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Land Capability of Narayanappa Kunta Micro Watershed, Anantapur District

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ABSTRACT : The development potential of land and water resources and their utilization are governed by a set of physical, geomorphic, climatic and socio-economic factors. Watershed management implies the proper use of land and water resources for optimum production with minimum hazard to natural resources. The data generated having capability to genarate area specific planning scenario based on land capability characteristics for land use planning and water management. In the present study Narayanappa Kunta micro watershed has been selected for evaluation of land resources to assess the land capability characteristics. The study reveals that the land capability class I to IV covers arable land and class V and VI covers non-arable land. Based on the land capability characteristics appropriate measures have been suggested for integrated management of land and water resources of the watershed.

Introduction

Land and soils are finite natural resources, whose proper utilization depends on the life supporting systems of a country and the socio-economic development of its people (Sehgal, 1990). The capacity of land to produce is limited and its production also depends on its use and management (FAO, 1994). The landscape-soil relationship may be utilised for proper understanding of soil and other edaphic conditions of a region (Vink, 1975). Land evaluation is the process of estimating the potential of the land for alternative kinds of use (Dent and Young, 1981). Shafi (1969) has given a good account of land classification and land capability. Nageswara Rao and Vaidhyanadhan (1981) have made attempts to bringout the land capability of Krishna district, Andhra Pradesh, using aerial photographs on disposition of landforms and physical characteristics. Sambasiva Rao (1985) has evaluated the land suitability of the Madurai district, Tamil Nadu, using aerial photo-interpretation and remote sensing techniques. Dent (1992) opined that the end product of land evaluation is a land capability map showing the capability of each land unit for each possible type of land utilization and its descripitions appropriate to the level of planning concerned.

Watershed is defined as a catchment area or geo-hydrological unit bounded by a ridge line on three sides of a valley. Inventary of resources is pre-requisite for judicious management of watershed (Cook, 1974). Watershed based evaluation of land resources and land capability classification is emerging as an efficient approach for rational utilization of land and water resources for sustained production. Watershed development and subsequent utilization of various natural resources, particularly land and water involves survey, mapping, measurement and integration of various terrain, topographic and environmnetal parameters to generate alternative scenario for decision making (Mohanty *et al*, 1994). This study examines the present status and salient

features of selected components *viz.* drainage, slope, landforms, soils and hydro-geomorphology for evaluation of land resources to assess the land capability characteristics and suggest appropriate measures for sustainable landuse planning and physical landscape as well as geo-ecological balance of the Narayanappa Kunta micro watershed.

Study Area

The Narayanappa Kunta micro watershed lies in between 77°39'E and 77°43'E longitudes and 14°37'N and 14°43'N latitudes. The total geographical area of the watershed is 6170 hectares. The average annual rainfall of the watershed is 532 mm, most of which is received during the south-west monsoon period (June-September).

Methodology

The Narayanappa Kunta micro watershed has been delineated based on Survey of India (SOI) topographical sheets and remotely sensed geo-coded data on 1:50,000 scale. Slope and drainage conditions of the watershed have been studied with the help of topographical sheets. The landforms, soils and hydro-geomorphological conditions of the watershed were delineated based on satellite image characteristics of tone, texture, pattern, shape, size and association, together with topographical information. The ground information has been collected for the validation of the results. The land capability of the watershed has been carried out based on the interpretation of the physical characteristics *viz.*, slope, drainage, landforms, soils and hydro-geomorphology. After studying the potential and problems of the each land capability unit of the watershed appropriate measures have been suggested for sustainable land use planning and maintenance of vital geo-ecological balance of the watershed.

Results and Discussion

Drainage

The watershed is drained by two intermittent streams terminating into tanks. The southern intermittent stream consist of 12 first order streams, two second order streams and one third order stream. The northern intermittant stream comprises 17 first order streams, four second order streams, two third order streams and one fourth order stream. In between these two intermittent stream is ending into a tank near Kondapuram village. The drainage pattern of the watershed is mostly dendritic (Fig. 1).

