SONKHEDI MINOR TANK PROJECT

Teh. Varla **Dist. Barwani**

CATCHMENT AREA TREATMENT PLAN FOR FOREST AREA

13.1 NEED FOR CATCHEMENT AREA TREATMENT

It is a well-established fact that reservoirs formed by dams on rivers area subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion. Entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the grow plants thus, a well - designed catchment area treatment (CAT) Plan is essential to ameliorate the above mentioned adverse process of soil erosion.

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion in many locations, winds, glaciers, etc. also cause soil erosion. In a hilly catchment area as in the present case erosion due to water is a common phenomenon and the same has been studied as a part of the catchment area treatment (CAT) plan.

The catchment area treatment (CAT) plan highlights the management techniques to control erosion in the catchment area life span of a reservoir in case of a seasonal storage dams is greatly reduced due to erosion in the catchment area. The catchment area considered for treatment of SONKHEDI Minor Irrigation project is 25.03 Sq.km. The sub watersheds in the catchment area of considered for the present
study is given in Figure -A

In the present study Silt Yield Index' (SYI) method has been used. In this method, the terrain is subdivided into various watersheds and the credibility is determined on relative basis. SYI provides a comparative credibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement Moreover, it can be applied to larger areas like sub watersheds, etc.

13.2 APPROACHES FOR THE STUDY

Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography land use and rainfall, not all areas contribute equally to the erosion problem. Several techniques like manual overlay of spatially index-mapped data have been used to estimate soil Erosion in complex landscape.

Geographic information System (GIS) is a computerized resource data base system, which is referenced some geographic coordinate system. In the present study real coordinate system has been used. The GIS is a tool to store, analyse and display various spatial date. In addition, GIS because of its special hardware and software characteristics. Has a capacity to perform numerous function and operations on the various spatial data layers residing in the database. GIS provides the capability to analyse large amounts of data in relation to a set of established criteria. In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted.
The various steps covered in the study are as follows:

- Data acquisition
- Data preparation
- Output presentation

The above mentioned steps are briefly described in the following paragraphs,

13.2.1 DATA ACQUISTION

The requirement of the study was first defined and the outputs expected were noted. The various data layers of the catchment area used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

13.2.2 DATA PREPARATION

The data available from various sources was collected. The ground maps, contour information etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of. accuracy required and any corrections required were made. All the layers were geo-referenced brought to a common scale (real coordinates) so that overlay could be performed. A computer programmed was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The gird size to be used was also decided to match the level of accuracy required the data availability and the software and time limitations. The format of output was finalized. Ground trothing and data collection was also included in the procedure.
For the present study IRS IC-LISS III digital satellite data was used for interpretation & classification the classified land use map of the catchment area of various dams considered for the study are shown in Figure-B. The land use pattern of the catchment area is summarized in Table-13.1.

TABLE- 13.1:- LAND USE PATTERN OF THE CATCHMENT AREA

Category	Area (ha)	Area (%)
Vegetation	349	13.94
Scrubs/ Grass Land	262	10.45
Agricultural Land	942	37.63
Barren Land	880	35.19
River	44	1.74
Settlements	26	1.05
Total	**2503**	**100.00**

Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the toposheets were digitized (100 m interval). The output of the digitization procedure was the contours as well as points contours in form of x, y & z points (x,y location and their elevation) All this information was in real world coordinates (latitude, longitude and height in meters above sea level.)

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map.

Various layers thus prepared were used for modelling Software was prepared to calculate the soil loss using input from all the layers

13.2.3 OUTPUT PRESENTATION

The result of the modelling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

13.3 ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD.

The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, credibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirement of prioritization of smaller hydrologic units.

The erosivity determinants are the climatic have direct or reciprocal bearing on the relationship can be expressed as factors and soil and land attributes that unit of the detached soil material. The relationship can be expressed as :

Soil erosivity = 1(Climate, physiographic, Slope, soil parameters, land use / land cover, soil management)

The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

Prioritization of Watersheds / Sub water heads:

The prioritization of smaller hydrologic units within the vast catchments are based on the Silt Yiled Indices (SYI) of the smaller units, the boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/ Sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model of prioritization of sub watersheds in the catchment areas involves the evaluation of :

a) Climatic factors comprising total precipitation, its frequency and intensity.
b) Geomorphic, factors comprising land forms, physiography, slope and drainage characteristics.
c) Surface cover factors governing the flow hydraulics and
d) Management factors.

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the filed investigations area required for estimating the other attributes.

The various steps involved in the application of model are :

- Preparation of a framework of sub-watershed through systematic delineation.
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion - intensity mapping units'
- Assignment of weight age value of various mapping units based on relative silt yield potential.
- Computing Silt Yield Index for individual watersheds / Sub watersheds.
- Grading of watersheds/ sub watersheds into very high, high medium. low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual sub watersheds area calculated using the following equations.

a Silt Yield Index

$$SYI = \frac{X(Ai \times Wi) \times 1OO}{Aw} \text{ where } i=L \text{ to } n$$

Ai = Area of ith unit (EIMU)
Wi = Weightage Value of ith mapping unit
n = No. of mapping units
Aw = Total area of sub watershed.

The SYI values for classification of various categories of erosion intensity rates are given in.

TABLE - 13.2 CRITERIA FOR EROSION INTENSITY RATE

Priority Categories	SYI Values
Very high	>1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

13.4 WATERSHED MANAGEMENT - AVAILABLE TECHNIQUES

Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:
- increase infiltration into soil
- Control excessive runoff;
- Manage & utilize runoff for useful purpose

Following Engineering and Biological measures have been suggested for the catchment area treatment .

1. Engineering measures

- Nallaha Bunding
- Contour Bunding
- Angle iron barbed wire fencing

2. Biological measures

- Development of nurseries
- Plantation / afforestation
- Pasture development
- Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table-13.3.

