Trans. Inst. Indian Geographers
Vol. 33, No. 1, 2011

Land capability of the Papagni river basin, Andhra Pradesh, Using remote sensing technique

Krishnaiah, Y.V., Nagaland

Abstract

The Papagni river basin covering an area about 8,250 sq km has been studied for the land systems, landforms, soils, land use, erosion susceptibility and hydro-geomorphology using IRS-1B Geo-coded and LISS-III data on scale 1:50,000. The major land systems are hilly terrain, undulating terrain, rolling plains and fluvial plains. The major landforms identified are classified into denudational, fluvio-denudational and fluvial. The major soils of the Papagni basin are shallow weathered red sandy soils, moderately to deep weathered red sandy soils, red sandy loams, black soils, relict soils, valley fill soils, insitu soils and alluvial soils. The major part of the land is utilized for cultivation of groundnut crop (kharif). The hills of the region contain degraded forest. The slope regions are utilized for development of pasture. The basin is subjected to erosion in the hill terrain due to degradation of forest. The erosion intensity is high in central and northern parts of the Papagni basin. Hydro-geomorphologically, the basin is divided into six categories of the ground water potential zones. The fluvial plains possess excellent ground water resources. The valley fills contain very good ground water resources. The black soil plain posses very fair ground water resources. The shallow weathered pediplains are composed of fair ground water potential. The hill terrain is run-off zone. Based on physical resources the land capability of the Papagni basin has been evaluated. About seven classes of land are identified.

Introduction

Land is an important natural resource. It embraces the atmosphere, the soil and the underlying geology, the hydrology and plants above and below a specific area of earth surface. It is always influenced by past and present human activities. River basins form convenient and appropriate spatial units for study of natural resources like land and water. The planning of land development and readjustment is usually carried out in a number of successive phases namely land evaluation, socio economic analysis, land classification and land development programmes effectuation. Land evaluation includes both qualitative and quantitative classification.

Ali Mohammed (1978) studied the land classification using slope, erosion susceptibility, stoniness, salinity, high water table, land use, soil texture, and soil moisture and soil fertility. Shafi (1969) has given a good account on methods and techniques of land use planning, land classification and land capability. A few geographers who have carried land use and land capability studies using air photos and landsats are Raju and Vaidynadhan (1978), Sambasiva Rao (1996) and Kanth *et al.*, (2010).

Objective

To evaluate the land capability on the basis of relief, slope, landforms, soils, land use, hydro-geomorphic units and intensity of erosion.

