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Landuse Pattern and Landuse Efficiency of the Papagni River Basin, India

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Abstract

The present study is an interdisciplinary focusing on the land cover / landuse pattern and landuse efficiency of the Papagni river basin. Hydrogeomorphologically, excellent ground water potential has been found in the fluvial plains. The intensity of erosion in the study area, both in the structural and residual hills is very high. It exceeds more than 45 m^3/ hectare/ year. Soils are predominately red sandy, black, alluvial and valley fill ones. The average annual precipitation of the basin is 720mm. Its landuse components are net area sown, forest, barren and uncultivable land, non-agricultural land, permanent pastures, groves, cultural wasteland and fallow land. Cultivation is mainly done through well and tank irrigation. The increasing population puts enormous pressure on the land in the basin. As a result, the landuse pattern of the basin keeps on changing. The wastelands are being acquired for cultivation, and the forests are shrinking due to human settlement and developmental activities. A decrease in rainfall has had its impact on the land; many areas formerly under cultivation have been transformed into wastelands and uncultivable lands.

Introduction

Land is an important natural resource, that embraces the elements like the overlying atmosphere, underlying geology, soil matrix, hydrology and plant kingdom. It is certainly a manifestation of the past and present human activities. River basins form the most convenient spatial unit for the study of natural resources like land and water. The planning and development of land and its subsequent readjustment is usually carried out in a number of successive phases, viz., *land evaluation, socio economic analysis, land classification* (Anderson, 1971; Torkashvand and Shivaligapppa, 2010) and *land development programmes*. Land evaluation includes both qualitative and quantitative classification. Landuse of any region expresses the interaction of the operation of the whole range of environmental factors modified by the socio-economic and historical elements (Narkhede and Gatade, 2010). It is a functional, diversified and dynamic concept because transformation of land cover (Rath *et al*, 2009; Joshi and Nagare, 2010; Punitha Vathi and Baskaran, 2010) is always aimed at satisfying specific goals like, agriculture, pasture, forest (Jain, 1990), settlement, industry and communication.

Landuse components are therefore distributed in interactive mixtures. The concept of landuse (Allan, 1949; Buck, 1937; Talukdar and Singh, 2011; Chopra, 2011; Singh, 2011) is considered as a relatively stable subject, related mainly to the use to which the land is put to use in a

certain season at a certain period of time. Transformation of land covers or conversion of a certain landuse type takes place for specific purposes to meet timely needs and necessities of mankind.

The ever-increasing population and decreasing man-land ratio are posing challenging problems to the planners and policy makers. Therefore, landuse planning is essential for the determination of the optimum utilization of every piece of land (Raju and Vaidyanadan, 1978; Rao, 2002). Landuse study is also very important from the point of eco-development and eco-planning. Landuse classification is generally made on the basis of different landuses like agricultural, non-agricultural and ecological. A few organizations like National Atlas and Thematic Mapping Organizations like the National Atlas and Thematic Mapping Organisation (NATMO) at Kolkata, the All India Soil and Land Use Survey (AISLUS) at New Delhi and the Directorate of Economics and Statistics (Department of Agriculture and Cooperation - Ministry of Agriculture, Government of India) have developed their own Landuse Classification Schemes (Gautham and Narayan, 1982; Singh, 1977; Mohammed, 1978). The Technical Committee on Coordination of Agricultural Statistics, Government of India has recommended a standard landuse classification and uniform definition of the same to be adopted all over India.

Study Area

The Papagni river basin (8,250 km^2) is a sub-basin of the Pennar river. It is located between 13°20´ 14°40´N and 77°50´ 78°40´E (Fig.1). It covers the districts of Anantapur, Kadapa and Chittoor of Rayalseema region of Andhra Pradesh and Kolar district of Karanataka. Geologically, the southern part of the basin is located in granitic terrain, while the northern part lies within the Proterozoic formations consisting of Vempalle dolomites and shales with basic intrusives and lava flows. The basin comprises 21 mandals of Andhra Pradesh (Amdagur, Bagepalle, B. Kotakota, Chakrayapeta, Chikbalapur, Chintamani, Galivedu, Gandlapenta, Kadiri, Kamalapuram, Lingala, Mudigubba, Mulakalacheruvu, Nallacheruvu, N. P. Kunta, Peddamandyam, P.T.M., Pendlimarri, Pullvendala, Siddlaghatta and Simhadripuram) and 9 mandals of Karnataka (Srinivaspura, Talupula, Tanakala, Tamballapalle, Thondur, Vallur, Veerapanayanipalle, Vempalle and Vemula) (Fig. 2).

