Executive Summary of the Project

Title of research project: "**The quantitative evaluation of soil erosion: A case study of upper Bhima Basin**"

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Man is directly dependent on soil for agriculture and indirectly for the non-agricultural activities like recreation, engineering projects such as building foundation and waste disposal. Soil, is a very essential resource as it serves ecological functions that supports life on earth. An increasing population, deforestation, improper methods of agriculture, uncontrolled grazing and unplanned use of natural resources is leading to irreversible degradation of soil. Soil erosion is the dominant cause of soil degradation at a global scale. Therefore, to preserve our existing soil resources, proper relationship of the parameters affecting must be studied. The continuous evaluation and monitoring of these parameters will ensure the appropriate solutions for the soil conservation efforts. Therefore, an attempt has been made to assess soil erosion in upper Bhima basin. The Remote sensing and GIS technology are best suited for this purpose as it has ability for assessing the potentials and limitations of the factors affecting soil erosion.

In view of the above, an attempt has been made in this study to suggest soil conservation measures to control the soil loss in the upper Bhima basin. This is carried out by following the steps given below:

1. Computation and mapping of the physical factors such as rainfall intensity, slope, morphometric attributes and soil erodibility in the upper Bhima basin
2. Assessment of areas under different landuse/land cover categories remotely sensed data in GIS environment.
3. Estimation of potential soil loss using USLE.
4. Multicriteria modeling using weighted overlay analysis.
5. Prioritization of watersheds within the basin based on soil erosion risk.
6. Preparation of guidelines for soil conservation plan.

Methodology:

Two approaches were adopted for evaluation of soil erosion-proneness of watersheds viz. Universal Soil Loss Equation and Multi-Criteria Analysis. The USLE developed by Wischmeier and Smith (1978) is used in this study for estimation of soil loss in the Bhima basin. Some of the parameters of this model are achievable through remote sensing. Hence this model was chosen for this study. Soil loss for entire Bhima basin is calculated by generating various input layers in GIS environment.

Approach 1: USLE:

The soil erosion estimation was done by the multiplying the parameters derived by the equation suggested by Wischmeier and Smith (1978) as below:

$$A = R * K * L * S * C * P$$

Where, A is computed soil loss (t/ha/yr), R is the rainfall-runoff erosivity factor, K is the soil erodibility factor, L is the slope length factor, S is the slope steepness factor, C is the cover-management factor, and P the supporting practices factor.

Soil loss obtained at watershed level is further analysed to understand the influence of rainfall intensities under different land characteristics to understand the response of elevation, soil properties and land use land cover.

Approach 2:MCA:

The second approach is the Multi-Criteria Analysis using weighted overlay analysis applied for the prioritization of watersheds. The criteria were topographic (slope-S), morphometric (drainage density-Dd and elongation ratio-Re), climatic (rainfall erosivity-R), pedological (Silt+very fine sand content-T) and anthropogenic (Land use/ land cover – LU/LC). Sub-class weights were assigned (Saaty, 1980) for each criterion for each watershed. GIS-aided analysis was done for all criteria mentioned above to generate watershed-wise area-weighted layers. Layers thus obtained were then multiplied by the respective weighting number using weighted overlay analysis. The final output of Composite Erosion Index (CEI) map was generated and it was classified into the categories of erosion intensity. Prioritization of watersheds was done according to severity of watersheds to the erosion.

Summary of Findings:

The spatial distribution of erosivity factor follows the rainfall pattern. Study area displays significant regional variations which is responsible for the differences in distribution, duration and intensity of rainfall which ultimately controls the erosivity. Higher erosivity values are observed in the area with high amount of precipitation, intensity and kinetic energy of rain.

The percentage of sand particles in the soils in the basin varies from less than 10 percent to 83 percent. Organic Matter content is observed very high in the western ghat region, as a result of forest and vegetation present in this area. Sub-angular blocky structure of soil was observed in the study area which refers to intersection of surfaces with rounded edges, a common feature where clay content is high. The intensity of K factor in the upper Bhima basin is following the increasing proportion of erodible matter associated with decreasing clay and OM content in the soils.

The erosive impact of rainfall varies as per the physiographic set-up of the region. The soil losses increase with the increase of the slope length and steepness, conditions where the surface flow reaches high-speeds.

Agriculture is the primary occupation in the study area. A growth and expanse of vegetal cover at the time of rains, however, reduces the actual soil loss. The canopy protection of crops not only depends on the type of vegetation, the stand, and the quality of growth, but it also varies greatly in different months or seasons. Nearly half of the area of the upper Bhima basin is under P factor of 1.0 indicating widespread lack of supporting practices in areas.

Qualitatively seven soil erosion classes namely very low, low, moderate, high, very high, severe and very severe were identified in the upper Bhima basin. High soil erosion areas has been identified in the regions having hill slopes accompanied by heavy rainfall and are typically associated with the land-use classes which have high erosion potential such as the higher elevation ranges, isolated pockets of open and dense forests which have been cleared for agriculture and horticultural. Steep slope, high intensity rains and deforestation or cultivation are responsible for Severe and Very severe soil erosion.

The general relationship of criteria with erosion intensity observed in the Multi-criteria analysis shows that, from west to east, number of significant criteria influencing Composite Erosion Index (CEI) decreases and number of counterbalancing criteria on Composite

Erosion Index increases and none of the criteria is uniquely observed to be influencing erosion intensity in the complete study area.

MCA / USLE approach:

MCA identified 2 watersheds while USLE 03 watersheds in the 'extremely severe' category. Critical examination of these two approaches with respect to severe category highlighted that 1 watershed out of 3 USLE watersheds were placed in moderate category MCA. This watershed reported high proportion of dense forest and morphometric attributes of watershed resulted in its inclusion in the MCA 'moderate' category. The USLE approach did not account morphometric attributes.

USLE identified 04 watersheds in the severe category out of which 1 watershed was reported by MCA to very high category. Though organic matter content is high in this watershed, erodible matter content and morphometric attributes place it in very high category of MCA. Morhometric characteristics and erodible matter are not included in the USLE.

Contribution to the Society:

A study would help improve understanding of relationship between environmental causative factors and soil loss. It has estimated soil loss and mapped soil erosion risk zones for conservation. It would help to maximize benefits of soil erosion control from minimum inputs enhancing efficiency of process of restoring the resource base. The study highlighted the relative contribution of causative factors to the soil loss which has helped to give proper guidelines for eosion control and frame appropriate conservation strategy. The practical methods of soil and water conservation fall into two important classes, viz. agronomic and mechanical measures. Watershed-wise conservation practices are recommended and included in the final report. The recommendations shall be useful for controlling soil loss and in turn improving the crop yield at field as well as regional level. Extension workers of the Department of Agriculture, Government of Maharashtra, NGOs working in the field of watershed management may facilitate their programmes focusing the prioritized area using the prescribed guidelines for the respective area.

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