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Assessment of Water Quality Status of Krishna River Basin of Karnataka

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Abstract:

Optimal management of water resources is the necessity of time in the wake of development and growing need of population of India. The National Water Policy of India (2002) recognizes that development and management of water resources need to be governed by national perspectives in order to develop and conserve the scarce water resources in an integrated and environmentally sound basis. Climate change affects water resources through changes in evaporation, groundwater recharge, temperature, runoff and rainfall. Such changes affect the mobilization of nutrients, distribution and mobility of pollutants in freshwater systems. The direct and indirect climate change impacts on water quality comprise biological, physical and chemical changes. Biological changes include pathogenic microbes in water. Physical changes include increased water temperature, reduced river and lake ice cover, more stable vertical stratification and less mixing of water of deep-water lakes, and changes in water discharge, affecting water level and retention time. Chemical changes include increased nutrient concentrations, water color and decreased oxygen content. The main objective of this paper is to assess the water quality at different point location in Krishna river course of Karnataka. Based on the Primary and secondary data narrate the water quality through some important laboratory tests. On the basis of result it is now accepted that some human-induced climate change is unavoidable. Potential impacts on water supply have received much attention, but relatively little is known about the concomitant changes in water quality. This paper fills a real gap on climate change impact on river water quality in Krishna River Basin of Karnataka.

Keywords: Climate change, Water quality, Surface water, Micro-pollutants, Physico-chemical parameters,

Introduction:

The 2007 Conference of the Parties to the United Nations Framework Convention on Climate Change, in Bali and the latest IPCC Report (2007) confirmed the consensus amongst scientists and policy makers that human-induced global climate change is now occurring. However, there is less certainty about the magnitude of future temperature changes and how these will drive precipitation, evaporation and hydrology at regional scales. Nonetheless, climate model scenarios provide the best available information for assessing future impacts of climate change on the water quality and ecology of surface water bodies

This paper provides a review of water quality seen through the lens of anticipated impacts in Karnataka State. The material is organized as follows. First, this researcher has review the potential impacts on surface water bodies, such as rivers and lakes, in terms of their hydrological regimes, hydro-morphology, nutrient status, mobilization of toxic substances and acidification potential. Second, she reviews long-term changes in the water quality for specific aspects of freshwater environments, such as estuaries and urban areas. These sections are followed by a review of recent water quality model developments and the treatment of uncertainty. The question of uncertainty is important, as predictions years into the future, based on uncertain GCM model outputs and uncertain process model parameters, will inevitably be used. Assessing

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this uncertainty is important. However, as was shown in the acid rain projects in the 1980s, uncertain models can provide some extremely useful information for planners and managers (Cosby et al., 1986). A testament of this is that those models have correctly predicted the broad recovery of acid lakes and rivers across northern Europe (Wright et al., 2005). Finally, the indirect consequences to water quality of wider climate change policies affecting land and water management or emission reductions are considered.

Study Area:

The Krishna River is the fourth-biggest river in terms of water inflows and river basin area in India, after the Ganga, Godavari and Brahmaputra. Krishna basin lies between latitudes 13° 07' N and 19° 20' N and longitudes 73° 22' E and 81° 10' E with the catchment area of 2,58,948 sq km., spanning across the three major basin states (Maharashtra (26.81%), Karnataka (43.74%) and Andhra Pradesh (29.45%).The Krishna river originates in the Western Ghats near Mahabaleshwar in Maharashtra state It flows across the whole width of the peninsula, from west to east, for a length of about 1400 kms, through Maharashtra (a distance of 305 kms; catchment area 69,425 sq.kms), Karnataka (length 483 kms; catchment area 113,271 sq.kms) and Andhra Pradesh (length 612 kms; catchment area 76,251 sq.kms). The principal tributaries of the Krishna in Karnataka are: (i) Ghataprabha (Origin in the Western Ghats and flows eastwards and joins the river Krishna. The river forms the well-known Gokak Falls in Belgaum District), (ii) Malaprabha (origin in Western Ghats and flows first in easterly and north-easterly directions and joins river Krishna at Kudalasangama), (iii) Bhima (originates in the forest of Bhimashankar in Pune, and flows through the states of Maharashtra and Karnataka and joins Krishna near Kudlu in Raichur taluk and (iv) Tungabhadra (formed in the district of Shimoga, by the union of the Tunga and the Bhadra rivers. The river Tungabhadra flows east across the Deccan Plateau and join river Krishna in Andhra Pradesh). The annual average water flow in the river course is about 11,10,000 cubic feet's (31,000 cubic meters). sharing the available water in the river course among the riparian state awarded as per the award of Bachawat commission dated 29 November 2013. An average annual surface water potential of 78.1 cubic kms has been assessed in this basin. Out of this, 58.0 cubic km is utilizable water. Cultivable area in the basin is about 203,000 sq.kms, which is

