BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

(*Not to be reproduced without the permission of BIS or used as an Indian Standard*)

भारतीय मानक मसौदा

जलग्रहण क्षेत्र उपचार योजना की तैयारी के लिए दिशानिर्देश

Draft Indian Standard

GUIDELINES FOR THE PREPARATION OF CATCHMENT AREA TREATMENT PLAN

Environmental Assessment and Management of Water Resources Projects Sectional Committee, WRD 24	**Last Date for Comments: 03/11/2023**

FOREWORD

(*Formal Clause of the foreword will be added later*)

Man-nature conflict, to meet the un-satiating demands of land and other natural resources like fuel wood, fodder, etc., has resulted in overexploitation of the limited natural resources. Encroachment of forests and pasture lands and faulty agricultural practices have further aggravated the problem of land degradation and soil erosion. Heavy soil erosion from the degraded patches of the catchment, results in sedimentation of the reservoir, thereby reducing its storage capacity and impeding the life span of a river valley project.

In order to address the menace of soil erosion, proper soil and water conservation measures are required to be implemented as a part of Catchment Area Treatment (CAT) strategy. An ideal CAT intervention should focus on checking the soil erosion at the source, addressing the landslide hazards in the direct impact zone of a project, checking the sediment load from the tributaries directly discharging into the reservoir, and, protecting the directly draining catchment from scouring / sloughing and slips.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second *revision*)'. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

The composition of the Committee responsible for formulation of this standard is given at Annex A.

Draft Indian Standard

GUIDELINES FOR THE PREPARATION OF CATCHMENT AREA TREATMENT PLAN

Environmental Assessment and Management of Water Resources Projects Sectional Committee, WRD 24

Last Date for Comments: 03/11/2023

1 SCOPE

This standard provides guidance on the methodology and criteria for preparation of catchment area treatment plans for hydropower, irrigation, drainage, flood control and multipurpose water resources projects.

2 GENERAL

The catchment area treatment (CAT) plan pertains to preparation of a management plan for treatment of erosion-prone areas of the catchment through biological and engineering measures, however, a comprehensive CAT plan should also include the social dimensions associated directly or indirectly with the catchment. A well-designed CAT plan should not only control the sedimentation of reservoir but should also provide a life support system to the local population through their active involvement. An effective CAT plan of a water resources project is a key factor in making the project eco-friendly and sustainable.

CAT plan is an essential document as it portrays the ecological health of the catchment area and various soil & moisture conservation and watershed management programmes are required to arrest soil erosion, to improve free drainage in the area and to rejuvenate the degraded ecosystem in the catchment. The catchment area plan should evaluate the appropriateness of present land use and aim at planning proper future land utilization. The infrastructure component like construction of buildings, vehicles, salaries of staff, etc. should constitute a very small percentage of the CAT plan, as the main emphasis is on soil & water conservation and ecological improvement of the area. Wherever development/procurement of infrastructure is required, it should be site-specific and should be supported by proper justification.

Integrated watershed management aimed at minimizing the sedimentation of reservoir and ecosystem conservation of the catchment area is the prime objective of the catchment area treatment, which can be further elaborated as listed below:

a) Soil conservation through biological and engineering solutions to reduce sediment load in the reservoir.

b) Ecosystem conservation through improvement in water retaining properties of soil and increase in vegetative cover.

c) To fulfill the fuel and fodder requirements of the local people.

d) Integration of the CAT plan with social and economic activities of the local population through employment generation and community participation.

3 Delineation of the catchment area

Silt Yield Index (SYI) model, as conceptualized by All India Soil and Land Use Survey is used to identify the severely degraded units either in the free draining (catchment area falling between the dam/barrage of a project and the next upstream proposed or existing dam/barrage), or, in the directly draining catchment (catchment area draining directly into the reservoir) that are producing high silt yield/ load from the surface runoff. The prioritization of sub-watersheds (smaller hydrologic units) within the vast catchment is also based on the Sediment Yield Indices of the sub-watersheds which depend on several climatic, physiographic (including geology), slope, soil, land use/land cover characteristics. The hierarchical delineation system developed by the All India Soil and Land Use Survey (AIS&LUS) may be followed for the demarcation of sub-watersheds falling in the free draining or directly draining catchment area of a project.

Satellite remote sensing-based methods may be adopted in combination with Geographical Information System (GIS) for spatial delineation and managing the various thematic layers. For characterization, the assessment of vegetation status, as well as spatial distribution, information on land use patterns, physiography, geomorphology, lithology, soil, drainage, slope (DEM) etc., are amenable through remote sensing. With multispectral capability, synoptic viewing and repetitive coverage, remote sensing techniques help in effective delineation of catchment area and they prove to be cost and time effective especially, in large catchments. However, limited ground checks should be resorted to validate the information.

