IMPLEMENTATION OF WATERSHED MANAGEMENT PLANS ON A SCIENTIFIC BASIS

by

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Abstract

With the massive development Programme undertaken by the Government with special reference to water resources development, the forest cover of the country has been reduced to 25%. Planning of major reservoirs have been done on the assumption that present climatic conditions and components of the hydrologic cycle to remain its characteristics. In addition reduction of the forest cover increases the erosion of top soil resulting land degradation. Therefore there is a need to preserve the original conditions of the reservoir watersheds and also to control numerous ill effects of soil erosion. The watershed management is an urgent need to our country and even neighbouring countries like India implements these Programme effectively. In this paper, concept of watershed management is discussed, emphasising the possible remedial measures.

1.0 General

The need for watershed management was recognised in the context of rapid degradation of forest cover and land degradation. Particularly with the Mahaweli Accelerated Programme, the Government is very much concerned with country's forest cover. According to the forest map of Sri Lanka in 1985 only 16,318 Sq.Km of forest was available for total land area of 65,610 Sq.Km. of land surface, which is only 25% of the total. It is beloved that more than 50% of the country was under forest cover at the time of independence in 1948. The erosion process by water begins with the initial raindrop impact. The understanding of the water shed management in relation to soil erosion and sedimentation process requires a basic knowledge of some fundamental concepts.

2.0 Erosion

Erosion and sediment yield studies are recent developments in the field of Hydrology. The prevention of soil erosion requires understanding of the factors that effect the rate and magnitude of the erosion. Upto now the sediment transport process is not fully understood by the scientists and engineers, though a considerable amount of progress has been made in this field.

Soil erosion from a drainage area can be classified into the process of detachment of particles and the sediment transport along channels and streams. Detachment of particles will depend on properties of soil, slope of the basin, size of rain drops and rainfall intensity. Sediment transport along stream, will depend on the transport capacity of the channel. Therefore it is clear that though erodable materials are available in plenty, sediment transport capacity could be limited and all erodable material necessarily need not get transported. Conversely, if the capacity is more than the available material in suspension scouring of channel beds and sides in fluvial channels would take place until the equilibrium is achieved.

Process of soil erosion can be mainly classified under four groups based on the factors effecting the soil erosion and these factors are given in the annexed Table 1.

2.1 Erosivity

It is the potential ability of rain to cause erosion depending on the size of the rain drop, intensity of the rainfall and the wind velocity. Kinetic energy of rain estimates the erosive power of the rainfall. Studies on rainfall characteristics in Sri Lanka indicate that rainfall intensity decreases with increasing altitude. Erosivity is a factor that cannot be controlled by man.

2.2. Erodability

This is mainly dependent on the properties of soil and the sediment transport capacity of the streams.

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2.3 Land Form

This represents the geographical formation of the land, land slope and shape and the parameters that determine the land forms.

2.4 Catchment Management

This is the only factor within the control of man and this can be sub divided into Agronomic practices and Engineering practices, which can be effectively used to control erosion to a certain degree.

In order to estimate sediment transport rates, two conventional methods are available. For example, use of empirical formulae and direct measurements by sampling are those. Though there are more than 13 empirical formulae, results obtained from such formulae vary by 100% to 200% and some times to 300%. This is due to the complex nature of the phenomena. Therefore, it is recommended to carry out sediment sampling by direct measurements to obtain better results and sometimes it would be possible to identify a specific empirical formulae to represent the catchment behaviour by comparing with measured data. However, as suspended load is going to depend heavily on rain drop size and rainfall intensities than total rainfall, observed data during a specific period would not be easily correlated to the long term conditions. However, conventional method of sampling sediment for bed load and suspended load is superior to empirical formulae.

Studies have been carried out in certain rivers in Sri Lanka in order to determine the sediment transport rates. For these studies potential reservoir sites were selected on the request of agencies responsible for planning and construction of these reservoirs. Studies were confined to a limited period of 12 months at each site for most of the places due to lack of equipment and funding. Studies were carried out by sampling of suspended sediment and bed loads and thereafter, correlating the sediment discharge to corresponding river discharge. The annexed Table 2 shows the results obtained. Due to complex nature of the sediment transport phenomena, one year of study will not be sufficient to draw any meaningful conclusions.

Regarding the management of reservoir catchment, engineering and agronomic practices have to be applied side by side depending on the land use of the catchment area. In areas where crop production is taking place agricultural practices become more predominant. In crown reservations engineering practices become more efficient. Agricultural practices are better known to the scientists and the people in comparison to engineering practices. Therefore, in this paper some of the engineering practices are discussed for implementation as such practices are not yet introduced in this country.

3.0 Engineering Practices

3.1 Identification of zones with high sediment yield

By interpretation of available aerial photographs or topographical maps, erosion intensity units have to be formulated on the basis of significant difference in physiography, slope, surface condition. Soil, vegetation, land use drainage density, erosion and rainfall intensities. Methodology for priority delineation is available in literature.