KRISHNA RIVER
RIVER COURSE AND ITS BASIN AREA

Fig. No: 1

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10.4% of the total cultivable area of the country. As the water availability in the Krishna river was becoming inadequate to meet the water demand.

In Karnataka state the river Krishna flows 483 kms long through the Belagavi, Bagalkot, Vijayapur, Gulbarga district and spread about 1,13,271 sq.kms catchment area.

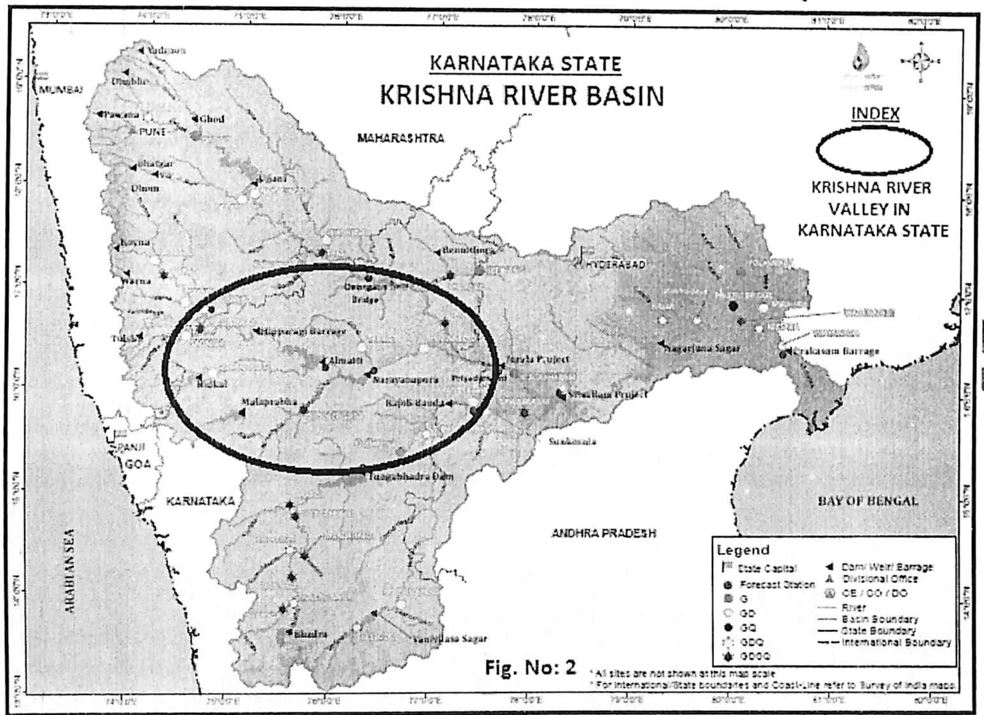

Fig. No: 2

Objectives:

The main objectives of this paper are:

- to study the available quantity of water in river course within the Karnataka region
- to assess the water quality in the different location of the river course.
- to analyze the impacts of water quality on surrounding environs.

Data Collection:

The necessary data is collected from secondary sources i.e., Krishna Bhagya Jala Nigam Ltd. (KBJNL), Water Resource and Conservation Board (WRCB), Krishna Command Area Development Authority (CADA).

Methodology:

Based on the available data apply the simple technique to narrate the water quality and quantity and its impact on surrounding environs.

Water quality Assessment: Water samples were collected at representative sample sites using polyethylene containers through grab sampling method. The representative sample sites were picked so as to represent the entire aquatic ecosystem taking in to consideration number of feeders or tributaries, sources of point and non-point pollution and outlet for various uses, etc.

