produce little litter, the management of a well developed understory may be necessary for effective erosion control. Following are some desirable characteristics which may be considered in selection of tree species for control of soil erosion and landslides.

(1) Good survival and fast growth rate - The time required to establish the vegetative cover is an important consideration.

(2) Ability to produce a large amount of litter.

(3) Strong, deep penetrating and wide spreading root system with numerous fibrous roots. In landslide zones deep roots are unusually essential for providing anchoring action.

(4) Ease of establishment and need for little maintenance - generally the soils in watershed areas are moderate to severely eroded due to the nature of their terrain and in appropriate use of land. Soils are very poor in physical properties as well as in nutrient status, and extremely unfavourable for plant growth. Hence, in watershed re-forestation programs, consideration should be given for species which are capable of successful establishment under such conditions.

(5) Canopy to form a dense crown and to retain foliage year round, or at least through the rainy season.

(6) Resistance to insects, disease and browsing by game, cattle and other animals.

(7) Soil improvement, such as nitrification by legumes.

(8) Provision of some economic returns.

AFFORESTATION AND REFORESTATION PROGRAMS IMPLEMENTED BY THE FOREST DEPARTMENT IN THE UPPER MAHAWELI WATERSHED

The land in the Upper Mahaweli watershed is characterized by rather steep slopes ranging from 45% to over 100%. The principal crop grown in the Upper Mahaweli catchment is tea, which occupies approximately one third of the Upper catchment land area. About 13.6% of the catchment is under natural forests and forest plantations. It has been estimated that around 35 percent of the area of the Upper Mahaweli Catchment area are

suffering extreme erosion. this includes vegetable and tobacco cultivated areas, degraded tea lands, shifting cultivated areas, "patana" lands and degraded scrub forests. Forest Department's current reforestation programmes include rehabilitation of last four categories of lands.

Forest Department has five ongoing reforestation and afforestation programmes in the Upper Mahaweli catchment.

(1) Reforestation and Watershed Management Project:

This is a seven year project with USAID assistance for afforesting 24,000 acres of degraded steep lands in the Mahaweli catchment. The primary objective of the project is to provide vegetative cover on steep slopes in the Upper Mahaweli Catchment in order to minimize soil erosion, and improve the quality and supply of water.

Pinus caribaea which is an ideal species for watershed protection is planted as the main species under this programme. It may be posssible to convert these plantations into broad leaved species in the second rotation by natural or artificial regeneration. By the end of year 1985, 16,800 acres of degraded state lands have been afforested under this Project.

(2) Community Forestry Project:

This is a six year project with financial assistance from Asian Development Bank. The Project component within Upper Mahaweli Catchment is establishment of 328 acres of Farmers Woodlots within Kandy and Nuwar Eliya Districts. Under this Project, farmers and suitable state lands are selected with the assistance of A G A and lands given to farmers after entering into agreements for cultivation of fuelwood and fruit trees.

(3) Integrated Rural Development Project - Nuwara Eliya District:

The Project commenced in 1980, was funded by the Government of Netherlands. By the end of year 1985, 3325 acres of degraded steep lands in Nuwara Eliya District have been afforested under this Project.

(4) Reforestation of mature Plantations:

A four year project commenced in 1984 under Forest Resource Development Project for reforestation of 2000 hectares within Nuwara Eliya District. Old plantations established in 1930's are overmature and not putting any additional growth and are not utilizing the sites to full potential. The Project is to harvest these with no environmental effect and replant them at the rate of 200 Ha/year.

(5) Non Forest Planting

This includes Avenue planting, stream reservation planting and Homestead planting etc., under the Forestry Extension Programme.

RECOMMENDATIONS

Following recommendations are made in order to improve the forest cover in watershed areas:

(i) Protection of Natural Foests and Forest Plantations against illicit fellings and fire.

(ii) Establishment of tree cover on

(a) Lands deforested or denuded and requiring reforestation.

(b) Lands under other uses but not suitable due to severe limitations (This includes - unstable slopes too)

(c) Reservoir perimeters and stream reservations

(iii) Community Forestry programmes

(iv) Enrichment planting

(v) Non Forest planting such as -

(a) Avenue planting
(b) Channel bank planting
(c) Homestead planting