Land Resource Inventory: A Primary Tool for Sustainable Integrated Watershed Management

Shreyasi Gupta Choudhury[1], Tapati Banerjee[2]

Regional Centre, Kolkata, ICAR-National Bureau of Soil Survey and Land Use Planning, Kolkata-700091
*Corresponding Author

Received:- 08 February 2022/ Revised:- 15 February 2022/ Accepted:- 21 February 2022/ Published: 28-02-2023

Abstract— *Land, the most indispensable natural resource has been facing challenges of soil degradation, water scarcity, reduced productivity, climate change, social deterioration etc. In these consequences, the rainfed areas might get the priority to develop because of its area coverage in India and great potentiality towards crop yields increment through improved resource management practices. Rainfed areas can best be managed through integrated watershed management approach involving human intervention in manipulating natural resources for overall societal development. Land resource inventory (LRI) is the first and primary step followed by planning, implementation, monitoring and evaluation in the watershed management programme. We surveyed and studied Dwarkeshwar microwatershed in Puruliya district of West Bengal for land resource inventory at 1:3960 scale considering soil, parent material, existing land use, physiography, climate and vegetation. Nine soil series and ten physiographic units were identified and mapped. Considering the above parameters with the existing socio-economic status and need, a management unit map regarding land use planning has been developed for further use as a primary tool for implementation purpose.*

Keywords— Land resource inventory, Watershed management, Geospatial technique, Purulia district, landuse.

I. INTRODUCTION

The judicious use of irreproducible natural resources acts as the most sensitive indicators of societal economic growth, development, resilience and empowerment. Land is the most indispensable natural resource consisting of soil, water, natural flora and fauna involving the ecosystem component. The ever-shrinking land resources and the decreasing trend of productivity might increase the probability of getting attention towards rainfed areas. India's 60% land is under rainfed condition which is characterized by poor soil health, water scarcity, land degradation, low input use and productivity. Still, these areas have huge potential for enhancing crop yield through improved resource management practices. To address the multiple issues of environmental, ecological, agricultural, geological aspects and other related natural resources, there is an imperative need of site-specific information and situation specific recommendations. The unavailability of site-specific soil and land information along with the recommendation at farm level might have been forming the hurdles towards the success of many developmental schemes around the country. This wide gap could have been filled with systematic land resource inventory at large scale and its subsequent mapping using geo-spatial techniques. Watershed approach has been recognized as a vital landmark in the direction of bringing visible benefits in rainfed areas, while attracting people's participation in watershed programme (Saxena and Prasad 2008) for the improvement and sustainability of agricultural and allied sectors for overall community development. The rainfed areas could be brought under the limelight of developmental and climate resilient agricultural practices through integrated watershed management programmes involving the process of human interventions in maneuvering natural resources for the overall societal upliftment under the natural boundary of watershed (Vittala et al 2008). A sustainable integrated watershed management programme includes three steps namely- land resource inventory, land use planning and implementation, monitoring and evaluation. The most basic and initial tool is land resource inventory without which precisely, the other following steps would seem to be futile in true sense. The detailed land resource inventory (LRI) at large scale can only discover the necessary soil and land information, which will be further exploited for subsequent agricultural land use planning and implementation purpose at watershed level. Simultaneously, the evaluation of the suitability of land for remunerative kinds of use requires a detailed natural resource survey to define and map the land units together with the collection of descriptive database of land characteristics and resources like soil, rock, climate, slope, erosion, landform, vegetation and socio-economic status as follows-

Soil Survey- For farm level land use planning in a watershed, a detailed soil survey at cadastral level is the primary need. Different soil series existing in different physiography might have a relationship with land use changes. Identification of soil series, delineation of soil boundaries and its mapping will assess the potential of the soils for increased and profitable agricultural production for societal sustenance.

Rock identification- The rock type has an influence on soil type and formation, surface stability and land use of any site. The existing rock type has to be surveyed for parent material identification, genesis and characterization of soils. Even the identification and delineation of lineament also helps to find out the underground source of water.

Climate-Climate plays a major role in land use potentiality assessment. Climatic data indicates the suitability of the existing land/ soil for agricultural/ horticultural/ pastoral cropping or forestry/ plantation use. It has a direct influence on soil formation processes, surface erosion, which are indicators of fertility and productivity of the system. The different climatic components like maximum and minimum temperature, rainfall, evapo-transpiration etc. are to be collected and considered while doing the survey work for having a sustainable land use plan.