Sample collection sites:

- Sample collection location where principal feeder tributary namely: Sample collection at confluence points of Ghataprabha, Malaprabha, Bhima rivers joins to Krishna river course in different parts of Karnataka. The Tungabhadra river is not consider for study because it joins to the Krishna river in Teangan state. Because of this region only 3 tributaries are consider for study.

- Central part of Lal Bahaddur Shastri reservoir of Alamatti Dam and Basavasagar reservoir of Narayanapur Dam to get a general quality of the water.
- Outlet from the Alamatti and Narayanpur dams.

The Physico-chemical and biological analyses for the representative samples is being done since February 2015, as per the standard methods prepared and published by NEERI (Indian Standard Specifications [IS: 1050-1983] and [IS: 2490 -1982]) and American public health association (APHA). The parameters include pH, temperature, color, transparency, turbidity, conductivity, total suspended solids, alkalinity, acidity, dissolved oxygen, chlorides, sulphate, total hardness, iron, residual chlorine, fluorides, ammonia, sodium, potassium, nitrates, phosphates and coliform bacteria.

Analysis Of Available Water Quality Of Krishna River In Karnataka Region:

Rainfall Profile:

The Karnataka Krishna basin receives its maximum rainfall during the south-west monsoon. The monsoon winds strike the west coast of the Indian peninsula from the west and south-west and strike the Western Ghats or the Sahyadri Range, which present an almost uninterrupted barrier ranging from 610 m to 2,134 meters in height. According to the India-WRIS database the average annual rainfall in the Karnataka Krishna river basin for the period of 1800 to 2015 is 859 mm. The south-west monsoon sets in the middle of June and withdraws by the middle of October. About 90% of annual rainfall is received during the Monsoon period, of which more than 70% occurs during July, August and September. The distribution of annual average rainfall for Krishna basin has been shown in Table No: 1. Western parts of the basin receive maximum rainfall. However, around 203 blocks of 16 districts falling in the basin are drought prone (Source: Drought Prone Areas Program, DPAP, MoRD, 2012).

Table No: 1.Rainfall Profile in the River Krishna Basin

S. No.	Year	Rainfall (in mm)	S. No	Year	Rainfall (in mm)
1	1971	565.46	6	1995	955.31
2	1975	953.69	7	2001	867.09
3	1981	555.36	8	2005	636.31
4	1985	565.26	9	2011	644.35
5	1991	750.35	10	2015	684.28

Source: WRIS database.

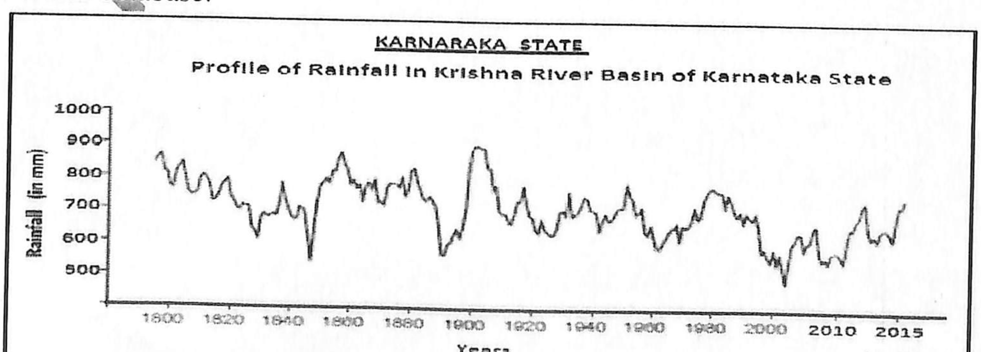

Fig.No: 3

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Temperature Profile:

The western area of the Karnataka Krishna river basin being closer to sea, is less continental and presents a comparatively low annual range of temperature. In winter while the maximum temperature in all parts varies between 30° C and 35° C, the minimum shows the significant variations. The places away from the coast show decreasing to minimum. Night temperatures are the main elements which make the winters more severe in central and western parts. In summers, while the western parts show a moderate heating, an effect of altitude and nearness to sea, the places deep inside the land and those remote from the maritime influences and at comparatively lower altitudes, show higher temperature. In contrast to diurnal heating in these parts the cooling in the night is slow.