The major landforms of the basin are denudational, fluvio denudational and aeolian in nature and origin. The dominant landuse component of the basin is the cultivated land under wet conditions, found mostly in the ayacut areas under tank and canal irrigations, covered with valley-fill soils and fluvial plains. Cultivated dry land is found in the shallow and weathered pediplains. The major soils of the basin are red sandy soils, black soils, alluvial soils, valley fill soils, in situ soils and residual soils. The average annual precipitation is 720 mm with a minimum of 544 mm and a maximum of 869 mm. The rainfall intensity ranges from a minimum of 15 mm/rainy day to a maximum of 18.5 mm/rainy day, with an average figure of 16.8 mm/rainy day. The rainfall variability ranges from 19% to a maximum of 35%. The rainfall ratio ranges from 100% to a maximum of 165%.

Database and Methodology

The land use of the Papagni basin has been studied from the IRS - 1B Geo-coded LISS-III data for both rabi and kharif seasons and Survey of India Topographical Sheets on 1 : 50,000 scale. The landuse data for the year 2008 2009 has been collected at mandal level from the Chief Planning Office to study the landuse concentration, net area sown, total irrigated area, intensity of irrigation, intensity of cropping pattern and land use efficiency of the basin. The statistical methods adopted by Bhatia (1965) have been used for the analysis of landuse pattern.

1. Landuse Pattern or Concentrations (for example, for Amadgur mandal forest area)

= (Forest area of Amadagur mandal / Total area of Amadagur mandal) / (Total Forest area of the basin covering all the mandals/Total Area of the basin)

2. The land use efficiency has been worked out taking five variables like net sown area, total irrigated area, area irrigated more than once, intensity of irrigation and intensity of cropping pattern based on 'mean' and 'standard deviation' method.

Landuse Pattern

The landuse of the basin has been classified into nine categories, viz., net area sown (40%), forest (15%), barren and uncultivable land (13%), current fallow (9%), land put to non-agricultural use (7%), other fallow land (6%), culturable waste land (5%), permanent pastures and other grazing land (4%), and area under miscellaneous trees, crops and groves (1%) (Fig. 3).

1. *Net Area Sown***:** It covers about 332,131 ha of land (Fig. 6 and Table 1) and accounts for 40.25% of the basin. The spatial pattern shows that only Muddigubba mandal located in northwestern part of the basin comes under the category of very high concentration. High concentration is found in about fourteen mandals located in the western, southeastern, eastern and northwestern parts of the basin. Medium concentration is found in case of fifteen mandals located in the northern, western, central, eastern and southeastern parts of the basin.

2. *Forest:* It covers about 124,860 ha of land and accounts for 15.13% of the basin (Fig. 4 and Tab*le* 1). Its spatial pattern shows that its concentration is very high in seven mandals located in the central and northeastern parts of the basin. High concentration is found in five mandals located in the northern, central and south-western parts of the basin. Medium concentration occurs in six mandals covering mainly the central, eastern and southeastern parts of the basin. Concentration is low in about eleven mandals located mainly in the southern and northern parts of the basin.

3. *Barren and Uncultivable Land:* It covers about 105,516 ha of land that amounts to 12.79% of the total geographical area of the basin (Fig. 4 and Table 1). Its concentration is very high in five mandals located in the eastern and northwestern parts of the basin. Concentration is high in six mandals located in the northern and central parts of the basin. Medium concentration is found in about fifteen mandals located mainly in the southern part of the basin, while concentration is low in four mandals.

4. *Current Fallows:* It covers about 76,085 ha of land that accounts for 9.22% of the total area of the basin (Fig. 5 and Table 1). Very high concentration is found in ten mandals located in the northern, central, and southern parts of the basin. In three mandals of the central and southeastern parts of the basin concentration is high. Medium concentration is found in seven mandals distributed in northwestern, central, and southeastern parts of the basin, while concentration is low in ten mandals located in the northern, southwestern and southeastern parts of the basin.

5. *Land put to Non-agricultural Use:* It covers an area of about 60,962 ha of land that accounts for 7.38% of the total basin area (Fig. 4 and Table 1). Its concentration is very high in five mandals located in the northern and southeastern parts of the basin. Concentration is high in eleven mandals distributed in the southern, central and northern parts of the basin. Concentration is medium in eight mandals located in the northern and central parts of the basin, while concentration is low in six mandals distributed in the southern and central parts of the basin.

6. *Other Fallows:* It covers an area of about 49,144 ha that accounts for 5.99% of the total geographical area of the basin (Fig. 5 and Table 1). Its concentration is very high in seven mandals located in the northern and central parts of the basin. High concentration is found in five mandals located in the northern, western, and southeastern parts of the basin. Medium concentration is noticed in six mandals located in the central and southwestern parts of the basin, while low concentration is found in eleven mandals distributed in the northern, northwestern, central and southern parts of the basin.