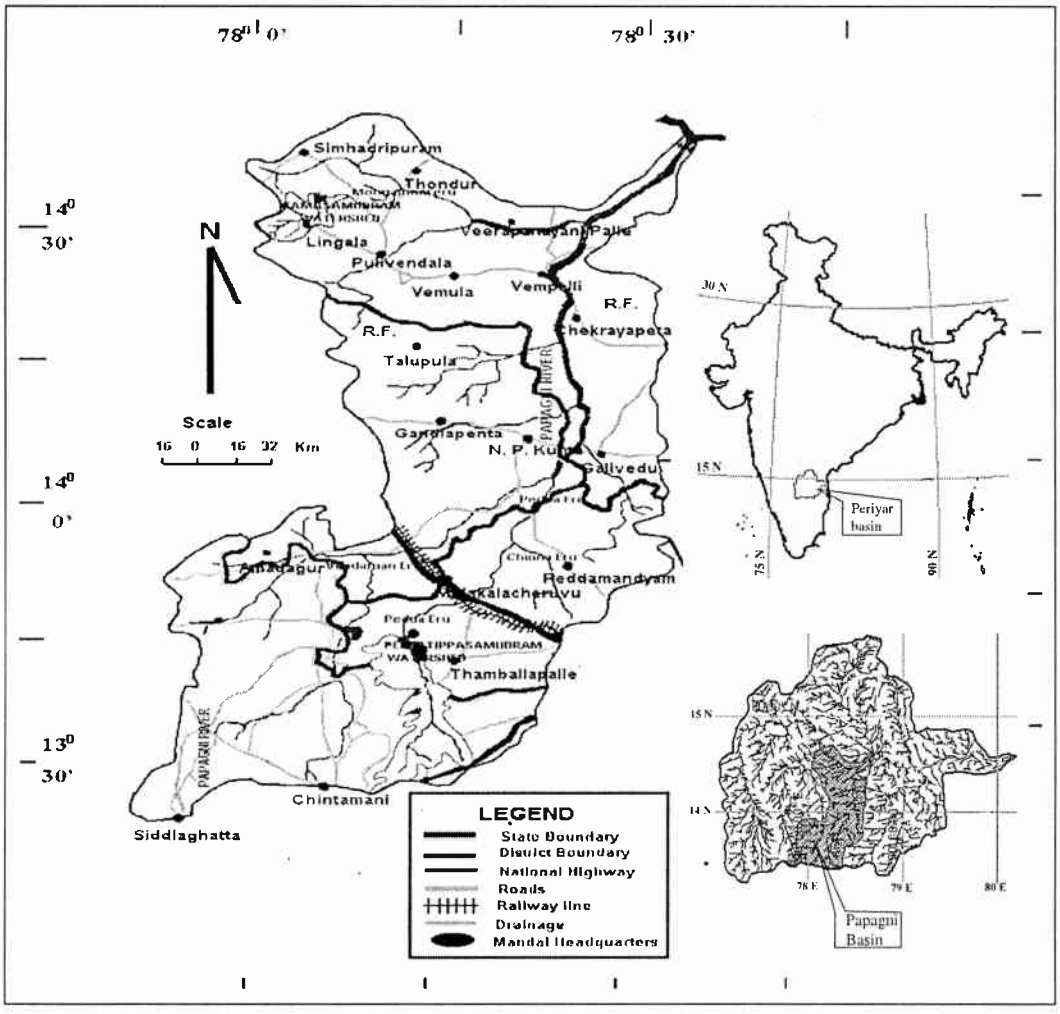

Fig. 1: Location map of the Papagni River basin

The Study Area

The Papagni river basin is a sub basin of Pennar River. It covers an area of about 8,250 km^2. It is located in the parts of the districts of Anantapur, Kadapa, Chittoor of Rayalseema region in Andhra Pradesh and Kolar district of Karanataka state. It is located between 13^0-20' to 14^0-40' North latitude, 77^0-50' to 78^0-40' East longitude (fig. 1). Geologically the major part of Papagni River is located in granitic terrain in the southern part and Proterozoic formations consisting of Vempalle dolomites and shales with basic intrusives and lava flows in the northern part of the basin. There are about twenty five mandals located in Andhra Pradesh and five taluks of Karnataka state.

Methodology

The land resources of the Papagni basin are studied using IRS – 1B Geo-coded, LISS - III data and Survey of India (SOI)

