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ANALYSIS OF SOIL EROSION PATTERN DUE TO HUMAN INTERVENTION IN THE WATERSHEDS OF TUNGABHADRA SUB-BASIN

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ABSTRACT

Soil erosion is a gradual process occurring due to the natural forces of wind, rainfall and surface run-off. Lately, its rate has accelerated due to human intervention. The current study is aimed at analyzing the soil erosion pattern for three watersheds of Tungabhadra sub-basin, namely Kumudavathi, Meruru2 and Meruru4. To achieve the objective, the research envisaged the physical characteristics of the watersheds by Morphometric analysis. Also, the Drainage Maps and Contour maps were prepared with the aid of Topographic maps obtained from the 'Survey of India' and 'Watershed Atlas'. Finally, soil erosion was determined by the 'Universal Soil Loss Equation'. The analysis has revealed a startling annual potential soil loss of 20.16, 46.08 and 32.90 tonnes/hectare for the aforementioned watersheds, respectively. The loss was found maximum in Meruru2, as the watershed was subjected to tremendous deforestation and mining activities being highly prevalent in Bellary region. Also, the loss in other 2 watersheds can be attributed to the makeover of the inherent land-use patterns to urbanization, industrialization, agricultural practices etc. The control measures apart from being sustainable, also need to focus on afforestation and preservation of tree cover mainly along the steep contour of the terrain.

KEYWORDS: Erosion, soil, deforestation, Tungabhadra, land-use.

1. INTRODUCTION

As civilizations thrive, they tend to negatively impact the natural ecosystems, especially its inherent green cover and soil. Top soil in particular is an irreplaceable natural resource supporting all natural vegetation and agricultural production on the earth. Hence, it's imperative to safeguard this resource from any form of exploitation that may lead to its permanent loss. Soil erosion in India is an acute, long standing and widespread problem. The control of this natural process is not only essential to sustain agricultural production, but also to protect the water storage reservoirs and dams from silt accumulation. Off-late, the observations have indicated that the rate of soil erosion has got aggravated, due to the influence of human activities in the proximity of the catchment areas.

2. STUDY AREA

The research focuses on Tungabhadra sub-basin, in the border area of the states of Karnataka and Andhra Pradesh. Tungabhadra sub-basin is considered a part of the Krishna Basin, occupying more than one fourth of its drainage area (Figure 1).

Tungabhadra River is formed to the north of Shimoga (Karnataka), by the confluence of two rivers - Tunga and Bhadra, at an elevation of 1198m, about 1.4 km^2 from the eastern slope of Western Ghats. Tungabhadra is the largest tributary of Krishna River, contributing an annual discharge of 14,700 million cubic metres, at its confluence point with the main river.

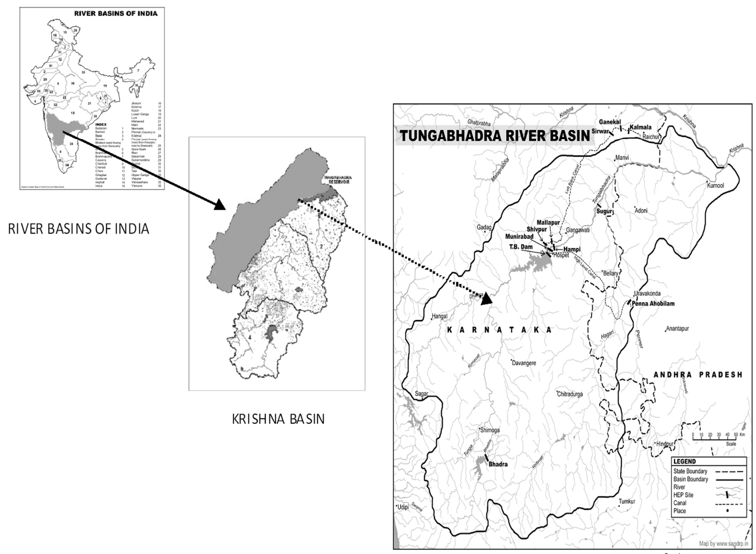

Figure 1 : Tungabhadra River Basin

This sub-basin is mostly rain-fed and is dominated by red soils (Geoffrey D Gooch et al., 2010). The geographical area of Tungabhadra reservoir catchment is about 28,860km^2. It has a drainage area of 47,827km^2 (IHD, 2006). The average annual rainfall in the catchment is 1,200mm and it experiences an average temperature of around 26°C (Geoffrey D Gooch et al., 2010). Farming dominates land cover of the basin, accounting for more than 55% of the surface area. The major crops grown are paddy, sorghum, sugarcane, cotton and millets. Other cultivable areas like fallow land cover up to 12.5% of the territory. 11% of the territory is not available for cultivation or for natural vegetation and around 5% is used as permanent pastures.