According to the India-WRIS database the average annual mean temperature in the Karnataka Krishna river basin for the period of 1971 to 2015 is 26.32° C. During January, which may be taken as representative of the winter months the average mean temperature for the period of 1971 to 2015 in the basin is 22.39° C. During April, which may be taken as representative of the summer months the average mean temperature for the period of 1971 to 2015 in the basin is 29.50° C. During July, which may be taken as representative of the monsoon months the average mean temperature for the period of 1971 to 2015 in the basin is 26.10° C. During October, which may be taken as representative of the post-monsoons months the average mean temperature for the period of 1971 to 2015 in the basin is 25.78° C. Monthly average temperature profile chart of the basin which depicts the maximum, mean and minimum temperature for the period of 1971 to 2015 has been shown in Table No: 2.

Table No: 2. Average Temperature Profile in the River Krishna Basin (1971.2015).

Sl. No.	Months	Maximum Tempetature (° C)	Minimum Tempetature (° C)	Average Mean Tempetature (° C)
1	January	30.12	16.02	23.08
2	February	34.18	19.89	27.09
3	March	35.68	20.53	28.05
4	April	37.24	23.59	30.45
5	May	37.40	24.87	31.08
6	June	33.11	23.68	28.53
7	July	30.28	22.75	26.51
8	August	29.53	22.35	25.49
9	September	30.62	22.17	26.35
10	October	31.20	21.15	26.54
11	November	30.42	18.75	74.46
12	December	29.44	16.50	22.80

Source: WRIS database.

Status Of Water Quality:

The Physico- chemical and biological characterization of water quality at various representative sites near the Krishna river valley. The water analysis results from Feb to July 2015 shows that the pH varies from 6.53 to 7.74, temperature ranges from 23.3 to 31.5OC, dissolved oxygen ranges from 5.0 - 8.0 mg/l, turbidity fluctuates from less than 10 NTU - 75 NTU (mon), electrical conductivity ranges from 0.005 - 0.44 ms/cm, total suspended solids ranges from 21.3- 110 mg/l, alkalinity and acidity ranges from 20-68 mg/l and 2.5 - 20 mg/l

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respectively, chlorides ranges from 4.9-24.9 mg/l and total hardness ranges from 27.25-81.7 mg/l. Sodium and potassium varies from 4.433-32.02 and nil- 2.5 mg/l respectively, sulphate ranges from 2.93-32.02 mg/l, nitrates and phosphates ranges from nil-0.42 and nil-0.032 mg/l respectively. Concentration of iron and ammonia shows less than 0.3 mg/l and less than 0.2 to 3 mg/l at varies sampling points respectively. Residual chlorine shows less than 0.2 mg/l and fluoride fluctuates between 0.6 and 1.5 mg/l. Color, varies from color-less to brownish color. Monsoon samples contain coliform bacteria at Krishna. River streams and it shows nil at remaining representative sampling sites.

Water Quality Assessment:

The water quality of river Krishna of Karnataka region with respect to pH, Conductivity, Dissolved oxygen(DO), Biochemical Oxygen Demand (BOD), Total Coliform (TC) and Faecal Coliform(FC) is being observed. The criteria for pH is 6.5 to 8.5. pH is observed in the range of 6.7 to 9.0. Higher values of pH are found at Jamakhandi Barage (9.0), Kudachi (8.7), Ghataprabha Confluence (8.6), Ankali Bridge along Chikkodi Kagwad Road, U/s of Ugarkhurd Barrage (8.7) and D/s of Devsagar Bridge (8.6) in Karnataka.

The criteria of conductivity for irrigation is 2250 µmhos/cm. Conductivity in the basin varies from 75 to 19960 µmhos/cm. Conductivity is not meeting the criteria near Andhra Pradesh border due to estuarine region.

The criteria for DO should be more than 4 mg/l. DO in the basin ranges from 0.0 to 12.6 mg/l. The lower value of DO is observed at Kudachi Bridge (0.0 mg/l), Chikkodi (3.1 mg/l) Hipparagi (3.6 mg/l), Alagur (3.8 mg/l) near Jamakhandi.

