J. Himalayan Ecol. Sustain. Dev. Vol. 1 (2006)

Limnological Studies of River Chenab

D. I. Baba, M. K. Jyoti and K. K. Sharma
Department of Zoology, University of Jammu, Jammu 180 006, J&K, India

ABSTRACT

The river Chenab, a major tributary of Indus, was studied for a period of two years from May 2000 to April 2002. Spatial and temporal variations in physico-chemical parameters at different stations were studied to adjudge the spatial variability in physico-chemical conditions of the river and the influence that tributaries exert on the river ecology and the seasonal changes that are caused by the changes in weather.

Keywords: Chenab river, J & K, drainage, water chemistry,

INTRODUCTION

Nowhere throughout the globe is a zoogeographic region so blessed with aquatic resources as India is. Out of a total area of 3.3 million km^2, India contributes 27,359 km^2 (Sharma, 1999) of area for riverine systems. One of the major riverine systems of India is the Indus drainage system that caters the erstwhile great Punjab (present Haryana and Punjab of India and western Punjab in Pakistan) through five catchment rivers viz., Sutlej, Beas, Ravi, Jhelum and Chenab.

The Jammu region of J&K state is drained mainly by Chenab watershed. River Chenab marks the NW and SE limits of Jammu and has a number of tributaries (seasonal and perennial), which cut across the hills and join it at different locations along its length. Some important streams like Marausudar, Khalnai, Neeru, Anji, Pouni, Tawi etc., add to the Chenab waters.

River Chenab is formed by the confluence of two snow / glacial melt-fed Himalayan streams, viz., Chandra and Bhaga at Tandi in the Lahaul valley of Himachal Pradesh. The river Chenab passes through Pangi, and enters J&K through the west between the steep cliffs of the Shivalik hills and lesser Himalayas at an elevation of 1818 m. Thereafter it flows through SW into Pakistan to its junction with Sutlej. It traverses a distance of 580 km (Sud *et. al.*, 1989) in the Indian Territory, most of which is through the mountainous terrain and hardly 40km is through the lower hills before it debounces into the plains of Pakistan.

The present study on the river was carried out in a 328 km long stretch of the river in order to have reasonable wholesome information of the river course (Fig 1.)