7. *Culturable Wasteland:* It covers an area of about 38,165 ha that accounts for 4.62% of the basin (Fig. 5 and Table 1). Its concentration is very high in four mandals located in mainly in the northeastern part of the basin. Concentration is high in three mandals located in the northwestern and eastern parts of the basin. Medium concentration is found in ten mandals located in the northern, central and southern parts of the basin, while low concentration is found in eleven mandals only.

8. *Permanent Pastures and other Grazing Land:* It covers an area of about 33,057 ha that amounts to 4.00% of the total geographical area of the basin (Fig. 4 and Table 1). Its concentration is very high in four mandals located principally in the southern part of the basin. Medium concentration is found in five mandals located in the northern and southern parts of the basin, while low concentration is found in nineteen mandals distributed unevenly in the central and northern parts of the basin.

9. *Miscellaneous Trees, Crops and Groves:* It covers an area of about 8,667 ha of land that amounts to 1.05% of the total area of the basin. Its concentration is very high in eight mandals distributed in southern, southeastern and northwestern parts of the basin (Fig. 5 and Table 1). Concentration is high in three mandals distributed in southeastern and northern parts of the basin. Medium concentration is found in five mandals distributed in the central and northern parts of the basin, while low concentration is found in twelve mandals distributed in the southwestern, central and northeastern parts of the basin.

Landuse Efficiency

The minimum landuse efficiency 14% is found in Gandlapenta mandal of the basin (Fig. 7 and Table 2). The maximum land use efficiency value of 63% is found in the Srinivaspura mandal of the Karnataka and Pendlimari mandal of the Andhra Pradesh. and Pendlimari mandal of the Andhra Pradesh. The average land use efficiency of the basin is about 32.6%. Its spatial pattern shows that the landuse efficiency is very high in three mandals located in the north-eastern, western, and south-eastern parts of the basin. High landuse efficiency is found in six mandals located mainly in the eastern and southern parts of the basin. Medium landuse efficiency is found in eleven mandals distributed in the northern-eastern, north-western, central, western, south-eastern and southern parts of the basin. Low landuse efficiency is found in ten mandals located in the northern, north-eastern, western and central parts of the basin. Thus, the southern, western and north-eastern mandals of the basin shows very high landuse efficiency, while the southern, central and north-western parts of the basin shows high, moderate to low landuse efficiency.

Conclusion

The dominant landuse /lancover category of the basin is cultivation (40.25%), followed by the forest (15.13%), barren and uncultivable land (12.79%), and others. The maximum landuse efficiency 63% is found in Srinivaspura taluk of Karnataka and Pendlimari mandal of Andhra Pradesh. The basin experiences high water deficit due to low rainfall and high loss of water due to evaporation and evapotranspiration. As a pilot project, it is suggested herewith to adopt one village in each mandal for introduction of the modern irrigation practices like sprinkler, drip and trickle.

The majority of the farmers of the basin owns less than five hectares of land. They are illiterate and are not aware of recent developments in agricultural and irrigation sectors. They need to be educated about the advantages of the use of high yielding varieties of crops, optimum use of fertilizers, pesticides, bio-fertilizers and use of credit facilities in nationalized banks. Finally, micro watershed management programmes can also be adopted for optimum utilization of land and water resources.

The Govt. of Andhra Pradesh is giving 50% subsisidy on procurement and installation of the sprinkler, drip and trickle irrigation systems. Pilot projects implemented in Kuppam mandal have been highly successful and have helped increase the crop yield and crop production. Irrigation tanks can be easily used for rainwater harvesting; however, they must be regularly dredged (desilted) under the Neeru-Meeru Programme of the State Government. A few more tanks could also be constructed to increase the storage capacity of surface water resources. This will also encourage the seepage of water to the sub-surface layers and then recharge the underlying aquifers. Thus, it will enable maintaining the optimum groundwater levels.

In order to increase the yield and production of various crops cultivated in the basin modern agricultural techniques like adoptation of high yielding varieties of crops, application of organic, inorganic and bio-fertilizers and use of pesticides have to be introduced and popularised.

The wastelands of the basin can well be used for plantations of fuel wood, pulpwood, manure leaf, leaf oil, fodder, timber, tamarind, jackfruit, eucalyptus, casuarina and babul under a social forestry scheme along roadsides, filed bunds, cultivable wastelands, tank bunds and stream courses. Lastly, awareness campaigns must be held through Doordarshan and All India Radio and by screening documentary films in the villages about the use/misuse of resources (land, water and forest), advantages of social forestry and adoption of modern tools and techniques of agriculture and irrigation with special emphasis on food crops, non-food crops, oil seeds, fruits and vegetables, horticulture and floriculture. Further, the Watershed Development Programmes (WDP) at micro units of 500 hectares of land could be adopted for optimum utilization of land and water resources and overall increase in the yield of crops and agricultural production in the basin.