Physiography– the physiographic delineation with elevation, slope gradients and aspect, erosional and depositional phases for each surface features are the basic components for soil characterization followed by future land use planning. It is to be measured through DEM analysis in GIS platform followed by field observation and ground checking.

Vegetation - Existing land use and vegetation are the essential components for preparing soil-based land use model for future land use planning. Vegetation is a good indicator of temporal land use changes and is to be derived from field survey and correlated with satellite imagery. The existing vegetative cover and land use often integrated with soil survey database to produce sustainable land use plan.

Socio-economic survey – the existing social status, norms, faiths and need of the villagers are the steering factor for a successful watershed management programme. A thorough survey of the socio-economic condition, future need and the villagers view towards acceptance of the changes in the pathway of development has to be acquired with their active participation for economic development and employment generation as well during the land resource inventory process.

The procedures of a land resource inventory within a watershed boundary contains checklist of thematic data that might be required in land evaluation. This approach allows the user to protect and conserve soil, water and other biotic resources with a rational planning process to combat the societal degradation and climate change.

II. A CASE STUDY FOR LAND RESOURCE INVENTORY

Considering the above facts, the Dwarkeshwar microwatershed has been surveyed and studied for land resource inventory in the eastern fringe of Chhotonagpur plateau consisting of three villages namely Parasibona, Batabathan and Kalaboni of Hura block in Puruliya district, West Bengal (Bhattacharya et al 1985). The microwatershed is characterised by high temperature with high variability of monsoon rainfall. The average normal climatic parameters (rainfall, potential evapo-transpiration, maximum and minimum temperature) were considered while doing the land resource inventory. It was observed that the average monthly rainfall for the last thirty years was 11.3 cm, while potential evapo-transpiration (PET) was 18.6% higher than rainfall with an aridity index 0.16, which categorized the area under dry sub-humid zone in eastern India. The observed mean annual normal maximum and minimum temperatures were 31.9 °C and 20.9 °C, with the highest rise in the month of June having 37 °C and 26 °C, respectively (Figure 1). Agriculture is the dominant livelihood option with monocrop paddy having an average yield of 1.8 to 2.0 t ha^{-1}. During land resource inventory, detailed work was carried out on landform, land use analysis followed by detailed soil survey at 1:3960 scale. Nine soil series with phases were identified and mapped in fourteen units on ten physiographic units developed over granite-gneissic formation (Figure 2). Land capability and suitability analyses of rice, wheat, maize, mustard, groundnut, cowpea, pigeon pea and sabai grass were done for the area with a focus on the application of the principles of sustainable development in order to maximize the benefits derived by the farmers from the existing resources of land and water through utilizing them in a scientific manner. Considering this, a management unit map (Figure 3) has been developed based on derived resource information of the microwatershed for implementation purpose. Even the base flow of water through the lineament in the Tilaboni hill and existing water structures at the upper reaches and their utilisation to irrigate the cultivated lands in the lower reaches were also explored in the microwatershed. Thus, land resource inventory has been admitted to be a primary tool for developing management units suggesting rational and scientific land use plan, which could be further utilized for implementation, monitoring and evaluation of the watershed management programme.

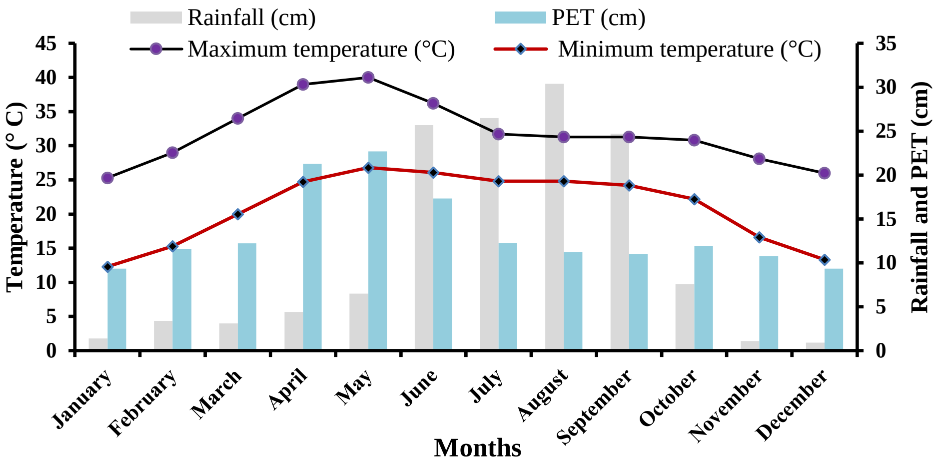

FIGURE 1: The normal monthly average temperature, rainfall, potential evapo-transpiration of the site

