ABSTRACT

INTEGRATED MICRO-WATERSHED MANAGEMENT IN MEGHALAYA PLATEAU - A GEOGRAPHICAL ANALYSIS

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ABSTRACT

Land and water are the most vital natural resources and these are under tremendous stress due to ever increasing biotic pressure. The optimal management of these resources with minimal adverse environmental impact is essential not only for sustainable development, but also for the human survival. Watershed management implies the rational utilization of land and water resources for optimum agricultural production with minimum hazard to natural resources. The concept of watershed management is the essential adoption of soil and water conservation practices in the watershed.

The natural landscape of Meghalya Plateau, especially its southern slopes, have been subjected to intensive acceleration of hydrological processes The areal variation of the average annual rainfall of the state with respect to its southern plateau has been found to vary from 1,200 mm to 12,000 mm. The occurrence of 90 % of the annual precipitation over the shallow soils and poor vegetal cover of the southern slopes creates seasonal floods during monsoon and, at the same time, this area reels under acute shortage of drinking water during the lean season. In addition, the increased human interference in terms of land mining and quarrying and faulty agricultural practices being resorted to along the hilly slopes, has degraded the land resources through heavy soil loss. In fact, against 55.83 % of the geographical area of Meghalya being affected by different types of land degradation, 52 % land of the total geographical area of the state, is affected by soil erosion.

In order to understand the natural intricacies of Meghalya Plateau, the watershed area of river Umiew, located on the southern slopes of Meghalya Plateau, has been selected for detail study. The watershed of Umiew river is located in the East-Khasi Hills District of Meghalaya between the average altitude of 1,650 m to 2,000 m with the average annual rainfall of 2,000.54 mm as recorded at IMD, Shillong.. The area of the watershed extends from 25^0-25' to 25^0-31' N latitudes and 91^0-45' to 91^0-52.7'E longitudes.

While dealing with the integrated management of micro-watersheds, the anthropogenic influence, though it directly concerns the management issues of

the watersheds, has not been dealt here. Therefore, this study is mainly concentrating on the analysis of geo-hydrological characteristics of Umiew watershed located in the East Khasi Hills District of Meghalya and its influence on soil erosion and water conservation. The hydrological studies include:

(i) The Rainfall Frequency Analysis,

(ii) The Derivation of synthetic Unit Hydrograph,

(iii) The Effect of Erosivity Index on Sediment Loss,

(iv) The Probability Analysis of occurrence of rainfall, and

(v) The Rainfall -Intencity-Duration Frequency Analysis.

Influence of geo-hydrological characteristics on the soil erosion and water conservation has been analyzed by delineating this watershed area into nine micro-watersheds namely, Mawphlang (Um1), Umgot (Um2), Mawreng (Um3), Nongkrem (Um4), Nongkynrih (Um5), Basio (Um6), Laitkroh (Um7), Laitkynsew (Um8) and Dympep (Um9) with the sizes varying from 5.59 Km^2 to 44.04 km^2. The soil erosion sensitiveness of the micro-watersheds have been done through their prioritization. These micro watersheds have been subjected to morphometric analysis for detecting soil erosion risk proneness and their prioritization as per erosion risk assessment. The analysis has generated data on morphometric parameters (physical characteristics) which could be used to relate quantitatively the process of sediment yield taking place from these micro-watersheds. The Integrated Land and Water Information System (ILWIS)-3.1 version and a Geographical Information System (GIS) software, have been used for the generation and analysis of morphometric parameters, relief features, slope and the land use pattern. The land use pattern of the delineated micro-watersheds existing on 2nd November, 2000 has been interpreted with the help of satellite imagery acquired by IRS-1D from LISS-III Sensor. The rainfall characteristics to the adjoining areas of this Umiew watershed have also been analyzed for predicting the availability of weekly rainfall at different probability levels. An attempt has been made to analyse the weekly rainfall data pertaining to Shillong IMD station for the monsoon period from 1996-2002 for predicting the availability of weekly rainfall at the probability levels of 10%, 20%, 50% and 80%. The rainfall erosivity index has been computed by analyzing the daily rainfall data

of IMD, Shillong for the monsoon period from 1996-2002. The selected watershed is very close to IMD observatory located in upper Shillong. The influence of erosivity index on the sediment yield rate has been studied. The relationship between the monthly flow of river Umiew and its sediment yield, and also between the monthly erosivity index and sediment yield during monsoon months, have been established by carrying out logarithmic regression analysis. In the absence of long term rainfall and observed discharge of river Umiew, the applicability of Synthetic Unit Hydrograph for the estimation of peak discharge of river for the specific return period, has also been checked up.