The ground water resources of the basin can be managed by construction of artificial recharges, underground check dams, cementing the discharging faces, prevention of leakages, pressure injection droughting and construction of surface reservoirs. The ecological management of the watersheds also need large-scale plantations to be set up. The first step is to find out the preferences of the different beneficiaries in the watershed. In this respect, collection of information regarding community plantation sites, user groups, self-help groups, indigenous management systems, nursery location, nursery establishment, land use management and plantation operations becomes an exercise of paramount importance. For successful development of plantations, the measures to be taken include levelling of land, conservation of soil and water, construction of rain water harvesting structures, adoption of strip cultivation and weeding, wise choice and use of seeds through treatment, use of chemical fertilizers and timely and adequate irrigation.

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Table – 1: Landuse Concentration of the Papagni River Basin (2008 – 2009)

Mandal	Forest	Barren & Uncultivable Land	Non-Agricultural uses	Permanent Pastern & other Grazing Land	Miscellaneous Tree, Crops & Groves	Culturable Waste Land	Other Fallow	Current Fallow	Net Area sown
Amadagur	2.08	0.68	0.63	0.40	0.71	0.27	0.52	0.42	1.16
Bagepalle	1.37	0.57	1.20	3.61	0.23	0.11	0.32	0.16	1.21
B. Kotakota	1.68	0.58	1.12	0.34	1.02	0.49	1.29	1.43	0.71
Chakrayapeta	0.76	2.77	1.71	0.06	0.11	0.48	0.56	0.70	0.77
Chickbalapur	2.10	0.57	1.13	0.90	1.56	0.09	0.09	0.20	1.19
Chintamani	0.25	0.93	1.36	4.91	1.82	0.81	0.20	2.17	0.79
Galivedu	0.96	2.55	0.28	0.02	0.31	0.23	0.42	1.21	0.97
Gandlapenta	2.48	0.17	0.22	0.30	0.16	0.54	0.82	1.99	0.86
Kadiri	0.90	1.00	0.18	0.26	0.21	0.65	2.64	2.58	0.79
Kamalapuram	0.01	1.01	1.43	0.01	0.42	7.62	1.63	0.30	1.32
Lingala	0.05	2.24	1.66	0.83	0.60	0.67	0.67	2.02	0.79
Mudigubba	1.12	0.56	0.67	0.38	0.10	1.03	0.03	0.20	1.66
Molakalacheruvu	0.42	0.63	0.78	0.23	2.41	0.00	3.59	0.64	1.34
Nallacheruvu	0.00	0.58	0.63	0.33	0.33	0.66	1.42	2.62	1.37
N. P. Kunta	1.06	2.04	1.01	0.37	0.74	0.97	0.49	1.09	0.84
Peddamandyam	1.50	0.74	1.03	0.38	0.55	0.85	0.63	0.56	1.22
P.T.M	0.10	0.90	1.16	0.23	1.25	0.00	3.56	0.63	1.32
Pendlimari	2.54	0.44	1.13	0.00	0.21	3.81	0.81	0.15	0.66
Pulivendala	0.34	1.61	1.06	0.56	1.05	0.57	1.35	2.60	0.79
Siddlaghatta	0.15	0.49	0.38	8.51	4.76	0.28	0.38	0.36	1.18
Simhadripuram	0.19	0.90	0.61	0.96	3.36	1.97	1.90	0.53	1.31
Srinivaspura	0.73	0.88	1.36	3.30	2.06	0.25	0.32	0.50	1.21
Talupula	1.50	1.46	0.22	0.39	0.28	0.65	0.29	0.62	1.19
Tanakala	1.70	1.02	0.26	0.36	0.11	0.45	0.90	1.52	0.98
Thamballapalle	1.63	0.69	0.77	0.46	3.96	1.07	1.34	0.24	1.07
Thondur	0.15	1.46	0.71	0.36	0.00	0.76	1.10	2.19	1.14
Vallur	0.17	0.35	3.02	0.00	0.00	2.52	1.66	2.13	0.83
Veerapanayani Palli	0.13	0.33	4.71	0.04	0.04	1.59	0.23	0.35	0.70
Vempalli	0.66	1.16	0.82	0.03	0.02	0.25	2.15	2.17	0.95
Vemula	0.55	1.30	0.85	0.62	1.49	0.22	1.20	0.99	1.28

Source: Compiled by the author

Table – 2: Landuse Efficiency of the Papagni River basin (2008 – 2009)

