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SPATIAL VARIATION OF PHYSICO-CHEMICAL AND HYDROLOGICAL PARAMETERS WITH LAND-USE IN VENKATAPURA CATCHMENT, KARNATAKA

B. KARTHICK AND T.V. RAMACHANDRA*

Energy & Wetlands Research Group, Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

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Abstract - Social, economic and political development of a region is dependent on the health and quantity of the natural resources. Integrated approaches in the management of natural resources would ensure sustainability, which demands inventorying, mapping and monitoring of resources considering all components of an ecosystem. The monitoring of hydrological and catchment landscape of river resources have a vital role in the conservation and management of aquatic resources. This paper presents a case study Venkatapura river basin in Uttara Kannada district of Karnataka State, India based on stream hydrology and land-use analyses. The results revealed variations in dissolved oxygen and free carbon dioxide according to the flow nature of the water and increased amount of phosphates and coliform contamination in streams closer to anthropogenic activities.

INTRODUCTION

Rivers are the most important freshwater resource for humans. Social, economic and political development has, in the past, been largely related to the availability and distribution of freshwater riverine systems (Chapman, 1996). In recent years intensive agricultural and other developmental activities to meet the needs of the escalating population have affected the surface and ground water sources at an alarming rate all over the country. Water quality, quantity and safety have become major issues in public and environmental health. This necessitates immediate measures to manage the water resources. In this regard, regular water quality assessment helps to elucidate the quality and appropriate mitigation measures. (Prasad, *et al* 2003) Studies pertaining to river ecological status monitoring of South Indian rivers like Godavari, Krishna and Tungabhadra (Mitra, 1982), Cauvery (Ganapati, 1955 Somasekar, 1983, 1985 and Anvar Batcha, 1998), Kapila (Ganapati, 1955 and Somasekar, 1984), Malampuzha (Chacko *et al* 1953) & Tamabaraparani (Ganapati, 1956) have received an attention for the last five decades. However, information on water quality of west flowing rivers in Karnataka is meager. Though some information is available on general limnological features of selected few streams (Anonymous, 1995) detailed water quality studies of all the rivers are not available. Uttara Kannada district of Karnataka, India has the distinction of having good natural forest cover (>70%) with large number of perennial to small seasonal streams. Most of these rivers and streams originate in the Western Ghats and joins finally the Arabian Sea.

In addition to the natural heterogeneity in the physical characteristics of the catchment, the distribution and disposition of different land uses may hugely influence catchment's response by modifying the connectivity and continuity of drainage lines (Schulze, 2000). The integrated aquatic ecosystem management requires proper study for sound understanding and effective management of water systems and their internal relations (Ramachandra, *et al* 2005), and hence an attempt has been done in the present study to determine the spatial variation of physico-chemical and hydrological parameters with respect to land-use in Venkatapura river catchment.

* **Corresponding author - E-mail :** cestvr@ces.iisc.ernet.in ; energy@ces.iisc.ernet.in

STUDY AREA

The Venkatapura river is located between 13.98° - 14 15° N and 74.48°- 74.73° E in the southern part of Uttara Kannada district of Karnataka, India (Fig. 1). It originates in Western Ghats and confluence into Arabian Sea after a course of 45 km near Venkatapura with a catchment of 335 km^2 (Kamath, 1985). Forest and agriculture are the major land use in the catchment. The river basin is divided in to six sub basins namely Venkatapura tributary, Chitihalla, Katagar Nala, Basti Halla, Kitrehole and Venkatapura river (Fig. 2) based on major tributaries.

MATERIALS AND MATHODS

In order to assess the spatial variation of water quality in the river basin, 11 sampling stations were identified (Table 1 and Fig. 1) and sampling was carried out during post monsoon. Physico-chemical variables were analysed according to APHA, 1985 and Trivedy and Goel, 1986. Streams network in the catchment was digitized based on Survey of India toposheets (1:50, 000) using GIS software. Based on this layer, hydrological parameters like drainage density, catchment area, stream density and stream length were computed. Land use analysis was done with the LISS - Data of IRS 1C remote sensing data (of 04 January 2004) using supervised classification based on the maximum likelihood classifier (MLC) with ILWIS 3.1 Image processing software.