Slope

The slope of the micro watershed varies from 2° to 20°. The steep slopes of more than 20° is noticed on the hills of western and south-eastern parts of the watershed. The slope varies from 10° to 20° on the north-eastern, north-western and southern parts of the watershed. Slope gradually decreases from 10° to 5° bordering the hilly terrain and rock out-crops. The major part

NARAYANAPPA KUNTA MICRO WATERSHED

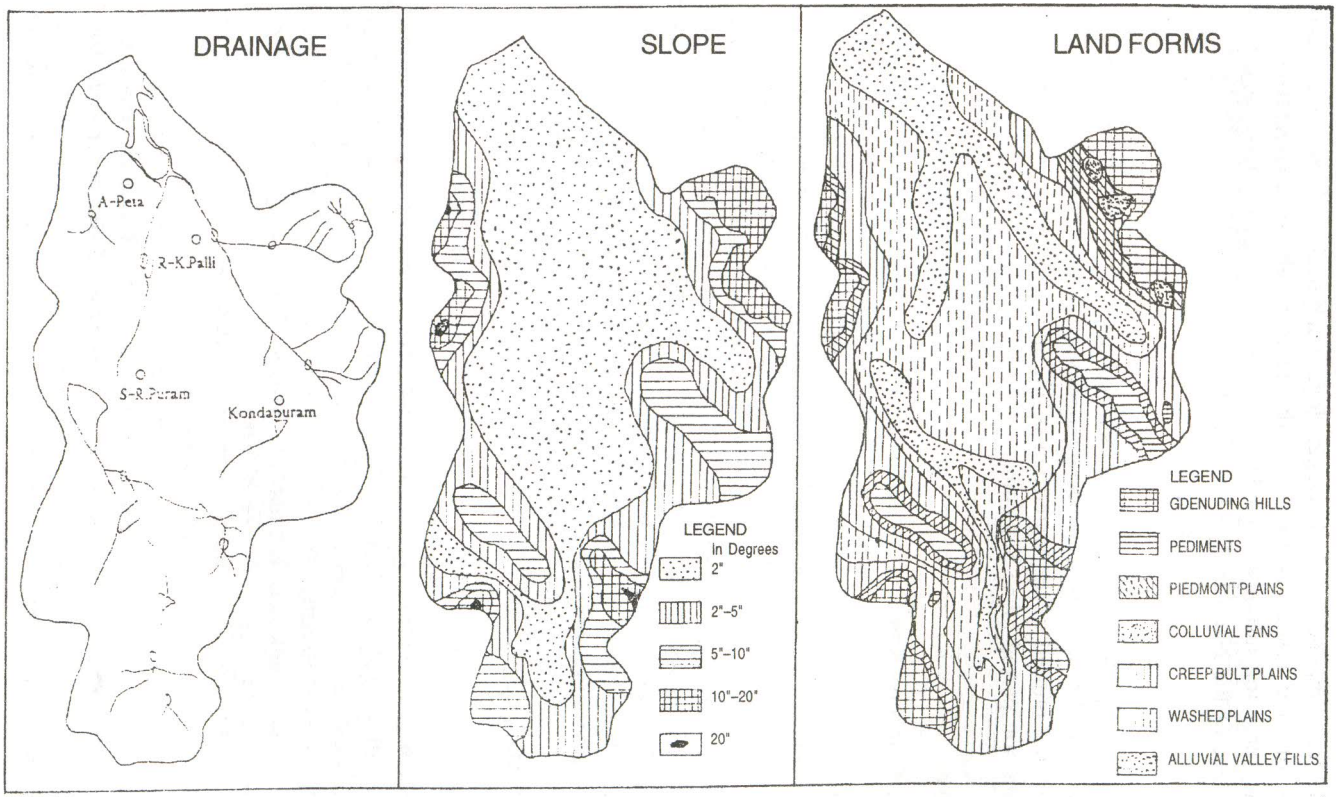

Fig. 1 Fig. 2 Fig. 3

of the watershed has less than 2° slope and its occupies the central and northern parts of lower portion of the wateshed (Fig. 2).