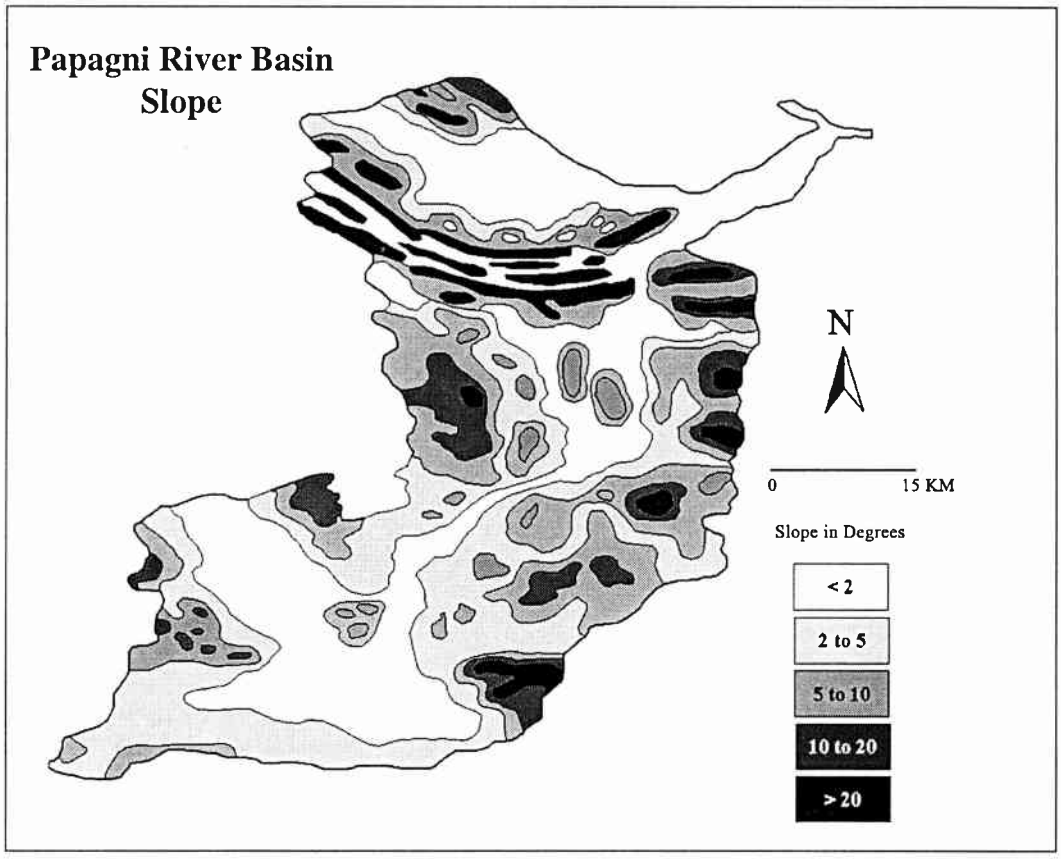

Fig.2: Slope of the Papagni river basin

topographic sheets on scale 1: 50,000. The relief and slope of the Papagni basin is studied from SOI toposheets. The landforms, soils, land use, hydro- geomorphic units and intensity of erosion are visually intepretated from IRS – 1B Geo-coded data on scale 1: 50,000 based on tonal variations, texture, shape, shadow and geomorphic processes and agents involved in the formation of landforms.

Results and Discussion

Slope

The slope of the basin has been worked out using Wentworth (1930) method. The slope units have been divided into five categories (fig. 2). The first category of slope units are found in black soil plains, fluvial plains, wash plains, creep built plains, valley fills and shallow weathered pediplains. The second category of slope unit ranges from 2^0 to 5^0. They are found in piedmont plains and pediplains. The third category of slope unit varies from 5^0 to 10^0. They are found in pediment inselberg complex area and around the isolated group of hills. The fourth category of slope unit ranges from 10^0 to 20^0. They are found in pediment inselberg complex, isolated group of hills, Velikonda hills and Palakonda hills. The above 20^0 slope units are found in Horsley