Table 1. Sampling sites at Venkatpura river basin

Site No	Site Name
1	Badabhag
2	Undlakatle
3	Midal
4	Arkala
5	Galibyle
6	Nagolli
7	Ondalasu
8	Hegganamakki
9	Kurandura
10	Bachohodi
11.	Kelanur

RESULTS AND DISCUSSION

The results of water quality analysis are shown in Table 2. The relative humidity in the atmosphere was high in upstream (56 -71 %) when compared with that of downstream (42 - 68 %). The pH of the stream water ranges within 6.65 - 7.81, which indicates the neutral condition of water. The variables related to ionic content of the water (electrical conductivity, total dissolved solids, alkalinity and chlorides) were recorded in lower concentration. The concentration of free carbon dioxide ranges from 6.16 to 52.8 mg/L in the whole stretch. The high amount of carbon

Table 2. Physico-chemical parameters at downstream sampling sites

Site No	1	2	3	4	5	6	7	8	9	10	11
pH	6.88	7.81	7.05	7.05	6.90	7.24	6.81	6.65	6.98	7.36	6.73
EC (µS)	44	33.67	39.33	51	44	54	46.33	58.67	69	54	40
TDS	22	16.67	19.33	25.67	21.67	26.33	23.00	29.33	34.33	26.33	20.00
WT(°C)	27.43	33.13	27.93	27.40	28.83	30.80	26.90	33.33	23.77	29.17	25.57
AT(°C)	30.67	33.40	28.33	34.23	32.27	31.83	28.60	32.67	21.00	29.33	26.67
RH (%)	52	52.00	68	47	63	46	71	65	73	56	66
CO_2	10.27	44.59	6.16	8.80	7.63	52.80	12.91	9.97	15.55	8.51	13.20
Alkalinity	25.64	22.44	30.13	21.79	24.36	22.44	21.79	21.15	42.95	28.20	26.28
Chlorides	11.15	10.01	10.65	10.01	10.79	10.51	10.30	12.00	9.59	9.66	8.84
Hardness	18.40	8.53	11.20	16.53	17.87	32	15.47	20.00	27.73	20.00	19.60
Calcium	3.37	2.67	1.82	4.92	3.63	4.17	3.95	1.76	6.36	5.61	4.81
Magnesium	15.03	5.86	9.38	11.62	14.23	27.83	11.51	18.24	21.37	14.39	14.79
DO	8.34	5.04	5.72	9.27	5.56	5.37	6.00	7.63	6.82	7.96	4.28
Nitrates	0.01	0.03	0.05	0.01	0.04	BDL	0.13	0.12	0.09	0.06	0.04
Phosphates	0.08	0.08	0.12	0.12	0.06	0.22	0.10	0.17	0.14	0.15	0.15
Sulphates	9.61	11.65	9.02	11.26	10.47	11.26	12.45	12.15	9.00	12.21	13.52
Sodium	8.13	6.72	7.63	8.48	7.78	8.59	8.13	8.53	9.95	8.48	7.73
Potassium	0.82	0.39	0.49	0.78	0.87	1.16	0.87	1.99	1.07	0.87	0.53
Coliform	P	A	P	P	P	P	P	P	P	P	P

Note : (All parameters are in mg/L except mentioned; WT- Water temperature, AT – Air temperature, RH – Relative humidity, DO – Dissolved Oxygen, BDL – Below Detectable Level, P – Present, A- Absent)

dioxide was recorded in site 2 and 6 (44.59 and 52.8 respectively) due to the stagnation of water in the streams. Total hardness ranges from 8.53 to 32 mg/L with mean calcium and magnesium hardness of 3.92 and 14.93 mg/L respectively. The highest amount of total hardness was recorded from the site 6, which has human interference. Among the factors regulating DO in streams, three primary processes are air-water exchanges, photosynthesis, and respiration. Different land-use may alter the relative importance of photosynthesis and respiration (Wilcock, 1986; Quinn *et al*, 1992 and Young and Huryn, 1999). In this study low levels of dissolved oxygen was recorded in sites having stagnant water (2, 3, 5 and 11) and flowing water bodies were well aerated, which is revealed in high dissolved oxygen values of 6 - 9.27mg/L. Nitrates ranged from below detectable level to 0.13 mg/L. Streams in the upstream recorded high amount of nitrates when compared to those at downstream. Organic and inorganic forms of phosphorous contribute to the total phosphorous of the aquatic environment, due to natural weathering, soil erosion, agricultural runoff, biological transfer and use of soluble phosphate compounds as detergents. In the present study the total phosphates ranges from 0.1 - 0.22 mg/L and the highest amount of phosphates were recorded at site 6, where the agricultural runoff and activities like bathing and washing clothes occurs in the stream bank. Sulphate values ranged from 9 - 13.5 mg/L with mean value of 11.15mg/L. The mean value for sodium and potassium was 8.19 & 0.90 respectively. Most sampling sites showed presence of Coliform contamination, which shows the human interference in aquatic system. All the parameters measured were within Indian standards specifications for drinking water (IS 10500 - 1983).