Forests and natural vegetation cover 16% of the area. The basin is mainly characterized by dense and open type of forests constituting 99% of the total forest area. The extent of forest area is more in the upstream of the basin. Very dense forest type is seen only in upstream of the basin in two districts – Shimoga and Chickmagalur to a small extent of 0.27%. In Shimoga, there are about 13,000ha of evergreen and semi-evergreen forests, about 23000 ha of closed deciduous forests, about 12,500ha of plantations & about 19,000 ha of degraded and open forests (Geoffrey D Gooch et al., 2010).

3. METHODOLOGY

The current study, investigating the influence of human activities on soil erosion, encompasses 3 watersheds of the Tungabhadra basin (Figure 2), namely, Kumudavathi (Figure 3), Meruru2 (Figure 4) and Meruru4. Primarily, the Toposheet of scale 1:250000 and the Land-use Remote Sensing Image (Figure 5) were acquired from the 'Survey of India' and ISRO respectively. Later, the Drainage and Contour maps were prepared and Morphometric analysis was also carried out to determine the linear, aerial and relief aspects. Digital Planimeter, Digital Curvimeter, Scanner and Sample Light Table were used to achieve the above objectives.

Figure 2 : Toposheet of Tungabhadra Watersheds
(Source: Survey of India)

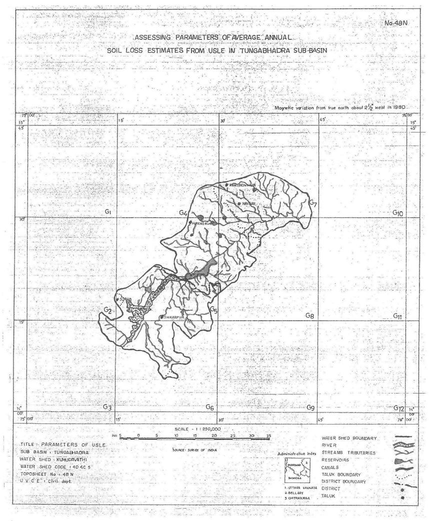

Figure 3 : Toposheet of Kumudavathi Watershed
(Source: Survey of India)

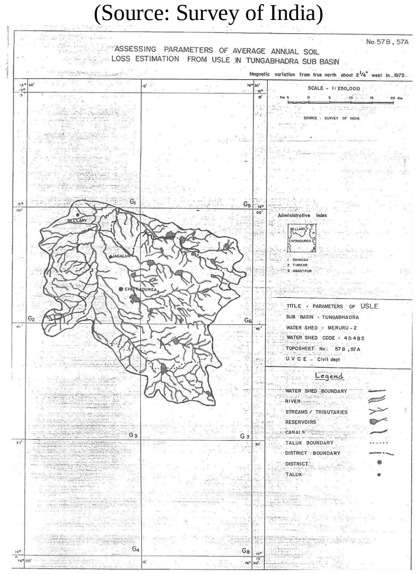

Figure 4 : Toposheet of Meruru2 Watersheds
(Source: Survey of India)

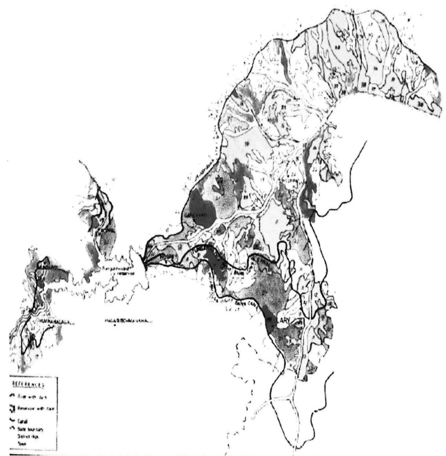

Figure 5 : Land-use Remote Sensing Image of Tungabhadra Basin

(Source: ISRO)