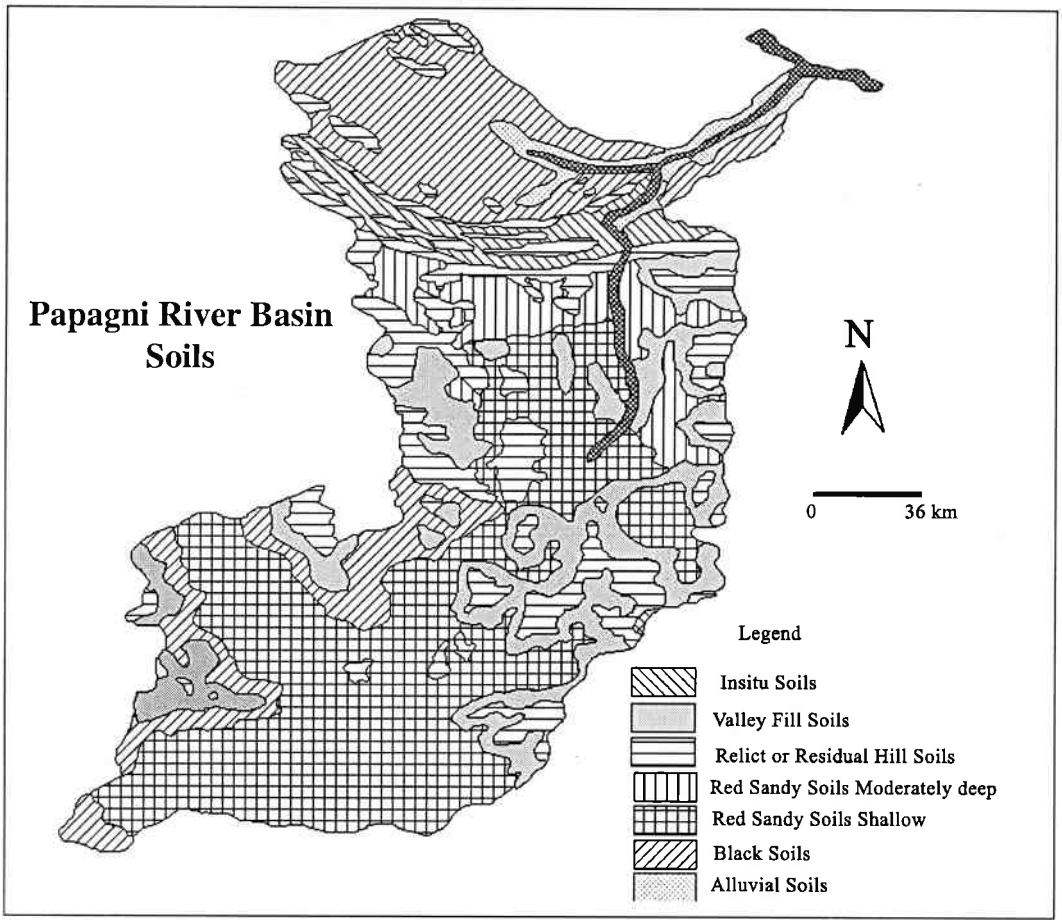

Fig. 3: Soils of the Papagni river basin

hills, Velikonda hills, Palakonda Hills and in a few isolated groups of hills.

Soil

The major soils of the Papagni basin are shallow red sandy soils, moderate red sandy soils, moderately deep red sandy soils, black soils, alluvial soils, valley fill soils, insitu soils and residual soils (fig. 3). The shallow red sandy soils are noticed in the shallow weathered pediplains located in southern part of the basin. The moderate red sandy soils are found in moderately weathered pediplains of the southern part of the basin. The moderately deep red sandy soils are found in the piedmont inselberg complex of the southern part of the basin. The black soils are found in the moderately weathered pediplains of Cheyyeru and Papagni series. They are located in northern part of the basin. The alluvial soils are noticed in the fluvial plains of the Papagni river. The valley fill soils are found in structural valleys of the Papagni series. The insitu soils are located on the structural hills. The residual soils are found on the residual hills located in central and southern parts of the Papagni basin.

Hydro-geomorphology

Hydrogeomorphologically the Papagni basin is divided into six hydro-geomorphic zones. They are excellent, very good, very fair, fair, and poor and run-off zones (fig. 4). The excellent ground water potential is found in the fluvial plains of the Papagni basin. The very good ground water potential zone is noticed in the structural valleys. The very fair ground water potential zone is found in the shallow weathered pediplains. The fair ground water potential zones are found in the shallow weathered pediplains. The poor ground water potential is found in the piedmont inselberg complex. The run-off zone is found in the structural hills and residual hills.