Land-use analysis (results are in Table 3) shows that the evergreen forest is the major land-use category covering 39.75%, followed by horticultural crops (areca, coconut, cashew) and agricultural lands, covering nearly 33.19% (111.23 sq.km). The other main land-uses are deciduous forests covering an area of 29.53 sq.km, exotic plantation accounts 21.4 sq.km (6.39%) and teak plantation 14.92 sq km (4.45%). Hydrological parameters in the catchment are listed in table 4. Overlaying land-use (Fig. 3) with stream network layer (Fig 1), indicates that the catchments dominated by evergreen to semi-evergreen type of vegetation have higher stream orders and density.

Table 3. Land-use categories in Venkatapura river catchment

Land-use classes	Area sq km	Area (%)
Agriculture/Fallow Land	35.69	10.65
Areca/Coconut/Cashew	75.54	22.54
Exotic Plantation	21.4	6.39
Teak Plantation	14.92	4.45
Evergreen Forest	133.19	39.75
Deciduous Forest	29.53	8.81
Scrub Savanas/Grasslands	6.6	1.97
Settlements	3.14	0.94
Open/Barren Land	12.6	3.76
Sand\Oyster\Dry River Bed	1.2	0.36
Water Bodies	1.3	0.39

CONCLUSION

Land-use analyses with catchment hydrologic parameters indicate that, the catchments dominated with evergreen-semi evergreen type of forests have higher stream density and most of the streams are perennial compared to catchments dominated by anthropogenic influences.

The variation in dissolved oxygen and free carbon dioxide is due to stagnant or flowing nature of the water body. The variation in phosphates and coliform is due to the anthropogenic activities in the catchment. The catchment area is mainly covered

Table 4. Hydrological parameters of Venkatapura River Basin

Sub basins	No. of Streams (stream orderwise)					Total Streams length (km)	Catchment Area (sq.Km)	Total Streams	Stream Density	Drainage Density
	1	2	3	4	5	a	b	c	c/b	a/b
Kitrehole	75	11	3	1	0	46.88	16.05	90	5.61	2.92
Katagar Nala	124	26	3	4	0	86.7	28.01	157	5.61	3.10
Venkatapura Tributary	753	158	30	7	2	593.7	147.7	950	6.43	4.02
Venkatapura River	30	9	3	1	0	30.12	26	43	1.65	1.16
Basti Halla	88	18	4	1	0	85.95	32.46	111	3.42	2.65
Chitlihalla	439	102	23	3	1	317.6	79.43	568	7.15	4.00