TABLE - 13.3: BASIS FOR SELECTION OF CATCHMENT AREA TREATMENT MEASURES

Treatment measure	Basis for selection
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protect is from grazing etc.
Nallah Bunding	Nalla bunding work consists of constructing bunds of suitable dimensions across the nalla or gullies to hold the maximum runoff water to create flooding of the upstream area temporarily for some days or weeks, with Surplussing arrangements at suitable intervals to drain the water.
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and ensure better survival.

13.5 CATCHMENT AREA TREATMENT METASURES

The erosion category of sub-watersheds in the catchment area as per a SYI index is given in Table-13.4. The details are shown in Figure-C. The area under different erosion categories is given in Table-13.5.

TABLE-13.4: EROSION INTENSITY CATEGORIZATION AS PER SYI CLASSIFICATION

SWS	Area (ha)	SYI	Erosion Category
W1	133	1230	High
W2	131	1150	Medium
W3	132	1160	Medium
W4	140	1180	Medium
W5	110	1150	Medium
W6	121	1210	High
W7	132	1190	Medium
W8	125	1180	Medium

SWS	Area (ha)	SYI	Erosion Categorv
W9	144	1220	High
W10	151	1210	High
W11	133	1230	High
W12	152	1240	High
W13	132	1240	High
W14	140	1220	High
W15	130	1210	High
W16	120	1170	Medium
W17	132	1180	Medium
W18	112	1210	High
W19	133	1280	High
Total :-	**2503**		

TABLE - 13.5 : AREA UNDER DIFFERENT EROSION CATEGORIES

Category	Area (ha)	Percentage
Very low	-	-
Low	-	-
Medium	1022	40.83
High	1481	59.17
Very High	-	-
Total :-	**2503**	**100.00**

The objective of the SYI method is to prioritize sub- watersheds in a catchment area for treatment. The total area under high erosion category in various dams is to be treated as a part of the project cost. The various measures suggested for catchment area treatment are depicted in Figure -D.

13.6 COST ESTIMATE FOR CAT PLAN

The cost required for Catchment Area Treatment is Rs. 6.94 Lakh. The details are given in Tables - 13.6 and 13.7

TABLE . 13.5 : COST ESTIMATE FOR CATCHMENT AREA TREATMENT OF SONKHEDI DAM .
BIOLOGICAL MEASURES

S.No.	Item	Rate/Unit (Rs.) (including maintenance cost)	Target	
			Physical	Financial (Rs. millions)
1	Gap Plantation	186800/ha	9 ha	1.681
2	Pasture Development	97500/ ha	5 ha	0.488
3	Social forestry	70000/ha	3 ha	0.210
4	Nursery development	120000 /No.	1 No.	0.120
5	Maintenance of nursery	125000/ No.	1 No.	0.125
6	Barbed wire fencing	50000/km	1.00	0.05
7	Watch and ward for 3 years for 5 persons	7500/ man-month	man- month	1.369
	Total (A)			**4.043**

TABTE = 13.7 : COST ESTIMATE FOR CATCHMENT AREA TREATMENT OF SONKHEDI DAM - ENGINEERING MEASURES

S.No.	Item	Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. millions)
1	Contour Bunding	15000/ha	Ha.	10 Ha.	1.500
2	Nallah Bunding	100,000	No.	01 No.	0.100
	Total :-				**1.600**

Total cost for Biological and Engineering measure = Rs. 4.043 Lakh (A)

Administrative expenditure

-	Government Expenditure 3% of A (including O&M)	Rs. 0.121 million
-	Establishment cost 8% of A	Rs. 0.323 million
-	Contingency 5% of A	Rs. 0.202 million
	Total :-	**Rs. 0.646 million**

13.5 (B) COST ESTIMATES OF CAT PLAN FOR FOREST AREA

The Total Catchment Area of SONKHEDI Dam is 535 l-hectares out of this 49.320 Hectares Forest Land. The cost required for Catchment Area treatment of Forest is Rs. 62.89 Lakh. The details are given in Tables-8 and 9.

TABLE-7 : COST ESTIMATE FOR TREATMENT OF CATCHMENT AREA IN FOREST AREA OF SONKHEDI DAM.BIOLOGICAL MEASURES

S.No.	Item	Rate/Unit (Rs.) (including maintenance cost)	Target	
			Physical	Financial (Rs. millions)
1	Gap Plantation	186800/ha	9 ha	1.681
2	Pasture Development	97500/ ha	5 ha	0.488
3	Social forestry	70000/ha	3 ha	0.210
4	Nursery development	120000 /No.	1 No.	0.120
5	Maintenance of nursery	125000/ No.	1 No.	0.125
6	Barbed wire fencing	50000/km	1.00	0.05
7	Watch and ward for 3 years for 2 persons	7500/ man-month	man- month	1.369
	Total (A)			**4.043**

TABLE.8 : COST ESTIMATE FOR TREATMENT OF CATCHMENT AREA IN FOREST AREA OF SONKHEDI DAM ENGTNEERING MEASURES

S.No.	Item	Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. millions)
1	Contour Bunding	15000/ha	Ha.	10 Ha.	1.500
2	Nallah Bunding	100,000	No.	01 No.	0.100
	Total :-				**1.600**

Total cost for Biological and Engineering measure = Rs. 4.043 Lakh (A)

Administrative expenditure

-	Government Expenditure 3% of A (including O&M)	Rs. 0.121 million
-	Establishment cost 8% of A	Rs. 0.323 million
-	Contingency 5% of A	Rs. 0.202 million
	Total :-	**Rs. 0.646 million**

Total Cost for Catchment Area Treatment for Forest Area of SONKHEDI Dam = 6.289 million.