Landuse

The land use of the Papagni basin has been studied using IRS –1B Geo-coded data and LISS-III data (Vijith and Satheesh, 2008; Shilpa *et al.,* 2010). The categories of land use identified are cultivated land (wet), cultivated land (dry), cultivated land (wet and dry), wasteland, fallow land and scrub forests (fig. 5). The cultivated land under wet conditions is found in the ayacut areas under tank and canal irrigations. They are found mostly in valley fill soils and fluvial plains. The cultivated dry land is found in shallow weathered pediplains. The cultivated wet and dry land is found in moderately weathered pediplains. The current fallow land is located in central and east parts of the basin. The wastelands are associated with piedmont inselberg complex. The scrub forests are found on the residual hills and structural hills.

Intensity of soil erosion

The intensity of soil erosion has been worked out at sub basin level using Flaxman (1971) method. From the study it is found that the intensity of soil erosion varies from 0.5 to 50 m^3 / hectare/ year. The intensity of erosion is very high in structural hills and residual hills. It exceeds more the 45 m^3/ hectare/ year. The intensity soil erosion ranges from 30 to 45 m^3/ hectare/ year in piedmont inselberg complex. The intensity of soil erosion varies from 15 to 30 m^3/ hectare/ year in shallow weathered pediplains. The intensity of soil erosion ranges from 5 to 15 m^3/ hectare /year in moderately weathered pediplains. In fluvial plains and structural valley fills the intensity of soil erosion is very low. It varies from 0.5 to 5 m^3/ hectare/ year (fig. 6).

Land capability

The land capability has been evaluated based on the physical characteristics of the basin seven classes of land are identified (Bagwari *et al.,* 2010; Shilpa *et al.*, 2010). They are Class – I (fluvial plains), Class – II (wash plains and valley fills), Class – III (black soil plains), Class- IV (shallow weathered pediplains), Class – V (piedmont inselberg complex), Class – VI (hilly terrain with less the 20^0 slope), and Class – VII (hilly terrain with greater than 20^0 slope) (table 1 and fig. 7).

Class – I

The Class – I land consists of fluvial plains deposited by Papagni river. They are located in northern part of the basin. The slope is less than 2^0. The ground water potential is excellent. The soil fertility is very good.

Table 1. Land capability of the Papagni river basin

S. No.	Class	Land Units	Slope	Soils Fertility	Ground Water Potential	Presemt Land Use	Erosion Susceptability	Land Development Activity
1	I	Fluvial plains	$< 2^0$	Very good	Excellent	Cultivated land (wet), Paddy, Banana, Mulberry, Betel nut, Vegetables & Orchards	Very low	Land levelling, Land mulching & Land grading
2	II	Wash plains & Valley fills	$< 2^0$	Good	Very good	Cultivated land (dry), Sugar cane, Vegetables, Ground nut, Paddy, Horse gram, Citrus, & Orchards	Low	Land levelling, Land mulching & Land grading
3	III	Black soil plains (Moder-ately weathered pediplains)	$< 2^0$	Moderate	Very fair	Cultivated land (wet & dry), Mango gardens, Mulberry, Maize, Sunflower, Citrus, Paddy & Dry food crops	Low	Land levelling, Land bunding, Land mulching & Land grading
4	IV	Shallow weath-ered pediplains & Piedmont plains	$< 2^0$ & 2^0 to 5^0	Moderate to Good	Fair	Cultivated land (dry), Sun flower, Ground nut, Dry food crops & Paddy	Moderate	Land levelling, Land mulching. Land bunding & Land grading
5	V	Pediment inselberg complex	5^0 to 10^0 & 10^0 to 20^0	Poor	Poor	Cultivated (dry), Barren land, Ground nut & Dry food crops	High	Terrace bunding, Rock fill dams & Land levelling
6	VI	Hilly terrain with less than 20^0	10^0 to 20^0	Poor	Run-off	Scrubs, Dry food crops, Cultivable waste lands & Degraded forest	Very high	Afforestation & Terrace bunding
7	VII	Hilly terrain with grater than 20^0	$> 20^0$	Poor	Run-off	Forest with scrubs & Degraded forest	Very high	Afforestation & Terrace bunding