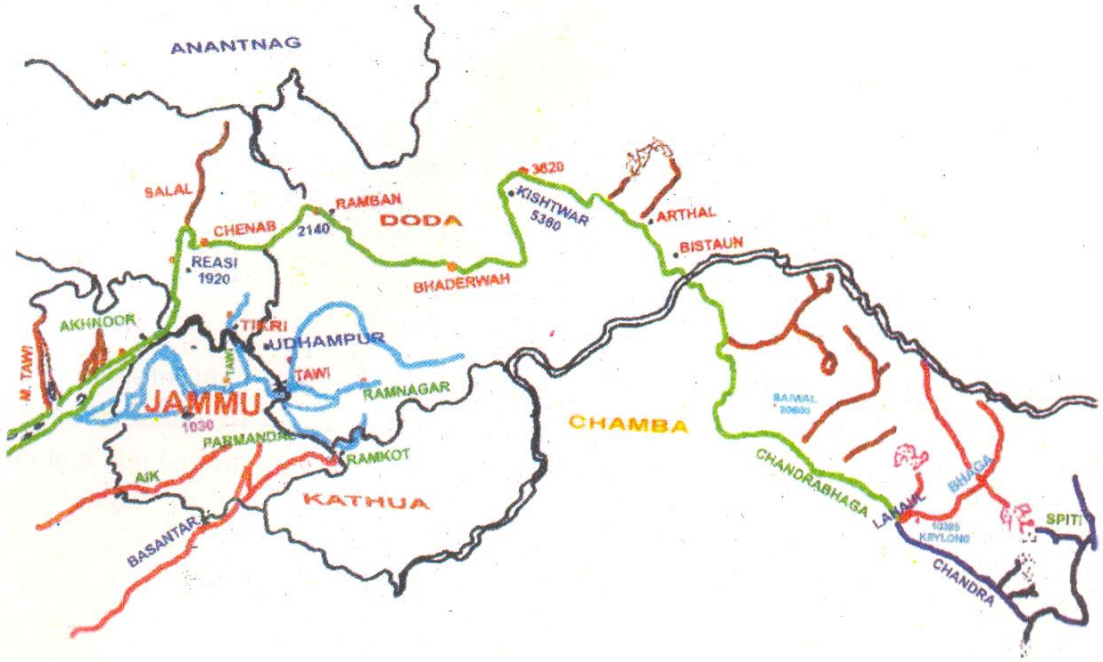

Fig. 1 CHENAB DRAINAGE SYSTEM

MATERIAL AND METHODS

In an effort to have an insight into the physico-chemical and biological features of the river Chenab, an inquisitive study was carried out from May 2000 to April 2002. The river was horizontally divided into zones and a study station for each zone was established. The division of river into study zones was made on the basis of variations in bottom structure or close to confluence of a stream / nallah with the main river. The river along its length was divided into 6 study stations namely Bhandarkot, Thatri, Pul-Doda, Ramban, Reasi and Akhnoor, (Fig.) so that a comprehensive picture about the physico-chemical parameters of river could be brought forth. Among physico-chemical parameters weather, air temperature, water temperature, transparency, pH, DO, FCo_2, Co_3^{2-}, HCo_3^-, Cl^-, Ca^{2+} and Mg^{2+} were recorded at all the study stations along the entire stretch of river Chenab.

To study the various parameters the samples were collected from selected sampling stations. Recording of some physico-chemical factors like transparency, water temperature, air temperature, pH and free carbon dioxide was made at the sampling site itself whereas the analysis of other chemical parameters like carbonate, bi-carbonate, chloride, calcium and magnesium was done in the laboratory after the methods outlined by APHA (1985).

RESULTS AND DISCUSSION

Physical Characteristics

Altitudinal and floral variations in the Jammu province of Jammu and Kashmir state, subject it to spatially variant climates. Depending upon the prevailing weather conditions, the area can be said to experience three sharp seasons with in a year viz., Summer (late April to late June) in which weather remains bright sunny and

temperature varies from 25°C to 37°C; Rainy season (late June to mid September) when weather remains cloudy and area experiences monsoon rains and winter (late November to late February) when temperature remains within -3°C to 20°C and other weather conditions like snowing and fog etc. vary considerably, depending on the altitude. In addition, two short transitional periods representing spring (early March to mid April) and autumn (early October to mid November) are also experienced.

The atmospheric temperature varies considerably both spatially as well as temporally. The range of variations recorded reveal that the minima of temperature vary between 3° C (Station Bhandarkot) to 20°C (Station Akhnoor) during the month of January. Similarly, maximum air temperature varies from 21° C (Station Bhandarkot) to 36.5° C (Station Akhnoor) during the month of May. In concordance with seasonal changes, the variations in temperature range from 3° C observed in January (2001) to a maximum range of 36.5° C in May (2000) along the river course was investigated (Table 1).

A large number of workers (Schmitz, 1961; Goldman and Wetzel, 1963; Mishra *et al.*, 1975; Geisler, 1975; Pandit *et al.*, 1996; Joshi, 1996 and Nath, 2001) have opined that water temperature follows closely the air temperature & this holds true for river Chenab also where water temperature varies from 1 °C to 20 °C.

The higher values of transparency was recorded as 152 cms and lower as 2cms. The water remains turbid from May to August mostly due to suspended silt and sand. For other remaining eight months the water is clear (with varying colours i.e. light green and green) with increased values of transparency.

Chemical Characteristics

The impacts of seasonal variations of temperature have clearly been observed on the concentrations of dissolved gases, Oxygen and carbon dioxide, on the dissolved salts, calcium and magnesium. The dissolved oxygen content in the river water was observed as 4.mg/l to 13.6 mg/l denoting the inverse relationship with the temperature and as well as with free carbon dioxide (averages 4mg/l). The free carbon dioxide was highest during summer and monsoon months as observed by Joshi (1985), Singh and Dobriyal (1981) and Nautiyal (1985) in some other Himalayan rivers.