Landforms

Lithologically the micro watershed is covered with Archean unclassified granitic gneiss and pre-cambrian basic intrusive dykes. The major landforms of the watershed have been delineated into alluvial valley fills, washed plains, creep built plains, colluvial fans, piedmont plains, pediplains and denudational hills (Fairbridge, 1968) (Fig 3).

Alluvial valley fills. The fluvial sediments derived from the catchment area of the watershed were deposited along the courses of river channel. This geomorphic unit consists of moderately to well sorted, stratified deposits of gravel, silt and clay on either side of river channels with thickness varying from 1 to 1.5 m over the granite and schist.

Washed plains. This geomorphic unit covers major portion of the watershed and formed by predominently sheet wash material derived from adjoining uplands transported over medium to long distances and deposited in the low lying area. It consists of heterogeneous mixture of unsorted fragments of various shape and size admixtured with sand, silt and clay.

Creep built plains. This geomorphic unit has been formed by continuous deformation, the creeping and sheet wash erosional activities. The sediments derived from nearby uplands were deposited and formed creep built plains. The sediments ranging from small gravels to larger gravels.

Colluvial fans. This landform unit is very limited in areal extent and confined to foot slopes of denudational hills. Due to local level lands and weathered material transported from uplands by the fluvial activity, the fine suspended clay to coarse fragment material has been deposited and formed isolated conical shaped colluvial fans in the north-eastern part of the watershed.

Piedmont plains. The narrow piedmont plains are formed on nearly plain lands along the foot slopes of the dissected pediments and denudational hills. The causative factor for the genesis of this landform is sediment deposition, which is carried from nearby uplands by fluvial activity and which consists of coarse to gravel clastic material.

Pediments. This geomorphic unit occupies nearby denudational hills and on eroded rock surface of considerable extent at the foot of hill slopes overlying granites, gneisses, schists and sedimentary rocks with a thin veneer of soil cover. Sheet and gully erosions are very active in the zone of dissected pediments exposing the underlying weathered mantle of bed rock.

Denudational hills. Denudational hills formation constitute stony materials composed of granites, gneisses and schists with very thin soil cover with sparce vegetation. In the north-east and sourthern parts of the watershed this geomorphic unit is composed of low mounds, knolls and exfoliation domes.

Soils

The soils of the watershed have been delineated based on study of physiography, slope, drainage, lithology, landforms and their inter-relationship. The selected soil profile studies have been carried out in each landform unit to classify the soils. (Soil Survey Division Staff, 1997) (Fig 4).

Deep colluvial valley fill soils. These soils are restricted to stream beds with limited lateral extension. They are deep, with dark grey, clayey surface layer and dark grey to dark greyish brown, clayey subsurface layer (90 cm) and well drained (Typic Ustifluvents). The soils are developed on very gently sloping (< 2°) lower sector of the watershed. The soils are composed of clay, silt, and fine to very fine sand fragments.

Mixed soils. Washed plains with very gentle slopes (<2°) have shallow to moderately deep, with dark brown, clay surface layer and dark greyish brown clayey subsoil, well drained and non-calcareous (Lithic Vertic). The composition of mixed soils vary from silt, clay and sandy loam to non-calcareous and moderately eroded soils.

Shallow red sandy soils. These soils are developed on creep built plains by *in situ* weathering and material derived from nearby granite, gneiss and quartzite parent rocks. The soils are shallow in depth and reddish brown to brown in colour. These soils are formed with clay, silt and loam surface layer and dark red gravelly clay subsoil (Lithic Ustropepts).

Deep red sandy soils. These soils are developed on gently sloping (2°–5°) piedmont plain landform near the foot hills of denudational hills. These soils are very narrow in extent and moderate to deep in nature and comprise reddish brown to brown and loamy skeletal to fragmental (Udic Rhodustalfs), occassionally calcareous material derived from the weathered parent material. These soils have low to medium water holding capacity due to varying proportion of gravel present in the sub-soil and have medium cation exchange capacity and low to medium fertility.