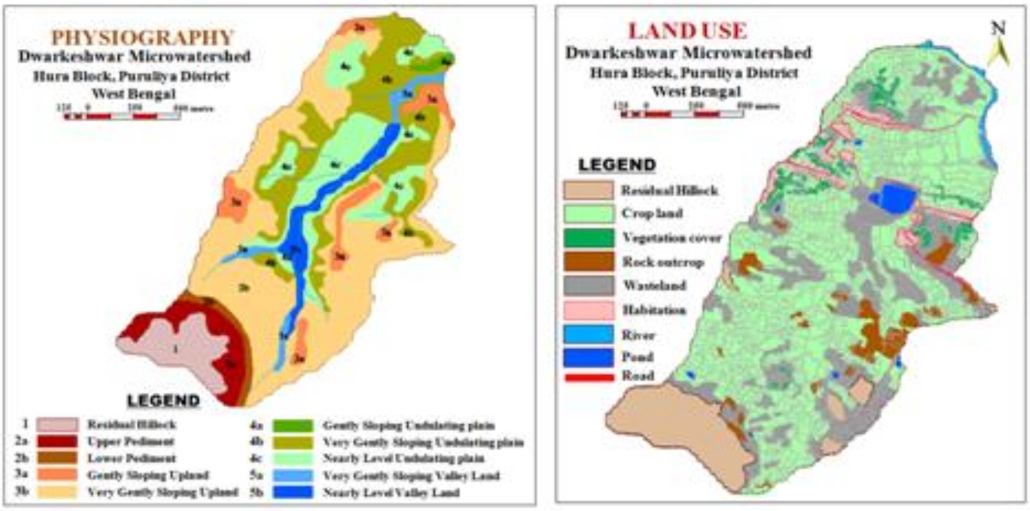

FIGURE 2: Physiography and land use maps for the Dwarkeshwar microwatershed

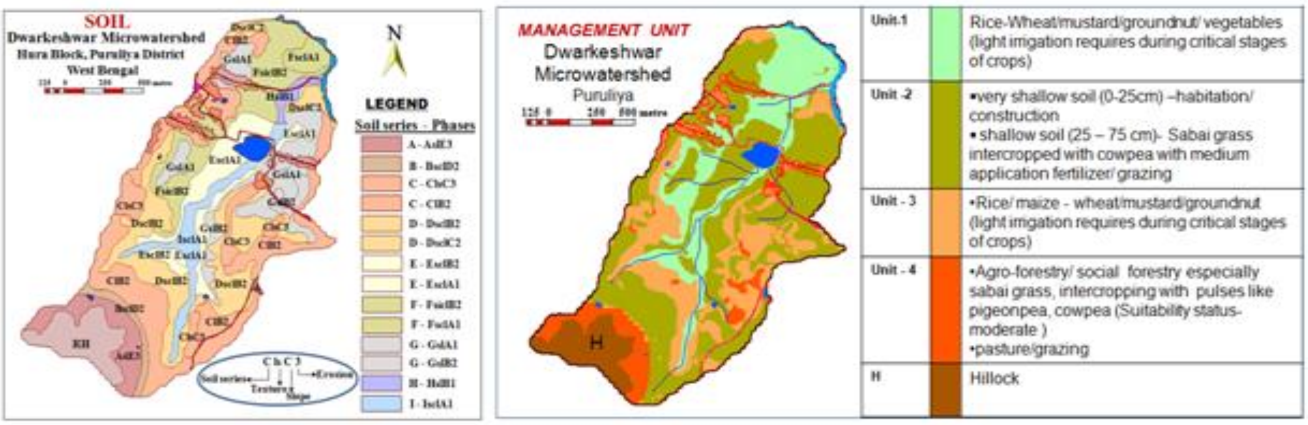

FIGURE 3: Soil and management unit maps for the Dwarkeshwar microwatershed

Although, watershed management has evolved long back, and passed through several developmental stages, but, initially, it only dealt with forestry related hydrology without any active involvement of people. With the passage of time, it changed its direction towards land resources management including activities with an emphasized view on economic benefits of the stakeholders. Wösten *et al*. (1985) transformed soil patterns on detailed soil maps into patterns of "functional units" that each had distinctly different hydraulic conductivity and moisture retention characteristics. A more sophisticated procedure was followed by Bouma *et al*. (2002) who delineated “management units” for precision agriculture on the basis of simulation runs for nitrogen transformations and pesticide leaching for point data, followed by interpolation. Knowing the internal variability within these “management units” allows estimates to be made of the variability obtained for simulation runs for the units. Therefore, effective functional unit is imperative based on hydrological parameters for achieving the goal of sustainable agriculture.