The large amount of water seems to influence other parameters such as pH, carbonate, bicarbonate, chloride, calcium and magnesium by reducing the concentration of their ions in river water (Table 1).

The water of river Chenab is alkaline, as is evident from studies carried spatially as well as temporally. The pH values range between 7.4-8.9, being lowest in summer and monsoon months when the river was swollen with floods and highest during winter. The observed increment in pH value during winter months appears to be influenced by low water level, better interaction between lime stone deposits and water and growth of phytoplanktons (especially diatoms) as has earlier been suggested for many other water bodies (Joshi, 1996 ; Sunder, 1996; Hassan, 1998). Very small range of fluctuations in pH, spatially and temporally, suggest that there occurs a very strong buffering mechanism in river Chenab.

The dilution factor with greater volume of water in the river was found to influence the values of carbonate and bi-carbonate. In river

Chenab it has been observed that carbonate ranges between 3 mg/l to 18 mg/l. Carbonate remains absent during summer and monsoon months. Jhingran (1978) has already indicated that at pH range 4.5 to 8.3, the carbonate value remains low and dominated the presence of free CO_2 and bicarbonates. The op. cit statement can also hold true for the findings conducted in river Chenab. Summer and monsoon absence of carbonate may be attributed to the presence of FCO_2 which appears largely due to various climatic and anthropogenic influences viz., process of decomposition of bottom deposits, drifting of phytoplanktons and vegetation which results in an increase in FCO_2 and influx of sewage etc. as has already been discussed by Ruttner (1953) and Gochhait (1991).

The values of bicarbonate fluctuate from 21mg/l to 169 mg/l. The rise in HCo_3^- levels in river Chenab from April onwards upto September establishes a direct relationship with FCo_2 whose concentration also records periodic increase during this period. The rise in bicarbonates recorded may be attributed to the additional influx through rainfall and surface runoff. It is well on record Saho *et al.*, 1959; Khan and Siddiqui, 1971 and Badola and Singh, 1981 that surface run-off generally leaches the surrounding sandy rocks of their calcium carbonate which subsequently are converted into soluble bicarbonates.

In the present study, higher chloride value was recorded during summer (June) and winter (December - January). The highest concentration of Chloride (7.98 mg/l) was recorded in the month of June at 16° C (water temperature) at station Akhnoor in the downstream area whereas lowest chloride value (4.99 mg/l) was recorded at station Bhandarkot in the month of June at 12° C (water temperature). These variations presently recorded in the longitudinal profile of river Chenab could also be linked to temperature variations, temperature linked microbial activities and low water speed during winter and related anthropogenic influences operating in and around the Chenab riverine system. Gonzalves and Joshi (1946); Zafar (1964); Pehwa and Mehrotra (1966); Verma (1969) and Jana (1973) have also made similar observations and advocated that individual as well as cumulative influence of these parameters results in prevalence of variations in chloride concentration in different water bodies studied by them.

According to Ohle (1934), waters with calcium values above 25 mg/l are classified as "Calcium rich". In the present observation, river Chenab recorded calcium between 3.208 mg/l - 34.887 mg/l slightly higher than the prescribed level. The rise in calcium content during autumn and winter months could be attributed to its great solubility at lower temperatures, while during summer and monsoon months, the decline in the values of calcium might be on account of its dilution as a consequences of mixing of run-off water from rain and its utilization by the phytoplankton in the river (Swarup and Singh, 1979).

In the present observations, magnesium recorded its higher concentrations (16.037 mg/l) during winter months (January-February) which could be attributed to low water level, whereas low concentration (2.187 mg/l) recorded in the monsoon months (July-August) may be linked with heavy rainfall (Sutcliffe and Carrick, 1973 which ultimately causes dilution of water.

Table 1. Minimum and maximum range of some physico-chemical parameters in River Chenab and its tributaries (May 2000 - April 2002).

