PRIORITIZATION OF WATERSHEDS

Unit: V

Semester: II

Paper Code: GIS 10

Name of Paper: Research Methodology and Application of Remote Sensing and GIS Techniques in Research

PG Diploma in RS & GIS

Dr. SHYAMA PRASAD MUKHERJEE UNIVERSITY, RANCHI

PRIORITIZATION OF WATERSHEDS

1.1 Concept of Priority Watersheds

In a watershed management programme, particularly in case of large watersheds, it may not be possible to treat the entire area of the watershed with land treatment measures. Identification and selection of few areas or sub-watersheds having relatively more degradation problem, for development planning and implementation of conservation activities according to level of need and status of degradation, are required. These few selected areas or sub-watersheds within a large watershed are called the priority watersheds. In this process, collection of sufficient bio-physical and socio-economic information is required for integrated watershed management planning. After effectively prioritization of watersheds (sub-watersheds), a sub-watershed management plan for each priority sub-watershed is prepared in order to minimize natural and human-induced hazards and to conserve valuable resources (soil, water, biodiversity and socio-cultural aspects). And finally, various integrated watershed management activities in the selected priority watershed (sub-watershed) is implemented.

1.2 Factors Influencing Prioritizing Watersheds

In the face of enormity of degradation problems and constraint of financial resources coupled with limitation of expertise, a scientific approach to land resource management calls for an evolution of suitable methodology for clear identification of critical areas for treatment. Prioritization of areas into very high, high, medium, low and very low vulnerability helps in addressing the conservation and management efforts to secure maximum benefit.

Watershed prioritization is a prerequisite to operationalize any major scheme as it allows the planners and policy makers to adopt a selective approach considering the vastness of the catchment area, severity of the problems, constraints of funds and man power demands of the local and political system. The prioritization of watersheds varies with the objectives of different schemes but the basic framework of watershed remains the same.

1.3 Basics and Methods of Watershed Prioritization

It is not feasible to take the whole watershed area at once for its management. Thus the whole basin is divided into several smaller units, as sub watersheds or micro watersheds, by considering its drainage system. Two different methods are listed in this section for prioritization of sub watersheds from a large watershed:

1.3.1 Sediment Yield Index (SYI) and Runoff Potential Index (RPI) Models

The methods used for determining the priority of the sub-watersheds for treatment from soil erosion and sediment yield point of view are; (i) reconnaissance surveys, (ii) soil and land use surveys, (iii) sediment observations, and (iv) Remote Sensing methods.

1. A **reconnaissance survey** of the entire watershed gives an idea of the relative erosion status of the sub-watersheds. This procedure is approximate and is to be used when no other method is available.

2. Detailed **soil and land use surveys** include the erosion information of the sub-watersheds. A careful interpretation of these reports could provide information on the relative erosion status of the various sub-watersheds.

3. Actual **measurement of the silt load** contributed by each of the sub-watersheds will give a clear picture of the extent of erosion in the sub-watersheds. Observations in respect of silt loads recorded over a period of three to five years will indicate the sub-watersheds which are contributing higher silt loads. The main difficulty with this procedure is that the data has to be collected over a period of years so that reliable conclusions can be drawn.

4. **Remote Sensing Techniques** consisting of satellite imagery and its interpretation offer a good scope for determining the priority areas in large watersheds.

Study of the Survey of India topographical map on 1:50,000 scale helps to have an idea of the catchment area and identification of the major landscape and land use. The methodology of Priority Delineation Survey comprises the following steps.

1. Preparation of framework of micro-watershed through systematic delineation.

2. Codification of different stages of delineation by using Alpha-numeric symbolic code.

3. Rapid Reconnaissance Survey on 1:50,000 scale base (SOI Toposheets, aerial photographs and other base material) leading to the generation of a map indicating Erosion Intensity Mapping Units (EIMU).

4. Assignment of delivery ratio to various Erosion Intensity Mapping Units.

5. Computation of Silt Yield Index (SYI)/Run-off Potential Index (RPI) for individual micro-watersheds.

6. Based on the descending values of SYI/RPI grading of micro-watersheds into very high, high, medium, low and very low priority categories is assigned.
7. Assignment of weightage values to various Erosion Intensity Mapping Units based on their relative sediment yield/run-off potential.

EIMU is an assemblage of land and soil characteristics, viz., physiography, slope, land use and land cover with density, surface condition, soil depth, texture and structure of surface and sub-soils, colour, drainage condition, salinity and alkalinity, stoniness and rockiness, erosion condition and existing management practices.