4 Identification of degraded areas in the catchment

The determinants that ultimately define the erositivity of a particular land mass include several factors. The functional behaviour of each of the factors is summarized in the following paragraphs.

4.1 Physiography & Slope

The physiographic setting and relief of the land is of vital importance in determining the levels of erosion. Most important among the factors of relief is the slope category of a landform. As the slope becomes steeper, the runoff coefficient increases, the kinetic energy and carrying capacity of the surface flow becomes greater, soil stability as well as the slope stability decreases and splash erosion increases.

4.2 Land use/land cover

Land use/land cover greatly modifies the effect of rainfall and thus affects soil erosion. The plant canopy intercepts raindrops and the water dripping off the leaves is less erosive than unhindered raindrops. Moreover, the detachment of sediments does not occur on the portion of the covered soil surface because the drops are intercepted and there is no fall distance for drops to regain energy. The surface cover also slows down the run-off thus increasing flow depth, which further decreases detachment by cushioning the impact of raindrops and reducing their hydrodynamic impact forces. Different land use/land cover categories also influence surface runoff. A land with dense forest cover, with substantial undergrowth, will have lesser or negligible soil erosion in comparison to land with open forests or degraded forests. Other landforms viz. agricultural land, scrubland, barren land, rocky area, settlement zones etc. will have their own surface runoff potential.

4.3 Soil parameters

The soil properties influencing erodibility include soil type, organic matter content, its association with different morphological features and effective soil depth. Infiltration rate and soil permeability, which is function of soil texture, coarse fragments, effective soil depth, etc., determine the quantity of surface flow. Soil structure or aggregate stability is another important factor offering resistance to soil detachment. Soil types of the catchment area could also be delineated based on the classification of mapping units of the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) which classifies (taxonomic classification) soil mapping units based on the soil type, permeability, association with different physiographic forms including slope, etc., as well as the erosion potential.

4.4 Climatic factors comprise total precipitation, its frequency and intensity, drainage characteristics

The relationship of soil erositivity with various attributes (parameters) is very complex. Moreover, there are interrelationships among different parameters. Based on remote sensing studies and integration of the Geographical Information System (GIS) technique, various thematic maps on Land use/Land cover, Soil, Slope, Drainage, Aspect, etc. are generated. All these thematic maps are overlaid on the GIS platform and after assemblage of varying combinations and permutations of the attributes, the Erosion Intensity Mapping Units (EIMUs) are generated in the respective sub-watersheds of a catchment. Various erosion intensity mapping units are categorized as ‘Very Severe’, ‘Severe’, ‘Moderate’, ‘Slight’ & ‘Very slight’.

5 Prioritization of sub-watersheds falling in a catchment

Prioritization of the sub-watersheds falling in the free/directly draining catchment is done in the following manner:

a) Preparation of a framework of sub-watersheds through systematic delineation and codification.
b) Rapid reconnaissance survey leading to the generation of a map indicating erosion-intensity mapping units (EIMUs).
c) Assignment of weightage values to various mapping units based on relative silt yield.
d) Assignment of maximum delivery ratios to various erosion intensity mapping units and assessment of adjusted delivery ratios for different sub-watersheds.
e) Computing Silt-Yield Index for individual sub-watersheds.
f) Grading of sub-watersheds into very high, high, medium, low and very low priority categories.

Satellite-derived layers such as the generation of erosion intensity units, soil maps along with the delivery ratio and corresponding weightage of the units, and spatial analysis of SYI can also be accomplished using GIS as well as other modeling techniques.

5.1 Assignment of erosion weightage values

The composite erosion intensity mapping units are assigned relative erositivity values based on the combined effect of erositivity determinants like physiography & slope, soil characters, land use/land cover pattern etc., as has been explained in the preceding paragraphs. A factor k is rated as an equilibrium state between erosion and sedimentation. Any addition to this factor is indicative of erosion, roughly in proportion to the added factors, whereas, the subtraction is suggestive of the deposition possibilities. The erositivity values may be assigned in the range of 8 (k-2) to 30 (k+20).

5.2 Assignment of Delivery Ratios (DR)

Delivery ratio (DR) refers to the percent of soil material detached from the source area reaching the sink area or a reservoir through surface flow or traveling through drainage courses. The values of delivery ratios employed as a measure of transportability of the detached soil material to the site of catchment reservoir are adjudged for individual mapping units based on the factors influencing the suspension and mobility of the suspended material. The maximum DR values, assigned to mapping units, range from 0.40 to 0.95.

The maximum DRs are further adjusted for individual sub-watersheds to account for the deposition of the detached material en route the reservoir. The distance of the sub-watershed from the active stream or from the reservoir site is the major factor for affecting the requisite adjustment. “In general, no adjustment is initially carried out for the sub-watersheds located within the periphery of 40 km from the reservoir site and the further reductions are made by values of 0.05 and its multiples for every additional 10 km distance.