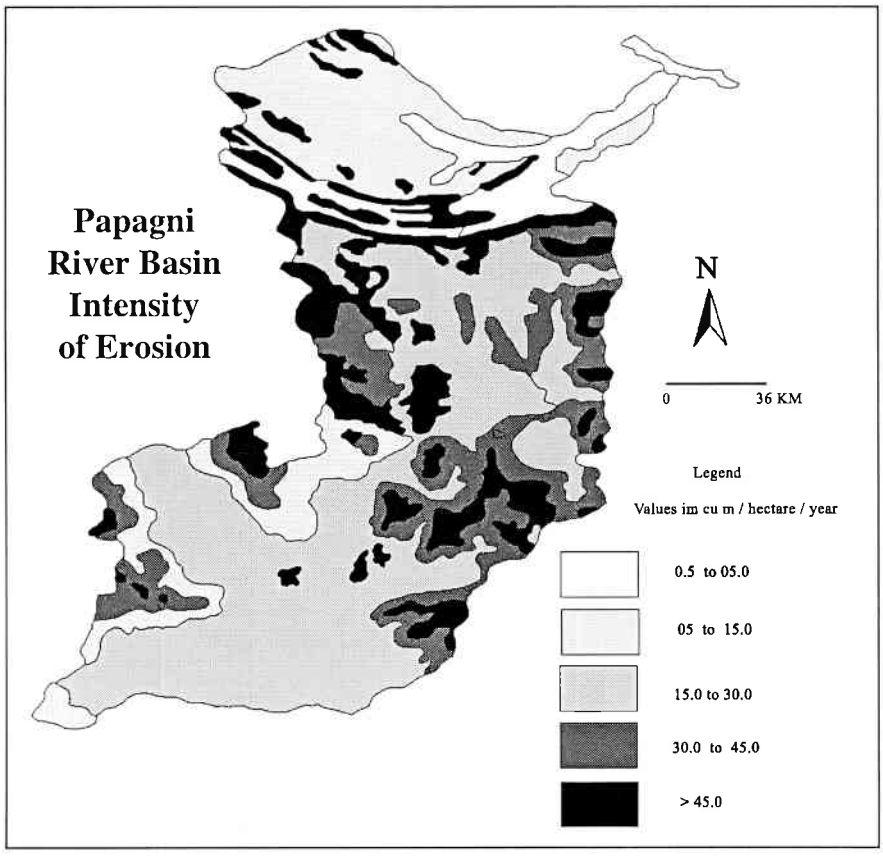

Fig. 4: Intensity of erosion of the Papagni river basin

The recharge and specific yield are high. The intensity of erosion is very low. The soil productivity is high. The major crops cultivated are paddy, banana, mulberry, betel net, vegetables and orchards. The land development activities that could be carried out are land mulching, land leveling and land grading.

Class – II

The Class – II land is comprised of Wash plains and Valley fills. The slope is less than 2^0. The ground water potential is very good. The recharge is high. The soil fertility is good. The intensity of soil erosion is low. The crops cultivated are paddy, sugar cane, groundnut, horse gram, vegetables and orchards. The land development activities that could be carried out are land mulching, land leveling and land grading.