The criteria for BOD should be less than 3 mg/l. BOD ranges from 0.3 to 9.6 mg/l. High values of BOD are observed in Alagur barrage (9.6 mg/l), Malaprabha confluence at Kudal Sangam (9.5 mg/l), Ghataprabha confluence at Chikk Sangam (9.2 mg/l), Krishna Bridge at Kilhar-Korti (9.1 mg/l), D/s of Devsagar Bridge (5.8 mg/l) in Karnataka.

Faecal Coliform should be less than 2500 MPN/100ml. Faecal Coliform (FC) ranges from 0 to 1400 MPN/100 ml and is meeting the criteria.Total Coliform should be less than 5000 MPN/100ml. The Total Coliform count varies from 8 to 170000 MPN/100 ml. High values are observed at A/c of near Bhima river confluence at Gulbarga district

The River Bhima is not meeting the criteria at Dhulakhed Bridge, Canegoan bridge the lower value of Do is observed near Jamakhandi (0.0 mg/l), High values of BOD are observed in Bhima river confluence near Malkapur (28.5 mg/l),.

Regarding the water quality of other tributary streams including Ghatprabha,Malprabha, Tunghabhadra, Tungha, Bhadra, rivers-Low value of pH is observed in Bhadra at Malleswaram D/s of KIOCL in Karnataka. Higher values are observed in Ghatprabha at D/s of Mudhol Rd. Cross Bdg. Malprabha at D/s of Aihole Town, Tunghabhadra at Haralahalli Bridge and Ghatprabha at W.A. Point to Gokak Town (8.7) in Karnataka.

The higher values of conductivity are observed in River Malprabha at D/s of Aihole Town (3800 µmhos/cm) in Karnataka. The lower value of DO is observed in River near Gokak town of Ghataprabha.

High values of BOD are observed in River Bhadra at Bhadravathi D/s (5.8 mg/l), River Ghatprabha at W.A. Pointto Gokak Town (5.4 mg/l), River Tungabhadra at Ullanur (5.2 mg/l), Haralihalli Bridge (3.7 mg/l) &Honnali Bridge (3.4 mg/l), River Tunga at D/s of Shimoga Town

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(4.3 mg/l) & D/s of KIOCL Road Bridge, Near Holehunnur (3.4 mg/l), River Malprabha at D/s of Khanapur Town & D/s of Aihole Town (3.4 mg/l)and Confluence point of Tunga & Bhadra at Kudli (3.1 mg/l) in Karnataka.

The maximum number of Faecal Coliform (9000 MPN/100ml) is observed in River Tunghabhadra at Ullanur in Karnataka & River Malaprabha confluence.

Total Coliform is observed higher than the criteria in River Bhadra at Bhadravati and Tungabhadra at Ullanur (16,000 MPN/100 ml), Tungha at D/s of Shimoga Town and Bhadra at D/s of KIOCL Bridge near Holehunnur (9000 MPN/100ml) in Karnataka.

Table No: 3. Water Quality level in the different location of Krishna river course in Karnataka