The findings, which have emerged after the detail study, are indicated below:

(1) Prioritization of the micro-watershed which is done by considering geo-morphic and land use characteristics of the study area, clearly reveals that the micro-watersheds, irrespective of their various stages of landscape evaluation has become soil erosion sensitive. The soil erosion interventions may be applied to the micro-watersheds depending upon the degree of sensitivity with which the micro-watersheds are affected to.

(2) The IDF chart prepared by applying log-Pearson Type-III distribution function is applicable to find out the theoretical values of rainfall intensity for any duration from 15 minutes to 120 minutes and for the return periods of 5 years to 50 years.

(3) The rainfall intensity for the desired frequency has been can be computed from this chart for the duration equal to the time of concentration of the watersheds and the same has been may be used in the rational method for estimating peak runoff from small watersheds. Thus, log-Pearson Type-III is the ideal distribution for showing the rainfall pattern of the southern slopes of Meghalya.

(4) While comparing the Intensity-Duration-Frequency (IDF) chart, prepared by applying log-Pearson Type-III distribution function with IDF relationship developed by ICAR, Barapani, Shillong, it is obvious from analysis that the

variation in the distribution of rainfall intensity of lower duration storms are recorded higher and vice-versa. It shows that the lower duration rainstroms are more fluctuating with frequent occurrences in the area.

(5) The log-Pearson Type-III distribution function is also found best fitted function as compared with others for the prediction of soil loss through the Universal Soil Loss Equation.

(6) Since the monthly rainfall computed from the observed rainfall values at 80 % probability level has been fairly higher to the tune of 105.25 mm and 106.42 mm respectively. The month of May itself can be utilized for the seedling and transplantation of kharif paddy. The rainfall during the months of July to September may be utilized for meeting the requirement of the paddy by making a provision of supplemental irrigation during this period.

The variations in the size and frequency of occurrences of rainfall in the micro-watershed areas have caused high variability in the monsoon discharge of the river Umiew. The range of variation between the observed minimum and maximum discharge during the monsoon months in 1996 has been found to be in the ratio of 1:227.5 to 1:3.29. For providing the supplemental irrigation under the scenario of high seasonal variability in the monsoon discharge of Umiew river, a three tier system for the conservation and utilization of rain water in the micro-watersheds of river Umiew could be introduced with certain modifications over the system of conservation suggested by Gupta and Narayan (1974) and Narayan and Pandey (1976). The modified features of suggested design are as:
A series of dugout storage ponds with adequate capacity, estimated on the basis of water availability study, may be panned at different elevation of the lands under all the nine micro-watersheds of river Umiew. These dugout storage ponds may be connected suitably by the drainage channels. The impounded water from the dugout ponds located at higher elevation, after getting utilised by the crop, the excess drainage water may be collected by the dugout ponds located at next lower elevation. This way the rain water tapped at higher altitude of the micro-watershed area may be utilized optimally by the lands located at different

elevations. The remaining excess water may then be discharged into the regional drainage system.

(7) It has been found from the average values of the monthly erosion index that the month of June, July, August and October have considerable erosion potential (Table-6.2). The agricultural field used to have crop canopy during October and remains almost barren. In order to safe guard the agricultural field from soil erosion adoption of proper crop management and soil conservation measures are essential to minimize the effects of rain storm. Similar suggestions have also been offered by the Indian Council of Agricultural Research (ICAR) for its model micro-watersheds developed at Barapani (Satapathy, 1996).

(8) The analysis of rainfall and erosion index has indicated that erosion index is influenced more by the higher intensity of rainfall than its overall magnitude. The single storm erosion index and sediment yield rate data of river Umiew for the period 1996-98 reveal that erosion index contributes significantly in enhancing the sediment yield rate. Wischmeier (1957) has also substantiated this finding that, if all factors other than rainfall are held constant, the annual erosion losses from cultivated areas are directly proportional to the yearly values of the erosion index.

(9) The analysis of discharge and sediment-erosivity index has revealed that there is a noticeable time lag between the rain drop striking the soil surface and its effect in the form of sediment yield. The reason for this time lag could be attributed to the time consumed right from the soil particles getting detached by the impact of rain drop upto getting these particles transported by overland flow through the connecting streams of different orders and finally coming into the main stem of river Umiew.

(10) In the absence of long-term rainfall and observed flow data, no empirical model can be developed or extended. However, the Regional Unit Hydrograph (RUH) relationship developed by CWC is the suitable may be used with a fair degree of accuracy in computing the Peak-discharge of river Umiew.