3.2 Remedial Measures

3.2.1.0 Trappingand retention of sediment by a vegetative screen.

A vegetative screen is more effective in preventing the sediment from entering reservoirs. Such screens whether artificial or natural at the head of the reservoir to diffuse the incoming flow, reduces its velocity and cause the sediment to deposit. Thus great amount of incoming sediment can be trapped at the head of the reservoir and prevented from penetrating further in to the basin. Forest belts have a multi purpose soil conservation role. They reduce wind velocity and improve micro climate, repress runoff and increase soil moisture. These are most effective when planted perpendicular to the direction of surface run off along the contour lines. However, in selecting the plant, it should be kept in mind that our interest is not only to conserve soil, but water as well. Plantation of Eucalyptus in crown forest is seriously challenged in many tropical countries including Sri Lanka due to high water loss from soil. This vegetation screen of a reservoir should be considered as a strict reservoir reservation where even grazing cannot be allowed. Following dimensions are recommended to fix the boundaries.

3.2.1.1 In dry zone flat country reservoirs.

1. Above bund top level contour along the periphery.
2. Reservation limits under the crown land ordinance along the streams.

These limits are given below.

i. Stream width less than 15 ft. - 66 ft. to either sides from the edge of the stream.
ii. Stream width less than 50 ft. - 136 ft. to either side.
iii. Stream width more than 50 ft. - 198 ft. to either side.

3.2.1.2 In up country reservoirs.

1. All slopes more than 45 degrees in the catchment.
2. 1000 ft. reservation along the slope of the catch ment above the B.T.L. contour along the peri- phery.
3. Reservation limits under the crown land ordinance.

3.2.2.0 Other Methods

In addition, following remedial measures are also recommended.

a) Land Steeper than 45% gradient should not be brought under any cultivation other than vegetative screen.

b) A minimum of 30% of the total area of the catchment area should be brought under heavy forest cover.

c) Grazing of livestock on steep slopes have to be prohibited.

d) Large scale construction activities in the river valley projects should provide a certain minimum percentage of total project cost towards the watershed management. Such conservation methods in watershed management are as follows.

i. Contour bunding.
ii. Percolation ponds.
iii. Construction of check dams to control gully erosion.
iv. Contour stone walls.
v. Land levelling.
vi. Forming drainage channels.
vii. Channel lining.

4.0 Conclusions

In order to justify the success of water shed management programme, a systematic monitoring of the effectiveness of water shed management measures have to be organised by monitoring following elements.

1. Estimation of soil erosion rates
2. Loss rate of soil fertility
3. Hydrological changes such as flood peaks, run off to rainfall ratio, seasonal and annual water yields and water quality.

5.0 References

1. Methods of computing sedimentation in reservoirs - UNESCO publication - 1985
2. Recent developments in erosion and sediment yield - UNESCO
3. Land Management - P. Krishnarajah, 1988
4. Sedimentation problems in river basins - UNESCO - 1982
5. Crown land ordinance of Ceylon

Table 1

FACTORS AFFECTING SOIL EROSION

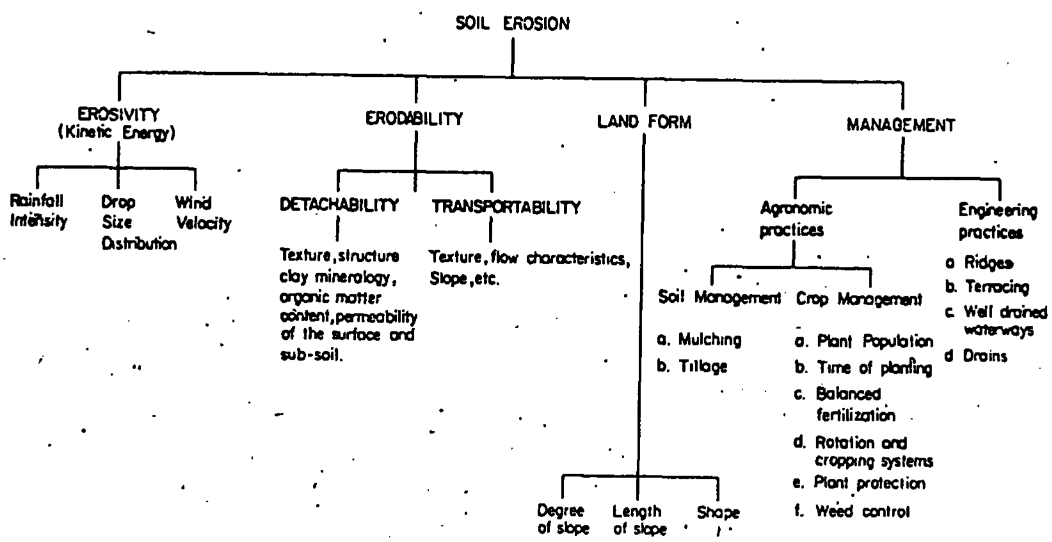

Table 2

SEDIMENT RUN-OFF ESTIMATES

River Basin	Station	Period Area	Drainage Yield Km^2	Annual T/Km^2	Sediment M^3/Km^2
1. Kelani Ganga	Hanwella	1987 - 1988	1809	875	442
	Metiya-dola	1962 - 1965	606	206	238
2. Mahaweli Ganga	Pera-deniya	1983 - 1984	1166	417	156
	Cale-donia	1986 - 1987	148	57	29
3. Walawe Ganga	Samanala-wewa	1985 - 1986	337	470	237
	Kumbal-gama	1959 - 1963	353	151	243
4. Kirindi Oya	Wellawaya	1985 - 1986	912	68	34