Residual soils. These soils are mostly eroded soils developed on denudational hills with slope ranging from 10° to 20° and derived from the parent rock present on the denudational hills. These soils are shallow to very shallow with yellowish brown gravelly clay loam surface layer and dark brown gravelly subsoil with rock out-crops (Lithic Ustorthents).

Hydro-geomorphology

The methodology adopted for generation of hydro-geomorphological map of the study area is based on analysis of various geomorphic, lithologic, structural and available data on aquifer characteristics for evaluation of the qualitative ground water potential zones in watershed (Obi Reddy and Sambasiva Rao, 1994) (Fig 5).

The colluvial valley fills, with very gentle slopes (< 2°), consist of thick alluvial and colluvial deposits by the fluvial action underlain by sand, and silt mixed with clay occupies the major channels and is acting as recharging as well as discharging zone for ground water. The ground water prospects in this hydro-geomorphic unit is good. Major portion of the watershed

NARAYANAPPA KUNTA MICRO WATERSHED

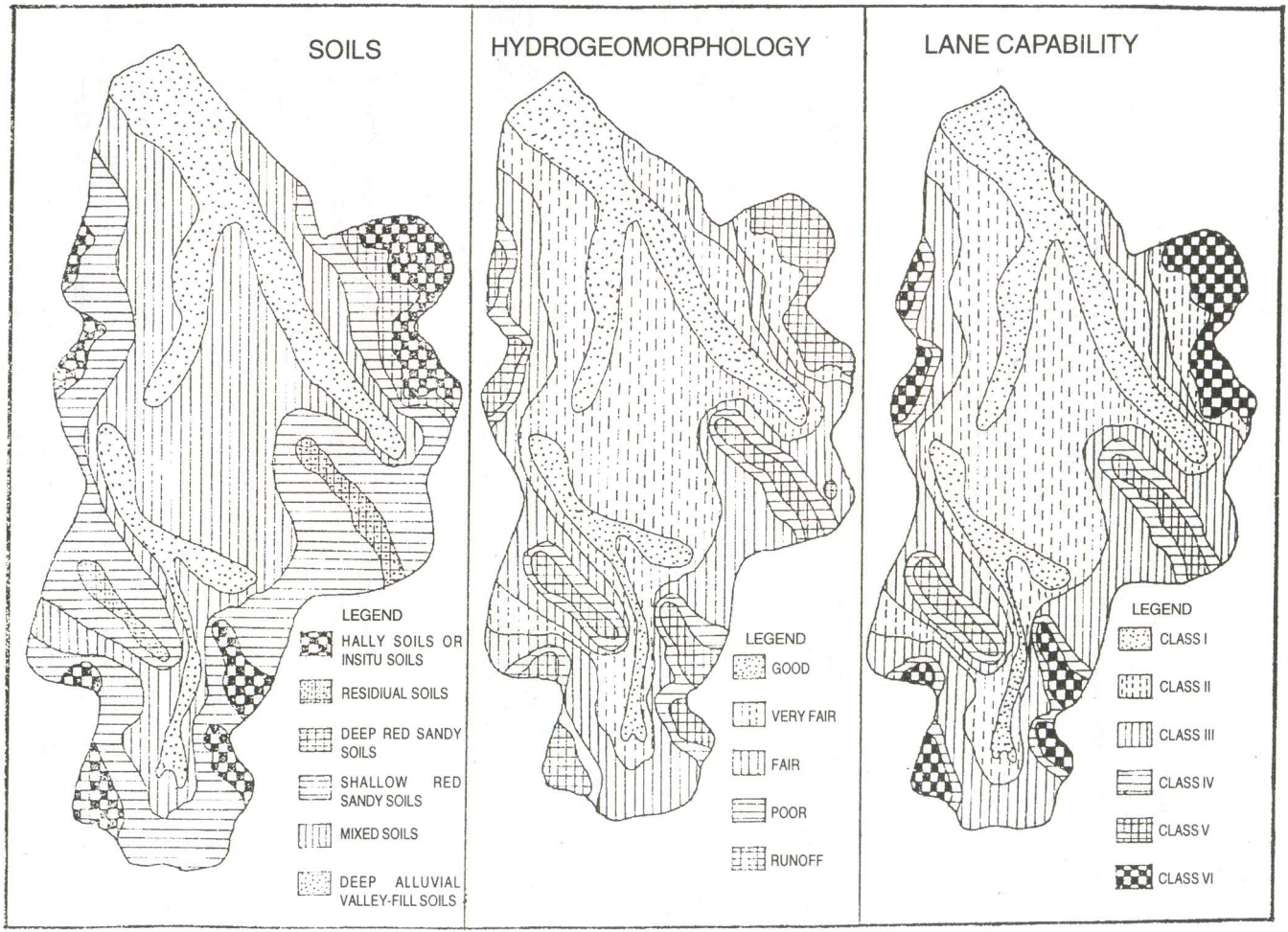

Fig.4 Fig. 5 Fig. 6

having washed plains with mixed soils and very genetle slopes (<2°), moderately weathered mantle (<1 m), low relief providing good scape for infiltration and recharge of ground water. The ground water potential in this hydro-geomorphic unit is very fair.

The undulating terrain landforms with shallow red sandy soils having moderate slope (2°–5°), shallow weathered mantle (< 50 cm) with thin soil cover provide limited scope for infiltration and re-charge of ground water. The groundwater potential in this hydro-geomorphic unit is fair. At the foot hills of denudational hills the piedmont plains lay having shallow red sandy soils with slope varying from 5° – 10°. Due to high relief, steep slopes, small areal extent, thin mantle and low infiltration capacity, the ground water potential in this hydro-gomorphic unit is poor. The denudational hills with rock out-crops and *in situ* soils having slope more than 15° acting as run-off zones have very little vegetative cover.

Land Capability

Land capability of the Narayanappa Kunta micro watershed has been carried out based on the study of lithology, landforms, slope, drainage, soils and hydro-geomorphological conditions (Klingebiel and Montgomery, 1961). (Fig 6).