S. No.	Parameter	I YR.		II YR.	
		Minimum	Maximum	Minimum	Maximum
1.	Air temperature (^{o}C)	3	36.5	3	37
2	Water temperature (^{o}C)	1	20.0	0	32
3.	Transparency (cm)	2	152	2	228.75
4.	Speed (m/s)	0.6	2.0	0.11	1.66
5.	pH	7.3	8.8	7.2	8.9
6.	DO (mg/l)	4.8	14.8	3.6	16.8
7.	FCO_2 (mg/l)	Nil	6.0	Nil	5.0
8.	CO_3^{2-} (mg/l)	Nil	18.0	Nil	39.0
9.	HCO_3^{-} (mg/l)	21.35	169.77	27.45	240.95
10.	Cl^{-} (mg/l)	0.99	7.98	0.99	7.98
11.	Ca^{2+} (mg/l)	3.809	36.09	3.007	32.08
12.	Mg^{2+} (mg/l)	2.308	18.608	2.065	18.468

CONCLUSIONS

The physico-chemical characteristics of river Chenab at different stations indicate that the river doesn't exhibit any deteriorating (nutrient pollution) trend as yet. However, the various anthropogenic effects like construction of bridges, barrages, Hydro electric projects, dams, raw sewage and domestic effluents find way in appreciable quantities regularly into the river and may eventually cause the change in the present tropic condition of the ecosystem making it unfit for biota especially the fish. The water characteristics at high altitudes compared to plains indicate a considerable change in the physico-chemical parameters.

The river was observed to remain turbid

during late summer and monsoon and the turbidity is due to soil-erosion, caused mostly as a result of heavy snow melting and steep gradient that results in fast water current that cut the margins and bottom by pouring in silt and organic matter flowing in from mountain forests. The added run off from catchment areas further aggravates the condition of the biota in the system. Toxic wastes, radioactive and heat contents are not the problems of the river under investigation. Domestic waste to some extent is one of the chief putrescible waste but probably it must be rapidly getting oxidised upon entering river (Taylor, 1948 and Coker, 1954).

During the present studies the depletion of dissolved oxygen or enhancement of any other chemical parameter was not observed even at Akhnoor station, which is a farthest location from river origin that receives all the civic effluent upstream. Moreover, it was observed from the water quality parameters of river Chenab that these are more or less parallel to those analyzed for some trout streams of the Kashmir valley by Kumar and Bhagat (1977) and Qadri, et al. (1981). The overall picture drawn on water quality is supportive of the cold water fishes especially snow trouts (Schizothoracids), whereas trouts (Salmonids) cannot thrive in the ecosystem which require much clear and less silty water.

REFERENCES

Badola, S. P. and Singh, H. R. 1981. Fish and fisheries of the river Alaknanda. *Proc. Nat. Acad. Sci. India*, B **51**(II).

Coker, Robert, E. 1954. *Streams, lakes and ponds.* The University of California Press, U.S.A., 327p.

Geisler, R. 1975. The Ecology of freshwater fishes in Amazonia present status and future tasks for Research. *Animal Research and Development*. **I:** 102.

Gochhait, B.C. 1991. *Studies on Limnological factors of river Buddhabalanga at Baripada (Orissa)*. Ph.D. thesis, Orissa.

Goldman, C.R. and Wetzel, R.G. 1963. A study of the Primary Productivity of Clear Lake, Lake Country, California. *Ecology*. **44**:283-294.

Gonzalves, E.A. and Joshi, D.B. 1946. Fresh water algae near Bombay, *J. Bombay Nat. Hist. Soc*. **46**(1) : 154-176.

Hassan, S.S., Sinha, R.K., Hassan, N. and Ahsan, I. 1998. The current seasonal variations in catch diversity and composition of fish communities vis-a-vis various factors in the Ganges at Patna (India) and strategies for sustainable development. *J. Freshwater Biol.* **10** (3-4): 141-157.

Jana, B.B. 1973. Seasonal periodicity of plankton in a fish water pond. West Bengal, India, Int. *Rev. ges. Hydrobiol.* **58**: 127-143.

Joshi, C.B. 1985. *Ecological studies of some hill streams in middle stretch of Sutlej river system feeding Gobindsagar reservoir in Himachal Pradesh.* Ph.D. Thesis, Garhwal University, Srinagar, Garhwal.