5.3 Computation of Silt Yield Index

The Silt Yield Index of a particular sub-watershed is calculated based on the following equation:

$$SYI = \sum \frac{(Ai \times Wi \times Di)}{Aw} \times 100; \qquad i = 1 \text{ to } n$$

where

SYI	=	Sediment Yield Index
Ai	=	Area of i^{th} mapping unit
Wi	=	Weightage value of i^{th} mapping unit
Di	=	Adjusted delivery ratio assigned to i^{th} mapping unit
N	=	No. of mapping units
Aw	=	Total area of sub-watershed

The area of each of the mapping units as well as the sub-watersheds is computed on a GIS platform.

5.4 Categorization of sub-watersheds into various priority categories

In most cases, the following values of SYI have been used to categorize the sub-watersheds into various priority categories:

Sl. N	Priority Category	SYI values
1	Very high	> 1300
2	High	1200 - 1299
3	Medium	1100 - 1199
4	Low	1000 - 1099
5	Very low	< 1000

6 Areas to be treated under CAT Plan

For the CAT, areas falling under very severe and severe erosion intensity categories are considered for treatment. The works necessitated on account of the immediate and direct adverse impact of the project during the construction phase along with the work on the direct draining sub-watershed for improving the carrying capacity of the degraded/highly degraded lands along the reservoir should be carried out pari passu with the construction programme of the project and provided for in the cost estimates of the project. The sub-watersheds to be taken first and thereafter should be as per the above priority ranking.

6.1 Treatment Measures

Various engineering and bioengineering measures like brushwood check dams, contour bunding, gabion structures, loose boulder check dams, silt retention dams, etc. can be proposed for the very severe and severe erosion intensity areas. In addition, biological measures like plantation of shrubs and trees can also be suggested for these areas.

In the upper catchment brushwood check dams can be proposed to control the erosion in the first-order basin. In first-order streams, in the lower reaches, where discharge is higher loose boulder check dams can be proposed at the required intervals. In those areas where discharge is much higher Gabion structures can be proposed. Contour bunding can also be proposed to address the problem of land degradation from surface run-off. Lower down the catchment i.e. in the third order drainage silt retention dams can also be proposed. Where required, i.e. open and degraded forest patches, where there is an availability of water, the proper plantation can be proposed with indigenous and water-conserving plant species.

6.2 While formulating the Catchment Area Treatment Plan, the following aspects should be considered:

a) In the dense forest area, the major concentration should be on soil & water conservation including water harvesting for which various water harvesting structures like check-dams, gully plugging, gabion dams, contour trenches and vegetative structures should be made.

b) In the open forest, besides taking up soil & water conservation measures, plantation of local indigenous tree and shrub species should be done. In higher altitudes, *Deodar* can be planted but plantation of *Chir* should be avoided.

c) A lot of pressure of the cattle is on revenue/civil soyam forest and these forests form an important component of the catchment. The CAT plan should therefore include a component of fodder development on the civil soyam forest or on revenue lands in order to meet the requirement of fodder/ small timber/firewood and in turn, reduce pressure on the Reserve Forest for the purpose.

d) Plantation of rare/medicinal species may be taken up in a defined area.

While proposing the treatment measures, especially the engineering measures (check-dams, gabion structures, gully plugs, contour trenches), etc., an assessment should be made on the number of engineering measures being proposed per m/ ha/ sq.m/cubic m of land, with proper justification. It should also be assessed how much area of land is anticipated to be treated from a particular measure, say check-dam, gabion structure, etc. A similar assessment should also be made while proposing the biological measures (plantation, turfing, etc.). Proper layout/section of each engineering and bioengineering measure is also required to be given in the section.

7 Monitoring

It is very essential that proper and regular monitoring is carried out for the effective implementation of the CAT plan. The multidisciplinary Environmental Monitoring Committee constituted for the monitoring of other Environmental Management Plans, should also monitor the progress of CAT works. The committee should have representatives from Forest, Wildlife, Horticulture, Soil and Water Conservation Departments of the concerned State Government.

Evaluation of changes in landscape during pre and post-treatment phases should be done by satellite and remote sensing-based methods in combination with GIS-based methods.

8 Period and Schedule of Implementation

The plan needs to be implemented in a phased manner so as to attain the goals set, successfully. The CAT plan should be implemented well before the stage of reservoir filling. While preparing the schedule, it may be kept in mind that the treatment measures (engineering, bio-engineering and biological) are proposed year-wise and sub-watershed-wise, along with the break-up of physical and financial targets being proposed year-wise.

9 Cost Estimate

Unit cost estimate of each Engineering, Bioengineering and Biological measures should be given under the head. The provision of overhead/administrative/contingency cost may also be kept in the cost estimate.