Sl. No.	Mandal	Landuse Efficiency (%)	Sl. No.	Mandal	Land use Efficiency (%)
1.	Amadagur	22	16.	Peddamandyam	41
2.	Bagepalle	50	17.	P.T.M	48
3.	B. Kotakota	24	18.	Pendlimari	63
4.	Chakrayapeta	26	19.	Pulivendala	17
5.	Chickbalapur	32	20.	Siddlaghatta	38
6.	Chintamani	40	21.	Simhadripuram	28
7.	Galivedu	19	22.	Srinivaspura	52
8.	Gandlapenta	14	23.	Talupula	28
9.	Kadiri	26	24.	Tanakala	34
10.	Kamalapuram	36	25.	Thamballapalle	47
11.	Lingala	24	26.	Thondur	19
12.	Mudigubba	63	27.	Vallur	15
13.	Mulakalacheruvu	37	28.	Veerapanayani Palli	35
14.	Nallacheruvu	21	29.	Vempalli	25
15.	N. P. Kunta	20	30.	Vemula	35

Source: Compiled by the Author

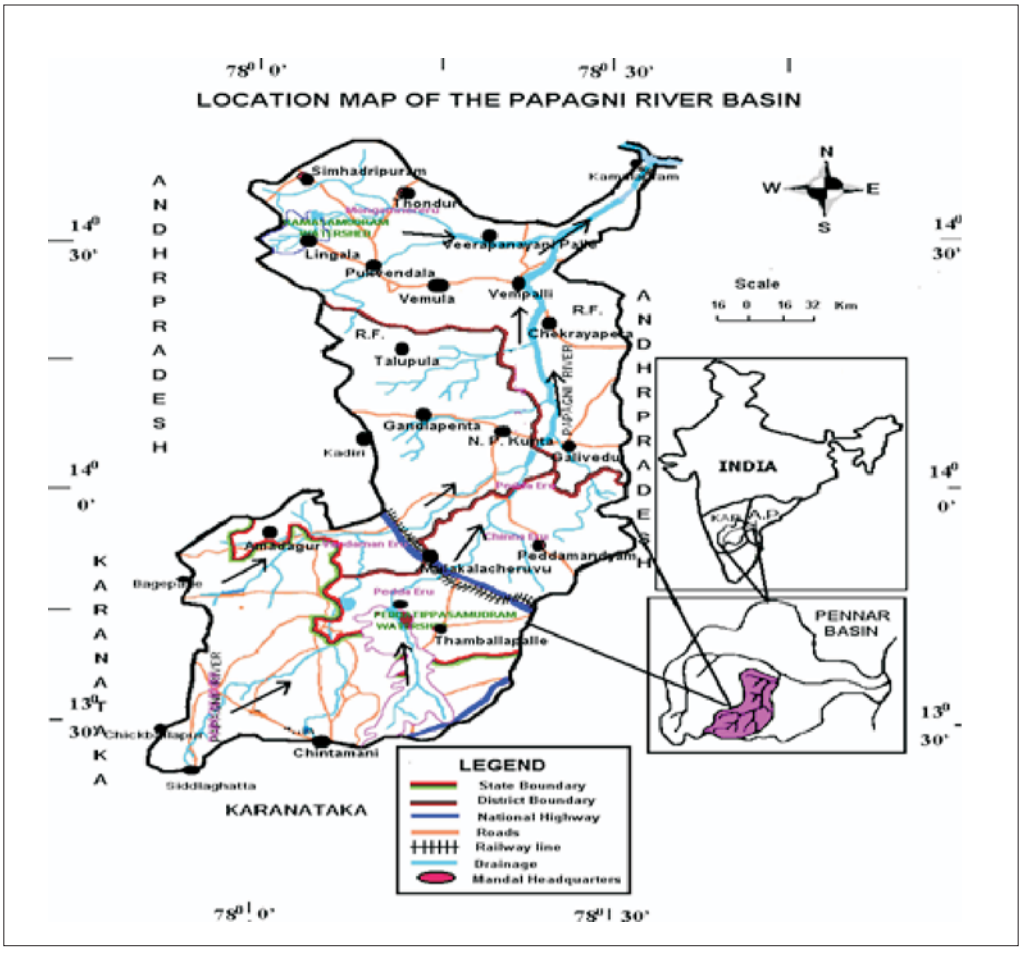