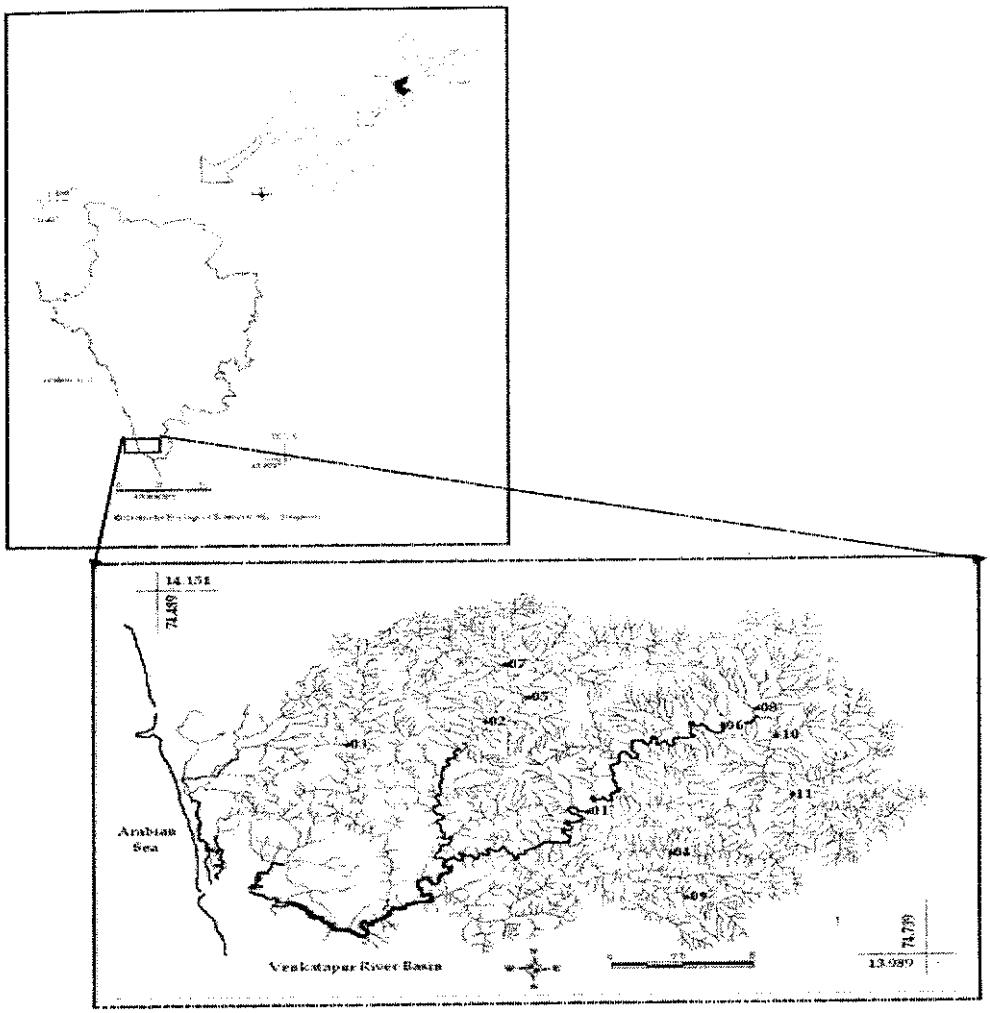

Fig.1 Location of sampling sites along the river Venkatapura

with forest and agricultural lands. The streams drain from agricultural area showed high phosphates value, reflecting that land-use linkage with the stream water quality. The water quality of the river is free of contaminants and serves as a suitable habitat for aquatic plants and animals.

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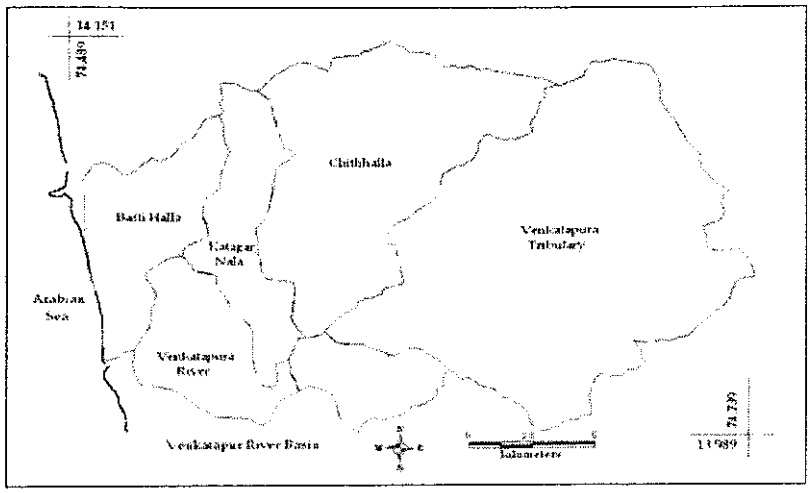

Fig. 2 Sub basins of river Venkatapura

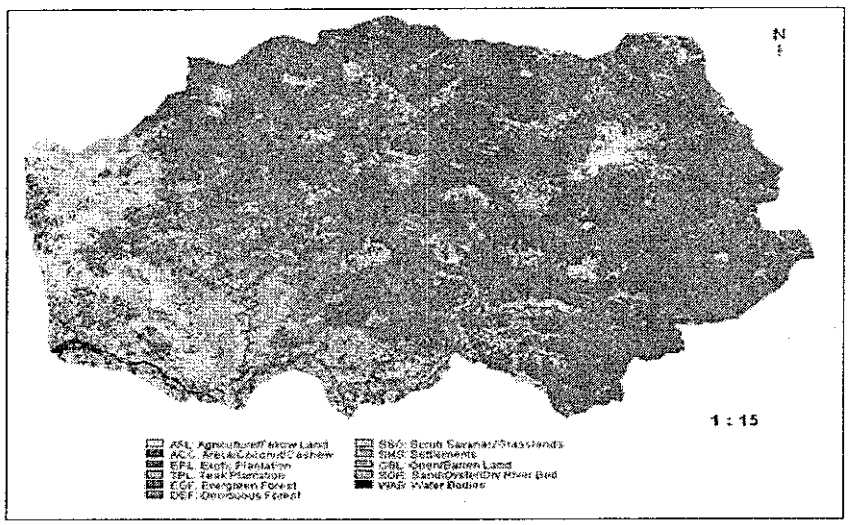

Fig.3 Landuse and landcover classification of Venkatapura river basin

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