Linear aspects included the measurement of linear features of drainage such as Stream order, Stream length, Bifurcation ratio, Overland flow and Stream length ratio. Aerial aspects envisaged the determination of Watershed shape factor, Drainage density, Constant of channel maintenance and Stream frequency. Under Relief aspects, the Watershed relief, Relief ratio, Relative relief and Ruggedness number was ascertained. Finally, the potential soil erosion was determined by the Universal Soil Loss Equation, ‘USLE’. All the requisite components were determined by standard procedures (Adhikari R.N., 1994; Jain S.P., 1992). The results have been tabulated in table 1, and analysis has been discussed in the following section.

4. RESULT & DISCUSSION

Table 1 : Comparative results of analysis for the watersheds

Watersheds	District Covered	Watershed Area	Annual Loss
		Square Kilometre	Tonnes / hectare
Meruru2	Bellary	1,350	46.08
Meruru4	Chitradurga, Bellary	696.1	32.90
Kumudavathi	Dharwad, Shimoga	1,284	20.16

The ‘USLE’ analysis revealed a startling annual potential soil loss for Meruru2 and Meruru4. As can be observed from table 1, the potential soil erosion for Meruru4 was 32.90 tonnes/ha/year, while the annual rate of soil erosion was the most for Meruru2 at 46.08 tonnes/ha and it was the least for Kumudavathi at 20.16 tonnes/ha. Kumudavathi has a relatively lower erosion rate due to the low overland flow and gentle slope. Also as per the Indian Government’s ‘State of the Forest’ reports for the period 1991-2009, Kumudavathi (Dharwad and Shimoga) has preserved areas with high inherent vegetative cover (FSI:1991-2009). On the other hand, huge losses were observed in Meruru2 and Meruru4, due to intense human activity carried out in Bellary. As can be observed from the satellite image (figure 6), during 1988-2000, deforestation was prolific in Bellary, mainly due to the Open-cast mining operations for Iron ores (FSI: 1991-2009). In addition, the forest of Bellary caters to more than 50% of the fuel needs of the rural population (Striver Report, 2004).

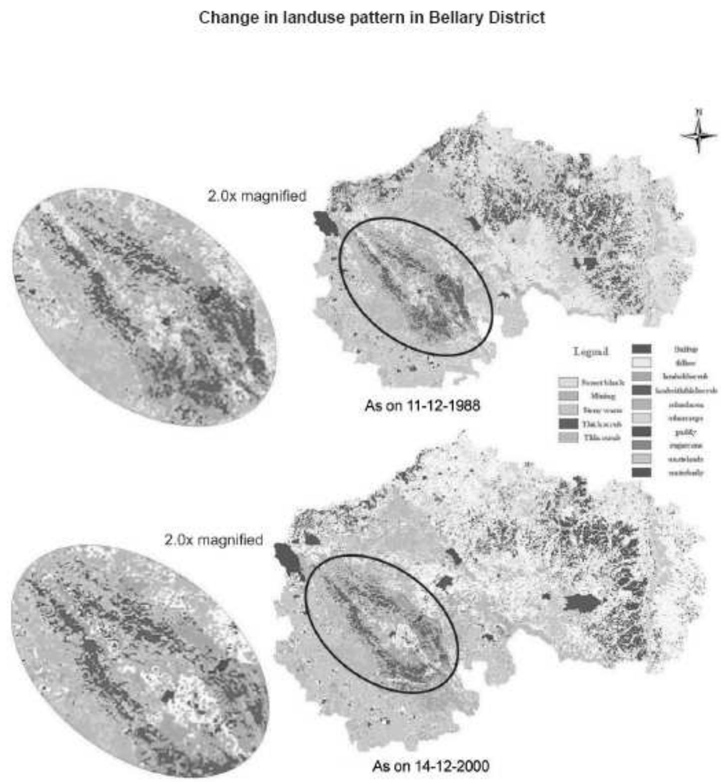

Figure 6 : Land-use for Bellary (1985-2000) (Source: State of Environment Report, 2003)