Fig. 1 : Location Map of the Papagni River Basin

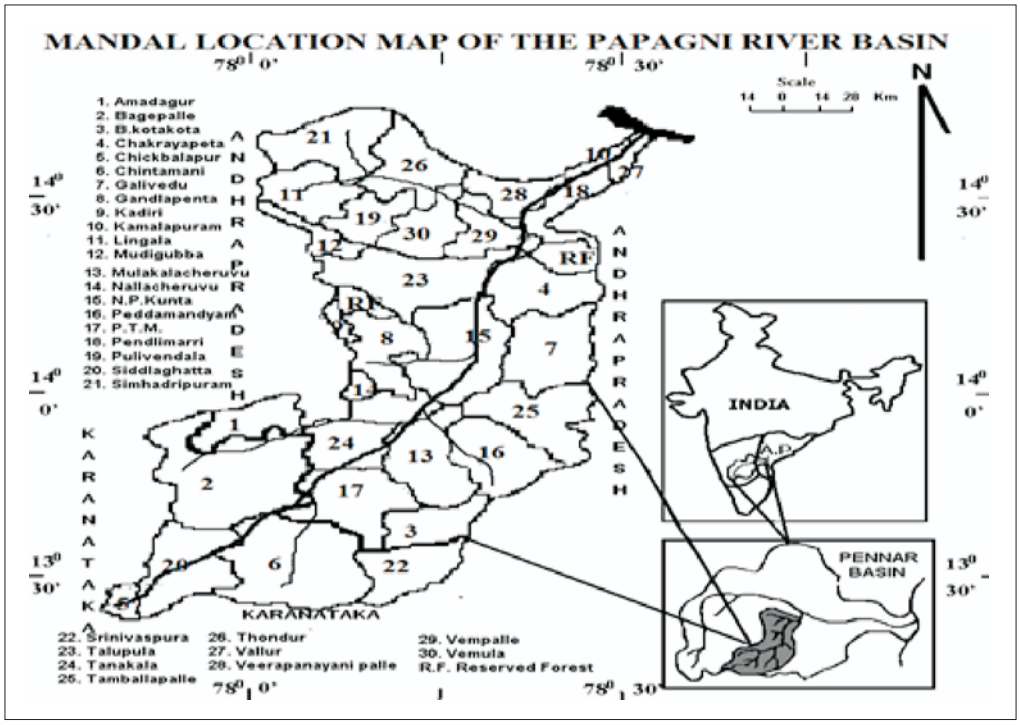

Fig. 2: Mandal Location Map of the Papagni River Basin

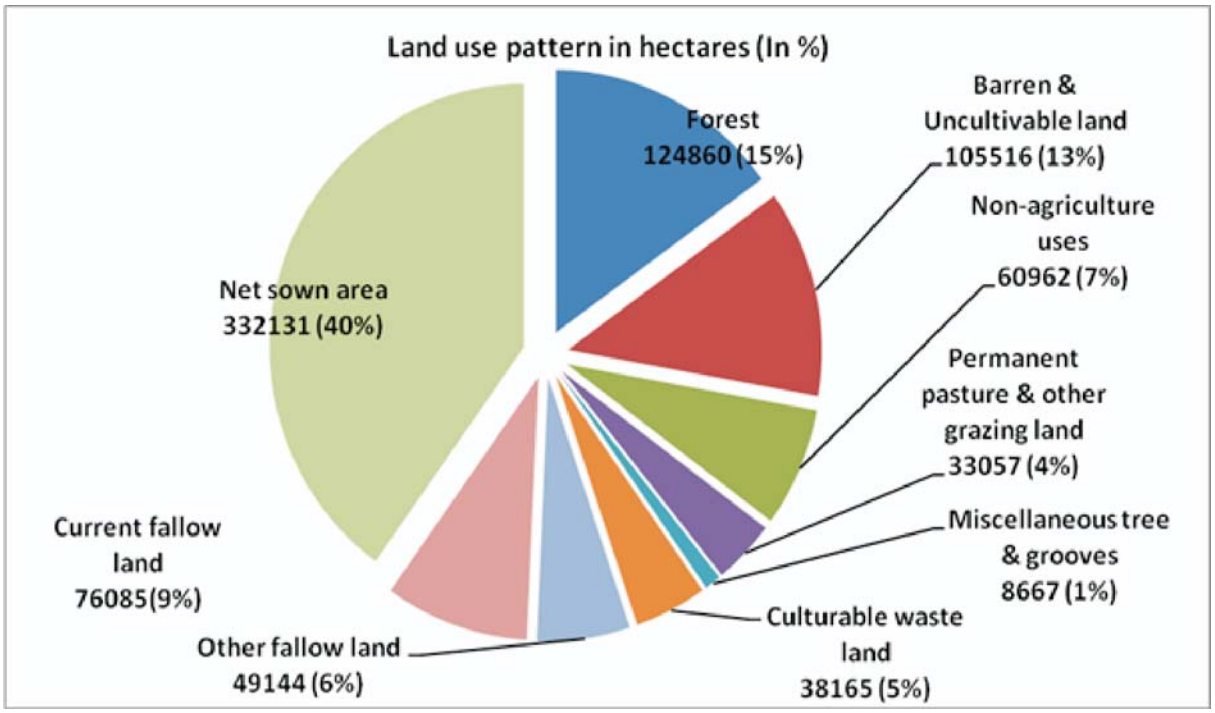

Fig. 3: Landuse Pattern of the Papagni River Basin

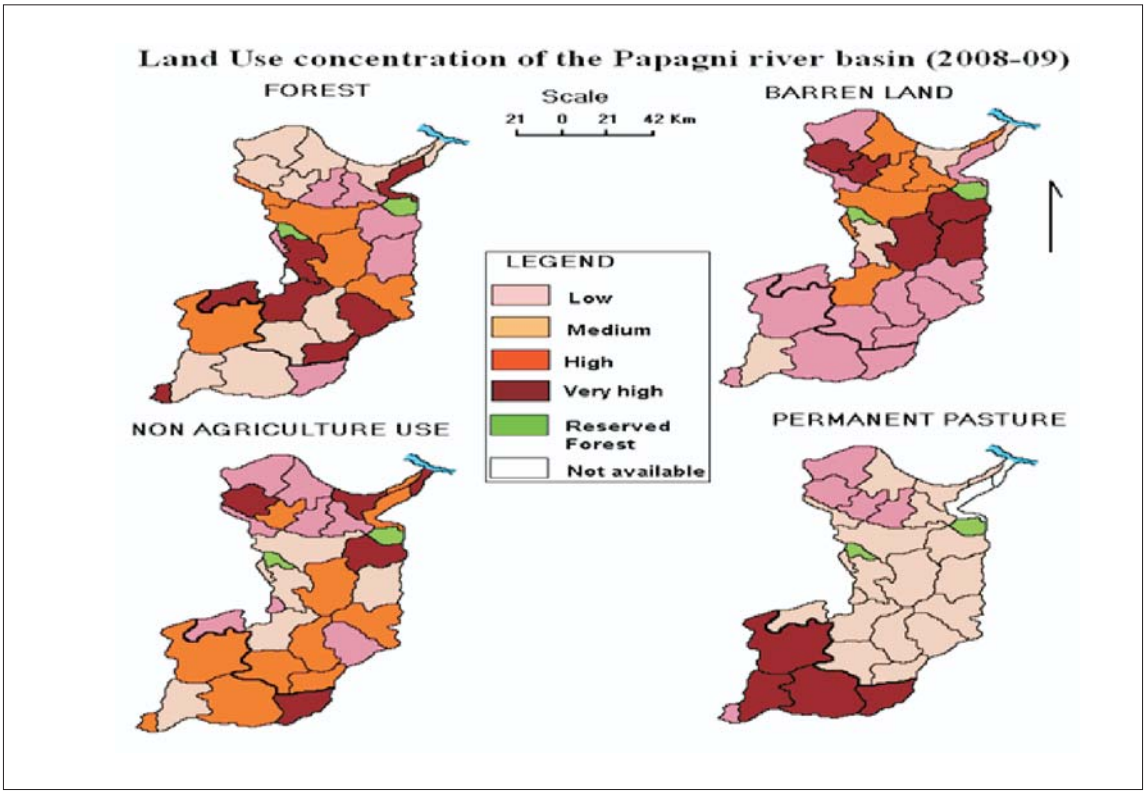

Fig. 4: Pattern of Landuse Concentration of the Papagni River Basin

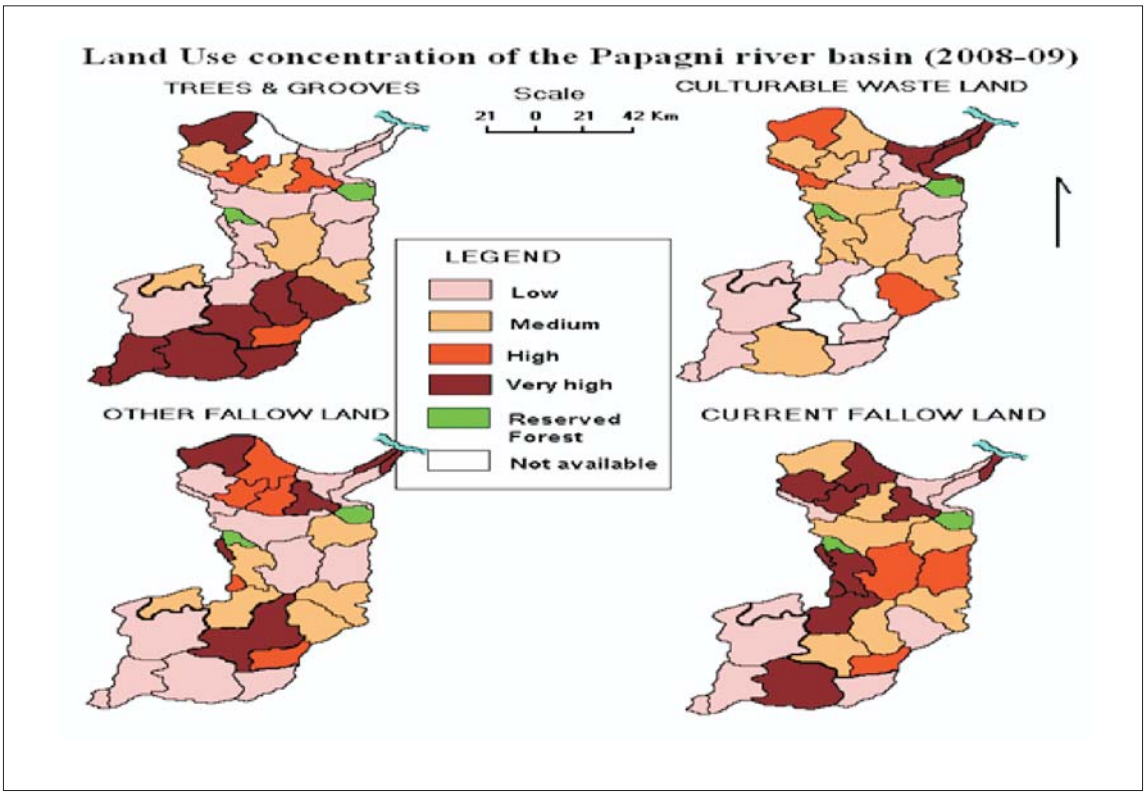