Sl. No	Parameters	Sample	Collected	Number	of	Locations									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	PHYSICAL PARAMETER														
	Transparency (cm)	23	16	14	8	50	45	50	43	34	53	45	42	8	8
	Temperature (OC)	23.8	24	23.9	24.3	23.3	24.1	24.8	26	24.5	23.4	25.5	24.5	24.1	24.4
	EC (ms/cm)	0.03008	0.04416	0.04032	0.0608	0.02048	0.02688	0.02944	0.02496	0.02304	0.02016	0.02528	0.02624	0.05952	0.0672
	Total Suspended Solids (mg/l)	65	78	76	110	40	35	65	55	65	45	55	55	102	108
	Turbidity (NTU)	50	35	30	60	<10	<10	<10	<10	<10	<10	<10	<10	25	75
	Color *	Brownish	Brownish	Brownish	Brownish	colorless	colorless	Light brown	Light Brown	Light Brown	colorless	Light Brown	Light Brown	Brownish	Brownish
	CHEMICAL PARAMETER														
	PH*	7.09	6.89	6.97	6.98	6.95	7.22	6.94	6.65	6.6	6.93	6.8	6.99	7.01	6.98
	Alkalinity (mg/l)	35	30	35	45	20	20	20	30	20	20	25	25	55	50
	Acidity (mg/l)	5	5	5	5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Chlorides (mg/l)	19.9	14.9	14.9	14.9	14.9	19.9	14.9	14.9	14.9	19.9	14.9	14.9	19.9	24.9
	Total Hardness (mg/l)	59.5	59.9	76.3	82.2	82.3	49.5	40.9	38.15	54.5	49.5	49.05	43.6	54.5	54.5
	Dissolvedoxygen (mg/l)	7.7	7.5	7.6	7.7	7.7	7.8	7.7	7.7	7.9	8.0	7.7	7.8	7.3	7.4
	Sodium (mg/l)	8.31	13.77	11.33	17.66	4.433	5.63	5.924	5.82	5.24	4.46	5.708	6.036	18.457	29.2186
	Potassium (mg/l)	1.134	2.151	1.564	2.151	0.195	0.743	0.860	0.743	0.391	0.2346	0.7039	0.899	1.447	2.5029
	Sulphate (mg/l)	4.96	11.278	9.47	22.10	7.44	2.93	4.511	11.278	10.15	7.44	7.66	6.76	21.20	20.07
	Nitrates (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Phosphate (mg/l)	0.014	0.0143	0.014	0.0197	0.005	0.0097	0.011	0.019	0.01	0.015	0.01	0.019	0.018	0.03
	Iron (mg/l)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
	Ammonia (mg/l)	0.2	0.2	0.2	2	0.2	<0.2	2	0.2	3	1.5	1.5	1.5	3	2
	Residual Chlorine (mg/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	BIOLOGICAL PARAMETER														
	Coliforms *	ND	Present	Present	Present	Present	ND	ND	ND	ND	ND	ND	ND	Present	Present

Source: Laboratory Experimental Calculations.

River Water Pollution:

Most of the years, the Krishna river water not reaches the sea coast due to full utilisation of water mainly in agriculture. Closed river basin of Krishna means that the river ecosystem is on the verge of death. The river receives the waste from the large number of Settlements (Towns and Villages), industries, agriculture field. The river basin population has increased to 80 million enhancing pollution load many folds into the river. Adequate average and minimum continuous environmental flows to the sea are not taking place in most of the years constricting salt export and leading to formation of saline and sodium alkaline soils in the lower reaches of the river basin. High alkalinity water is discharged from the ash dump areas of many coal fired power stations into the river which further increases the alkalinity of the river water whose water is naturally of high alkalinity since the river basin is draining vast area of basalt rock formations. The following are the few coal fired power stations located in the river basin.

Conclusion:

The Krishna and its tributaries are an inter-state river system flowing through the state of Karnataka. Its principal tributaries joining from right are the Ghatprabha, the Malprabha and the Tungabhadra whereas those joining from left are the Bhima and Doni. The basin falls into four major Agro-Climatic Zones and six Agro-Ecological Zones. As per the assessment of LULC (2005-06), Major part of the basin (75.86%) is covered with Agricultural area. Approximately 10% of the basin area is covered by forest, wasteland covers around 7% of the total basin area and around 4% of the basin area is covered by water bodies. Numbers of small and large projects have been constructed in the basin and some are under construction. The approach all along has been to construct projects for the benefit of the particular state concerned except in a few cases where the projects are being constructed jointly by two states.

Systematic and Scientific exploratory work is needed for a quantitative and qualitative assessment of the ground water resources in the basin so that these resources can be exploited in a national way either independently or in conjunction with surface waters. There is need for inter-State co-operation and agreement in respect of soil Conservation measures to conserve the storage capacities of existing and proposed reservoirs in the basin. The holistic approaches in planning involving all components are required to maintain the health as well as to ensure the sustainability. This requires timely and accurate data pertaining to the quality and quantity. This necessitates inventorying, and regular mapping and monitoring involving hydrology, and physico-chemical and biological properties.

This indicates that the land-use pattern in the catchment area plays a major role in the health of the aquatic ecosystem, which is evident from the water and soil quality analyses. The occurrences of perennial streams highlight a vital relationship between the ecology and hydrology. This result could be a pointer to the decision-makers considering a severe water stress faced in various parts of the Country. Hence, forest management activities should incorporate multifarious objectives of improving water production, both by quantity and quality through an appropriate land use planning. The main conclusion which can be drawn is that a degradation trend of drinking water quality in the context of climate change leads to an increase of at risk situations related to potential health impact.

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