Class – III

The Class – III land is composed of moderately weathered pediplains, which consist of black soil plains. The slope is less than 2^0. The ground water potential is very fair. The soil fertility is moderate to good. The intensity of soil erosion is low. The major crops cultivated are paddy, mango gardens, groundnut, sunflower, maize, citrus

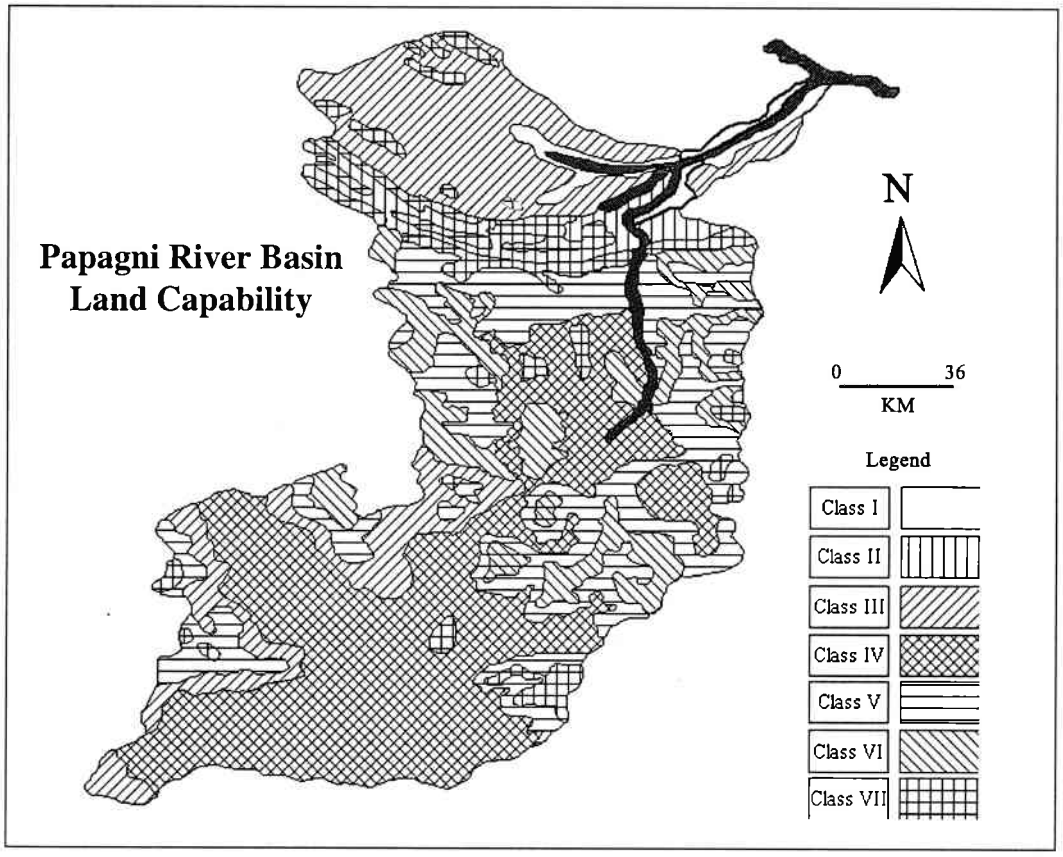

Fig.5. Land capability of the Papagni river basin

and dry food crops. The land development activities that could be carried out are land leveling, land mulching, land grading and land bunding.

Class – IV

The Class – IV land consists of shallow weathered pediplains and piedmont plains. The slope varies from 2^0 to 5^0 and less than 2^0. The soil fertility is moderate to good. The ground water potential is fair. The ground water recharge is moderate. The crops cultivated are paddy, sunflower, groundnut and dry food crops. The land development activities that could be carried out are land leveling, land mulching, land grading and land bunding.

Class – V

The Class – V land consists of piedmont inselberg complex. The slope varies from 5^0 to 10^0 and 10^0 to 20^0. The soil fertility is poor. The ground water potential is poor. The recharge is low. The intensity of erosion is high. The crops cultivated are groundnut and dry food crops. The land development activities that could be carried out are terrace bunding, rock fill dams and land leveling.