Class I. It is associated with alluvial valley fills with good quality of soils and ground water conditions. Soils have high productivity and irrigability. The land could be utilized for cultivation of paddy, irrigated groundnut, sunflower, citrus, grapes, mulbury, floriculture and vegetables. The land developmental activities that could be carried are mulching, fertility and water management.

Class II. It comprises of washed plains with slope less than 2°. It is composed of mixed soils with silt, clay and sandy loam, moderately well drained and very fair ground water conditions. The land is cultivated with irrigated groundnut, sunflower and citrus. This class of land unit has limited constraints and is suitable for irrigated crops like, mulbury, dry food crops, fruits and vegetables in addition to those mentioned earlier. Land levelling and mulching practices are needed for reduction of moderate sheet erosion.

Class III. These lands are composed of creep build plains with gentle slope (2°–5°). Soils are mixed with red sands, clay, silt and loam and well drained. The ground water potential of this unit is fair. In this unit slope and erosion are the constraints. These lands are under cultivation of rainfed groundnut, redgram (*pigeon pea*) sunflower, *bajra* and *jower.* The proposed cultivated crops are rainfed sorghum and dry land horticulture in addition to those mentioned. The land developmental activities that could be needed are land levelling, contour cultivation, strip cropping, etc.

Class IV. This category of land consists of pediments with slope varying between 5° and 10°. The soils are generally gravelly to coarse gravelly and well drained. The ground water potential of this unit is poor and with limitations of sheet and rill erosion. The land is under cultivation of rainfed groundnut, redgram and *bajra*. These lands could be used for rainfed crops mentioned earlier, and dry land horticulture. The land developmental activities are terracing,

contour bunding and soil erosion has to be prevented by vegetative methods and stone bunding across the *nalas*.

Class V. This land unit consists of undulating terrain with pediments having 5° to 10° slope. The land capability unit is subject to high soil erosion and cannot be used for cultivation of crops due to exposure of rock out-crops. The land can be put under pasture and social forest development. The land developmental activities like contour bunding, contour terracing, stone bunding and vegetative hedges are need of the hour to protect the erosion-prone areas.