The new generation approach is focused on the participatory and integrated watershed management, with active participation and contribution of the local people. A concise and organized step should be maintained while working with the watershed management as it directly deals with the livelihood and social upgradation of the farmers, whose wellbeing is thoroughly dependent on the survey, planning, implementation, monitoring and cooperation of the planners with a scientific and authentic land resource inventory

III. CONCLUSION

The modern day microwatershed program includes the strategic and efficient use of natural resources with the participatory approach of community users that led to carry out inventory of resources. The paradigm shift from traditional structure-driven watershed program alone to holistic approach of poverty alleviation with livelihood promotion choosing the alternate income option through conservation of local resources. The authors tried to explain this concept in this paper which is the only possible way by converging the natural resources and the society without any further degradation of resource base. This new paradigm especially in rainfed agricultural region may be a powerful tool that may be enhanced in a more innovative and cost-effective manner to secure land and society.

REFERENCES

[1] All India Soil & Land Use Survey (1985) Report on Demarcation of PrioritySubwatersheds of the Rupnarayan Flood Prone River Catchment, WB. R.K.Dutta, M.K.Mitra, S.S. Mishra, R.R.Biswas, RC, Calcutta, Report No AGRI 691.

[2] Bhattacharya, B.K; Chakraborti, B.R.; Sen, N.N.; Mukherji S., Ray P., Sengupta S., Sengupta K.S. and Maity T. (1985). West Bengal District Gazetteers, Puruliya, Govt of West Bengal

[3] Bouma J, van Alphen BJ, Stoorvogel JJ (2002) Fine tuning water quality regulations In agriculture to soil differences. Environ Sci Policy 5:113–120, Current Science, Vol. 95, No. 3, 10 August

[4] FAO (1976) Framework for Land Evaluation, Food and Agriculture Organisation, Rome, 72 Pp.

[5] FAO (1983) Guidelines: Land Evaluation for Rainfed Agriculture, Food and Agriculture Organisation, Rome, 237 Pp.

[6] Hennrich Kirsten. Jochen Schniidt& Richard Dikau (1999) Regionalization of geomorphometric parameters in hydrological modelling using GIS Regionalozation in Hydrology, Proceedings of a conference held at Braunschwerg, March 1997 IAHS Publ. No.254, 1999.

[7] IARI (1971) Soil Survey Manual, All India Soil and Land Use Survey Organisation, IARI, New Delhi, 121 Pp.

[8] Naidu, L.G.K, V. Ramamurthy, O. Chella, R.Hegde and P. Krishnan (2006) manual soil site suitability criteria for major crops. NBSS Publ. No. 129, NBSS&LUP, Nagpur, 118p.

[9] Natarajan, A., Krishnan, P., Velayutham, M. and Gajbhiye, K.S.(2002) Land Resources of Kudankulam, Vijayapati and Erukkandurai Villages, Radhapuram Taluk, Tirunelveli District, Tamil Nadu.

[10] Saini, H.S. (2008). Climate Change and its Future Impact on the Indo-Gangetic Plain (IGP), Earth Science India, Vol. I (III), 2008, pp. 138-147

[11] Saxena, P. R. and Prasad, N.S.R. (2008). Integrated Land And Water Resources Conservation And Management-Development Plan Using Remote Sensing And GIS of Chevella Sub-Watershed, R.R.Distict, Andhra Pradesh, India. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B8. Beijing

[12] Vittala Srinivasa S., S. Govindaiah and H. Honne Gowda 2008 Prioritization of sub-watersheds for sustainable development and management of natural resources: An integrated approach using remote sensing, GIS and socio-economic data

[13] Wösten J. H. M., Bouma. J. and Stoffelsen G.H. Use of Soil Survey Data for Regional Soil Water Simulation Models. Soil Science Society of America Journal, Volume 49, Issue: 5September-October 1985Pg:1238-1244