Class – VI

The Class – VI land is comprised of hilly terrain with less than 20^0 slope. The slope varies from 10^0 to 20^0. It is a run-off zone. The soil fertility is poor. The recharge is low. The intensity of erosion is high. The crops cultivated are dry food crops. Scrubs, cultivable waste lands and degraded forests are noticed. The land development activities that could be taken up are afforestation, terrace bunding, contour bunding, land terracing, stone terracing and rock fill dams

Class – VII

The Class – VII land is comprised of hilly terrain with slope greater than 20^0 slope. The soil fertility is poor. It is a run-off zone. The intensity of erosion is very high. The slope is above 20^0. It should not be disturbed for cultivation of crops. Biodiversity has to be maintained. The land development activities like land terracing, contour bunding, terrace bunding and rock fill dams should be carried out. This class land should be used for the growth of natural forests.

Conclusion

The analysis of land resources based on physical aspects using Survey of India topographic sheets, IRS – 1B Geo-coded and LISS-III data on scale 1: 50,000 revealed that the whole basin could be divided into seven major classes. They are class – I (fluvial plains), class – II (wash plains and valley fills), class – III (black soil plains), class – IV (weathered pediplains), class – V (pediment inselberg complex), class – VI (hilly terrain with slope less than 20^0), class – VII (hilly terrain with slope more than 20^0). Among the seven classes, the class –I and class – II lands are highly productive lands. They can be used for cultivation of paddy, banana, betel leaf, sugar cane, fruits and vegetables and orchards. The class – III lands is moderately productive and the class – IV land is less productive. The crops that could be cultivated are groundnut, sunflower, fruits and vegetables and dry food crops. The class – V land is unproductive. It is used for cultivation of groundnut and dry food crops. The class-VI and class – VII lands are found in hilly terrain. The class – VI lands could be used for dry food cops, pastures and development of fruit crops like lemon, mango, guava, pomegranate, sapota and citrus. These fruit crops could be cultivated by adopting soil conservation practices. The class – VII land has to be used for growth of natural forests.

References

Ali Mohammed, 1978. Studies in Agricultural Geography. Concept Publishers, New Delhi, India. 229 p.

Bagwari, .H K., Negi, G. C. S. and Todaria, N. P. 2010. Characterisation of Rawanganga watershed in Garhwal Himalaya. *Indian J. Soil Cons.* 38(1): 37-41.

Flaxman, E. M 1971. Soil conservation service, Technical Service Centre, Advisory Eng. Po-1, Sediment Yield Predictive Equation. 1-660p.

Kanth, T.A. and Zahoor ul Hassan, 2010. Assessment of Land use/Land cover change in Wular catchment using Remote sensing and GIS. *Trans. Inst. Indian Geographers*, vol.32, No.1:53-62.

Raju, K.N.P. and Vaidyanadhan, R. 1978. Geomorphology of Visakahapatnam, Andhra Pradesh.

Journal of Geological Society of India, 19 (1):26-34.

Samabasiva Rao, M.1996. Water Balance and Development of Land, Water and Agricultural resources of Tamil Nadu State, India, *Project Report 1992-96*, UGC, New Delhi. India.230p.

Shafi, M. 1969. Land use planning, Land classification and Land Capability, *The Geographer*, vol.14, pp-6.

Shilpa.S.Patil, Nagaraju, M.S.S. and Rajeev Srivastava, 2010. Characterization and evaluation of land resources of basaltic terrain for watershed management using remote sensing and GIS. *Indian J. Soil Cons.* 38(1): 16-23.

Vijith,H. and Satheesh, R. 2008. Evaluation of Land use pattern and Geomorphology of parts of Western Ghats using IRS P6 LISS III Data, *IE(I) Journal – AG,* 88:14-18.

Wentworth, D.K.1930. Simplified method of determining average slope of land surfaces. *American Journal of Sciences,* 20:184–194.

Acknowledgement

The author expresses sincere gratitude to Prof. M. Sambasiva Rao, Department of Geography, Sri Krishnadevaraya University, Anantapur, Andhra Pradesh, for his guidance and endless support throughout the paper.

Krishnaiah, Y.V.
Department of Geography
Nagaland University (Central)
HQ: Lumami, Nagaland (India)
yvkrishna09@gmail.com