Class VI. These lands consist of debris, with 10° to 20° slope associated with very shallow *in situ* soils. This barren landscape is actively under rill and gully erosion. The debris of this unit are most suitable for development of pastures and social forestry by adopting proper land management practices *i.e.* vegetative barriers, run-off mangement structures and stone bunding across the valleys.

Conclusion

In the Narayanappa Kunta micro watershed the land capability Class I to IV are arable and Class V and VI are non-arable lands. In the arable lands for maximising the productivity in unit area and unit of water for a unit of time the land treatment measures like contour bunding, contour vegetative barriers, contour cultivation, dead furrows, farm forestry along the existing bunds, farmers' field bunds and engineering methods like land levelling and mulching activities are the need of the hour to be implemented at farm level. The production system under arable land is required for alternative cropping system based on land capabilities, crop demonstration and use of organic manures. In the non-arable lands (Class V and VI) conservation of land and water resources to ensure sustainability of geo-ecosystem befitting the eco-system are needed. These lands can be treated with drainage line development measures like construction of run-off management structures/check dams, rock fill dams, stone checks, constructions of water harvesting structures, gully stabilization and stream bank erosion controlled by vegetative methods and clearance of drainage lines with velocity control for protection of top soil and rain water infiltration. Safe utilization of degraded and marginal lands are most important measures for landscape management and for maintenance of the vital geo-ecological balance of the micro-watershed.

References

Cook, R. V. and Doornkamp, J. C. (1974). *Geomorphology in Environmental management*, Calrendon press Oxford, U.K.

Dent, D. and Young, A. (1981). *Soil Survey and Land Evaluation.* Allen and Unwin, London.

Dent, F. J. (1992). Land evalution and Land use planning, in proceedings of the regional FADINAP seminar on *Fertilization and the environment*, Chaing Mai, Thailand.

Fairbridge, R. W. (1968). *The Encyclopedia of Geomorphology,* Dowden, Hutchinson and Ross., Stroudsburg, Pennsylvania, pp. 1295.

FAO, (1994). *Agro-ecological Land Resource, Assessment for Agricultural Development Planning.* World Soil Resources Report No. 71/9, FAO, Rome.

Klingebiel, A. A. and Montgomery, P. H. (1961) *Land capability classification* USDA, *Agril Hand Book* **210**, Washington, D.C.

Mohanty, P. R, Debajit Mishra, Mohapatra, A., Mishra, P., Pattnaik, K. S., Hussain, A. and Das. S. (1994). Land and water management of Chandragiri watershed, Koraput district, Using Remote Sensing and topographic data. *Proccedings of ISRS silver jubilee symposium,* pp 258-265.

Nageswara Rao, K. and Vaidyanadhan, R. (1981) Land Use Capacility Studies from Aerial Photo Interpretation – A Case study of Krishna Delta, India. *Geographical Review of India,* Vol **43**(3), pp. 226-236, Calcutta.

Obi Reddy, G. P. and Sambasiva Rao, M. (1994). The hydro-geological and hydro-geomorphological conditions of Anantapur district, using Remote Sensing data, *Indian Geographical Journal,* vol **69**. no 2, Dec'94, pp. 128-135, Madras.

Sambasiva Rao (1985). Land Suitability of the Madurai District using Remote Sensing Data, Tamil Nadu, *The Geographer,* Vol. 32, No. 1, 1985, Aligarh.

Sehgal, J. L. (1990). Land Use Planning Experiences in India, in *Land Use Planning Application* Proceedings of the FAO Expert Consultation, pp. 30-40.

Shafi H. (1969). Land Use Planning, Land Classification and Land Capability, *The Geographer,* Vol. **14**, pp. 1-6, Aligarh.

Soil Survey Division Staff (1997). *Soil Survey Manual. Agric. Handbook* No. **18**, USDA, Washington, D. C. pp-503.

Vink, A. P. (1975). *Land use in advancing agriculture,* Spriger Verlag, Berlin.

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