The delivery ratio of an erosion intensity mapping unit indicates the transportability of the soil material detached from the area enclosed by the unit to the site of the dam/reservoir. The maximum values of delivery ratio adjudged for individual EIM unit are based on factors influencing the suspension and mobility of suspended material like texture, mineralogy and pH of the soil, land use/land cover conditions, terrain slope, surface stoniness/rockiness and soil conservation measure adopted. The adjustment delivery ratios are also dependent on the watershed attributes such as drainage pattern/drainage density, watershed gradient, and proximity to active stream resources. The maximum delivery ratio value, assigned to various EIMU ranges from 0.40 to 0.95.

The Following Literature may be considered.

Prioritization of watershed is done by comparing severity of erosion and sediment yields. The method is devised under the following steps:

1. Determine the erosion intensity of different watersheds, called as "erosion intensity unit" and grade them in accordance with their increasing severity. Also, find out the probable sediment yield of the watershed and grade them by order. For grading, the least eroding units are assigned by the number 1 or 0.50, while more eroding units are assigned by higher weights such as 2, 3, 4 …..

2. Calculate the area of each erosion intensity unit within each small sub-watershed and also determine the total area of sub-watershed.

3. Multiply the area of each erosion intensity unit to its weight assigned. The obtained value is termed as weighed product. Compute the total weighted value of each small sub-watershed by adding all together.

4. Compute the erodibility index of sub-watershed by dividing the total weighted value obtained for sub-watershed with its total area i.e.

$IE = T_w * 100/T_a$,

where IE = Erodibility index of sub-watershed (%)

T_w = total weighted value for sub-watershed

T_a = total area of sub-watershed

5. Measure the distance between erosion intensity unit and the reservoir, in which runoff is going on and assign the weight to each as per given in Table below. This weight is added to the erodibility index of each sub-watershed. The erosion intensity units located close to the reservoir are given more weightage as compared to the ones located far off because from the nearer watershed silt load has more probability to reach the reservoir than from far off.

6. After finding the total value of weights for each sub-watershed, arrange them into suitable priority classes such as: very high, high, medium, low and very low.

Table 1. 1. Proposed Weights as per Distance from the Reservoir

Distance from reservoirs (Miles/Kms)	Weights
<5 / < 8.0	50
6-10 / 9.7-16	40
11-25 / 17.7-40.2	30
26-50 / 41.8-80.5	20
51-100 / 82.1-161	10
>100 / > 161	5

1.3.2 Morphometric Analysis

Morphometric analysis could be used for prioritization of micro-watersheds by studying different linear and aerial parameters of the watershed even without the availability of soil maps.

Morphometric analysis of a drainage system requires delineation of all existing streams. The stream delineation is done in GIS environment using Digital Elevation Model (DEM) either prepared from contour map or directly taking DEM from reliable sources, eg. ASTER 30 m DEM. The various morphometric parameters such as area, perimeter, stream order, stream length, stream number, bifurcation ratio, drainage density, stream frequency, drainage texture, length of basin, form factor, circulatory ratio, elongation ratio, length of overland flow, compactness coefficient, shape factor, texture ratio are computed. The linear parameters such as drainage density, stream frequency, bifurcation ratio, drainage texture, length of overland flow have a direct relationship with erodibility. Higher the value, more is the erodibility. Hence for prioritization of sub-watersheds, the highest value of linear parameters is rated as rank 1, second highest value is rated as rank 2 and so on, and the least value is rated last in rank. Shape parameters such as elongation ratio, compactness coefficient, circularity ratio, basin shape and form factor have an inverse relationship with erodibility. Lower the value, more is the erodibility. Thus the lowest value of shape parameters is rated as rank 1, next lower value was rated as rank 2 and so on and the highest value is rated last in rank. Hence, the ranking of the micro watersheds is determined by assigning the highest priority/rank based on highest value in case of linear parameters and lowest value in case of shape parameters.

The prioritization is carried out by assigning ranks to the individual indicators and a compound value (Cp) is calculated. Watersheds with highest Cp are of low priority while those with lowest Cp are of high priority. Thus an index of high, medium and low priority is produced.

1.4 Purpose and Benefits of Watershed Prioritizations

The purpose to identify priority basins are to identify focus watersheds to complete a series of restoration activities. Those can address the critical needs in that watershed and allow for natural recovery.

Benefits of Prioritization

1. This approach is simple to adapt and useful for managers, as it combines the best available information from scientific investigations with the knowledge and intentions of local stakeholders.
2. While comparing among watersheds or varying condition within the same cluster type or across cluster types, this approach generates a relevant list of prioritized watersheds.
3. It assists the users in developing a profile of watersheds of interest, by graphically locating a watershed and obtaining relevant information about its vulnerability.
4. The contemplative process used to locate multiple watersheds is helpful in deciding upon a course of action with regard to prioritizing watershed protection and restoration.

References

- ✓ Nelson, M. A., & Soerens, T. S. (2001). Arkansas Water Resources Center.
- ✓ Wani, S. P., Rockström, J., & Sahrawat, K. L. (2011). Integrated Watershed Management in Rainfed Agriculture. CRC Press.