Fig. 5: Pattern of Landuse Concentration of the Papagni River Basin

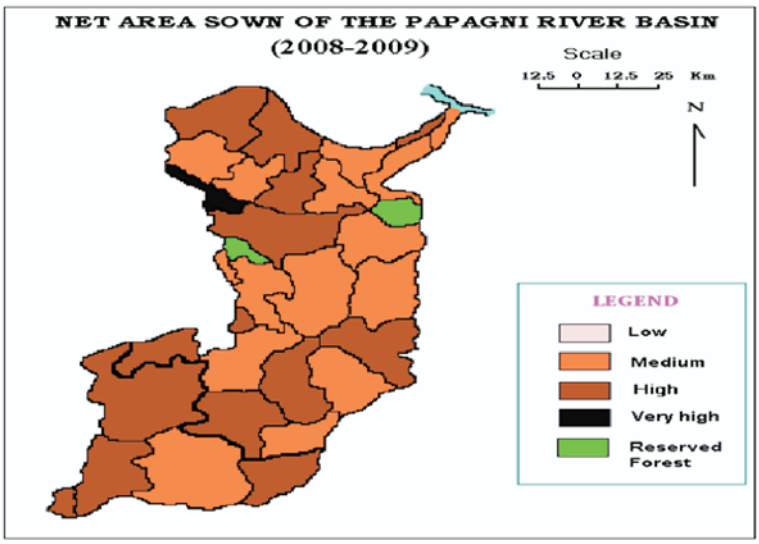

Fig. 6: Pattern of Net Area Sown of the Papagni River Basin

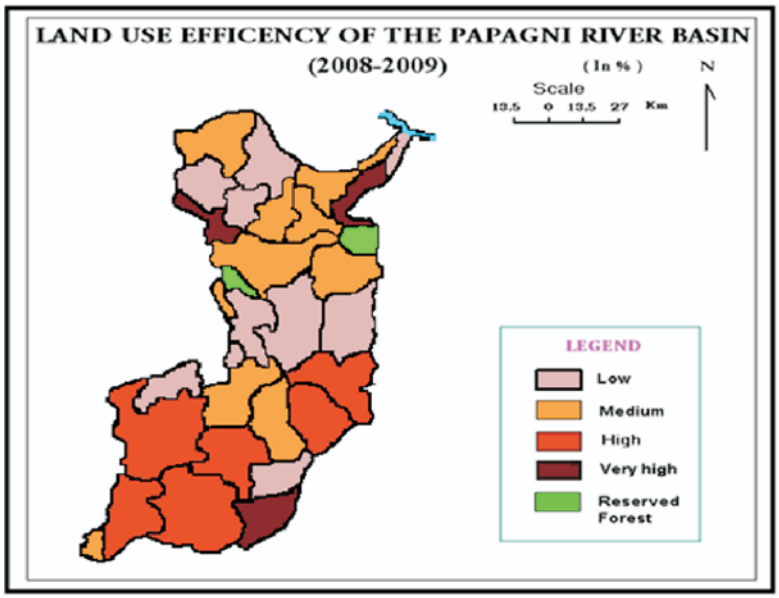

Fig. 7: Pattern of Landuse Efficiency of the Papagni River Basin

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