Also, it can be added that the Bellary forests have also deteriorated, by overgrazing far beyond their productive capacity. The total encroachment to the forestland in Shimoga is 3,466ha, while 5,537.58ha of forestland of Bellary is under mining leases. The extent of land degraded in Bellary district till 2000-01 was about 896.5ha and is estimated to increase to 1,5490ha by 2013 (Striver Report, 2004). These human factors can be attributed as pivotal reasons for the loss of top-soil. Comparing the two watersheds - Meruru2 and Meruru4, least top-soil loss was observed at Meruru4, due to the considerable forest cover retained in portions of Chitradurga (FSI: 1991-2009). The total mine area under forest was 65.5% (11,130ha) in Bellary, while it was 38% (757ha) in Chitradurga (Striver Report, 2004). The forest cover of Chitradurga between 1991-2009 might have increased from 3% to 4.95%, yet it witnessed a loss of about 6%, specifically in the last decade due to the splurge in industrial activities and illegal felling. Though this loss maybe marginal, it still cannot be deemed insignificant. Nevertheless, in this context for Bellary, the transition has been most unfortunate with a loss of 16%.

To summarize, the urban land-use demands have been most predominant in the Tungabhadra sub-basin. In 1960-61, the land under non-agricultural area (Built-up) was 1,61,553ha (5.44% of the total geographical area) and it expanded to 1,94,489ha (6.86%) by the year 2004-05 (Striver Report, 2004). Apart from the illegal and unsustainable licensed felling of trees for supporting a number of industrial activities, the basin also included a wide range of commercial agricultural activities with irrigated agriculture rapidly and prominently replacing areas under rain-fed farming. This modern agricultural practice under the influence of huge/heavy machineries also has contributed to the removal of top-soil. As a result, the Tungabhadra reservoir has been consistently loosing its water storage capacity over the decades by about 25% due to siltation (Striver Report, 2004). The above data can also be substantiated from the fact that the maximum deforestation and disturbance of top soil in the basin, due to human activities such as mining and agriculture, have occurred in the belt of active erosion.

As depicted in the figure 7, the zone or belt of active erosion forms the side-slope/mid-slope. The process of soil erosion is fastened, if the vegetation cover is sparse in this zone, and that is precisely what has happened over the years of human intervention for Tungabhadra sub-basin. In the long run, the process of deposition in the course of water-flow has reduced the differences in the contour levels of crest and foot slope, thereby making the mid slope steeper and infertile.

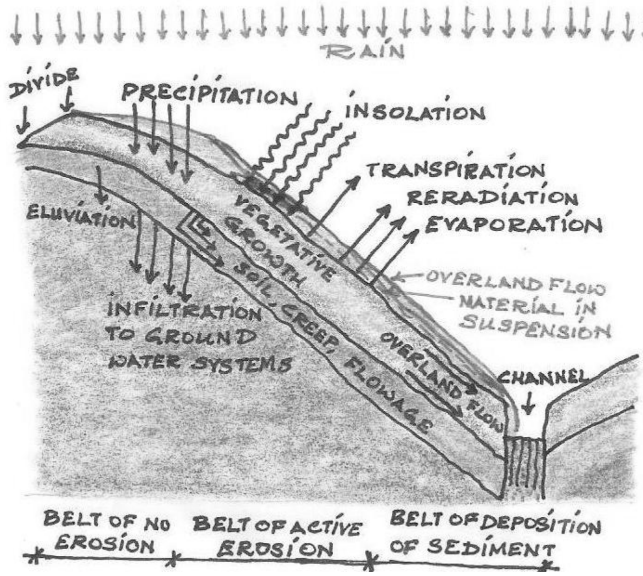

Figure 7 : Zones of Erosion

5. CONCLUSIONS

The demand for domestic and industrial needs has increased with the increasing population in the Tungabhadra sub-basin area. As an outcome, land-use pattern in the basin has changed a lot over the time due to the inorganic rate of deforestation. Presently, the basin is characterized by vast agricultural, industrial and urban settlements resulting in enormous siltation. Meruru2 and Meruru4, when compared with Kumudavathi, have witnessed more soil erosion due to illegal mining activities in Bellary. This along with the licensed mines, apart from inducing fragmentation of forest land, has exposed the land cover, posing a clear threat to conservation of top-soil of the Basin. The control measures need to be identified in a sustainable fashion which besides retarding the run-off, will also control silt inflow into the rivers, and this should essentially envisage afforestation and preservation measures along the contours representing the belt of active erosion.

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