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Land Use and Watershed Management for Sustainable Development Using Geoinformatics

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Natural resources, particularly land, water and energy, which form the basis for sustainable development, have reached a critical point by the anthropogenic pressure posed by the rapidly growing human population in India. Land use is one of the significant drivers of sustainability. More than 90 % of rural and nearly 30 % of urban population (Kumar and Singh, 2003) in India is dependent on ground water sources for meeting their drinking and domestic water requirements. It also forms the major source of irrigation. Frequent flood and drought are the regular phenomena (Singh, 2005). 60 % of Indian population depends on land-based biomass energy. In order to regenerate forests and vegetation cover for about 33 % from present about 20 % in India, land-based Joint Forest Management (JFM) is being implemented (Singh, 2009). Such multiple requirements call for the optimum utilization of land in order to achieve sustainable development. After 73rd Constitutional Amendment, watershed development has been included in the schedule of subjects to be handled by panchayats (village government). This provides opportunities for combining development of grass roots democracy and land and water resources in an integrating way. This calls for an integrated watershed management for better utilizing land and water resources after taking into account the landscape synthesis and prevailing environmental conditions.

Geoinformatics-based spatial information technology has been applied to generate sustainable development plan for an area, which is optimally suitable to the terrain and to the productive potential of the local resources so that the level of production is sustained without decline over time. Geoinformatics include integration of data coming from remote sensing, GPS and conventional sources like Census and Survey of India maps etc. together with analyzing under Geographical Information System (GIS) framework (Jha and Singh, 2008). The objectives of the paper include (i) to monitor the existing land use pattern and changes, (ii) to promote the water harvesting structures for water resource development and (iii) to suggest integrated land and water management plan for sustainable development. Agriculture is the backbone of Indian economy. Agriculture and allied sectors like forestry, logging and fishing accounted for about 16 % of GDP and employ about 60 % of India's population. About 43 % of total geographical area of the country is used for the land based agricultural practices. Despite a steady decline of its share in the GDP, agriculture remains largest economic sector and plays a significant role in the overall socio-economic development of India. Indian agriculture is dependent on monsoon. Rice and wheat are the principal food crops grown over the large tract (about 70 % of agricultural land) of the country.

The present study area - the Ganga sub-basin - is one of the highly densely populated and underdeveloped regions of India. Indian remote sensing data has been used for land use analysis. The region is predominantly alluvial plain with about one-fourth area under single crop which should be taken into consideration for the optimum use. About 15 % of the area is under the fallow land and these lands can be used for other purposes. The analysis reveals that there is little area under forest category and more than 50 % are degraded in form of open and scrub forest. The analysis reveals that the double crop area can be increased from

one-third to two-third area. In this way, geoinformatics have been very useful for land capability classification, predicting land degradation hazards like soil erosion taking into consideration of slope, vegetation, soil quality and rainfall intensity (Singh, 2006) using multi-criteria analysis.

Integrated land management plan should be based on participatory design, diagnosis and development incorporating responses of the people. The alternative land use systems like horticulture, agro-horticulture, agroforestry, fish culture and integration of livestock enterprises with the agriculture system have been suggested for integrated land management. For water resource development various water harvesting structures like farm ponds, percolated tank, check dams, etc., have been suggested. These land and water resource development plans can increase the productivity and reduce wasteland to negligible level. The analysis reveals that about two-third of the total land should be used for double cropping. About 8 % and 3 % of the study area should be put under agro-horticulture and horticulture respectively. The watershed wise alternate land use model is prepared in such a way that every piece of land should have optimum use. Multiple land use options are well-received by the people. Thus, geoinformatics technology is emerging as a tool for decision support system in land and water management in India.

The present study contributes required input for policy makers and other agencies for planning the best use of the available resources in order to improve the socio-economic and environmental conditions. The approach is gaining currency based on various interventions related to land and water resources at the micro-watershed level. There is a need to improve environmental governance in the country towards promoting sustainable development. Civil society, particularly business houses (companies), have to take a pro-active role. Recently the Citizen's Front for Water Democracy came into existence. However, there exist regional differences in the implementation. Thus, improving governance would ensure the supply of water to every field, remove poverty from poor areas, provide green cover over deforested areas and improve the environmental quality. Integrated land and water management is also described as the programme that holds the key to solving problems of sustainability through improvement of employment, economy, exports, equity and environment.

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