Joshi, C.B. 1996. Hydrobiological profile of river Sutlej in its middle stretch in Western Himalayas, Uttar Pradesh. *J. Zool.* **16**(2) : 97-103, 1996.

Khan, J.A. and Siddiqui, A.Q. 1971. Water, nitrogen and phosphorus in freshwater plankton. *Hydrobiologia*, **37**: 531-536.

Kumar, K. and Bhagat, M.J. 1977. "Observations on the ecology of two trout streams in Kashmir and its possible effects on the brown trout (*Salmo trutta* fario L.) catches", *J. Inland Fish. Soc. India*, **10**:1-8.

Mishra, S.D., Bharagava. S.C. and Bohra, O.P. 1975. Diurnal variations in physico-chemical factors at Padmasagar. *Geobios.* **2**: 32-33.

Nath, D. 2001. Water and Soil characteristics of the Narmada estuary before commissioning of Sardar Sarobar Dam. *J. Inland Fish. Soc. India*, **33**(2): 37-41.

Nautiyal, P. 1985 Studies on the riverine ecology of torrential waters in the Indian uplands of the Garhwal region. I. Seasonal variations in percentage occurance of planktonic algae. Uttar Pradesh *J. Zoology.* **5** (1): 14-19.

Ohle, W. 1934. "Chemisch and Physikalishe untersuch unglenhor dentscher seen", Arch. *Hydrobiol.*, **26**: 386-464.

Pandit, S. Adhikary, S. and Roy, S. 1996. Abiotic factors, Environmental stresses and population dynamics of coleopteran inseects in three distinct sites of Damodar river. *J. Fresh water Biol.* **83**(3): 147-151.

Pehwa, D.V. and Mehrotra, S.N. 1966. Observations of fluctuation in the abundance of plankton in relation to certain hydrobiological conditions of River Ganga. *Proc. Nat. Acad. Sci.* **36** B (2): 157-189.

Qadri, M.Y., Showkat, A.N., Mustafa, G. and Yousuf, A.R. 1981. Limnology of two trout streams of Kashmir, *J. Indian Inst. Sci.*, **63**:137-141.

Ruttner, F. 1953. *Fundamentals of limnology.* Univ. of Toronto Press : 242.

Saho, G.N., Sehgal, K.L., Mitra, E. and Nandy, A.C. 1959. Variations in physico-chemical and biological conditions of a perennial freshwater pond. *J. Ind. Fish. Surv. India*, **3**: 79-102.

Schmitz, W. 1961. Fliesswasserrorschung Hydrographic and Botanik. *Verh. Int. Verein. Theror. Angew. Lemnol.* **14**: 541-586.

Sharma, A. 1999. *Limnological studies of Ban-Ganga and Distributional pattern of Stream Bottom Fauna.* Ph.D. thesis Jammu University, Jammu.

Singh, H. R. and Dobriyal, A.K. 1981. Potamology of the stream Chakagadera in relation to the productivity of cold water minor carps in Garhwal Himalaya. *Proc. Indian. Nat. Sci. Acad.* B **47** (5) : 652 655.

Sud, S.C., Bathija, T.S. and Gupta, S.D. 1989. Development of Hydel Potential in Chenab basin.

Sunder, S. 1996. Biotic community of a Kumaon Himalayan river The Gaula. Uttar Pradesh. *J. Zool.* **16** (2).

Sutchliffe, D.W. and Carrick, T.R. 1973. Studies on the mountain streams in English lake district 1. Aspects of water chemistry in River Duddon. *Fresh Biol.*, **3**: 561-568.

Swarup, K. and. Singh, S.R. 1979. Limnological studies of Suraha lake (Ballia) II. The periodicity of phytoplankton. *J. Indian Bot. Soc.* **58**: 319-329.

Taylor, E.W. 1948. *The Examination of Water and Water Supplies*. J and A Churchill Ltd., London.

Verma, M.N. 1969. Hydrobiological study of a tropical impoundment Tekeapur reservoir, Gwalior, India, with special reference to the breeding of Indian carp. *Hydrobiol.* **34**: 358-368.

Zafar, A.R. 1964. On the ecology of algae in certain fish ponds of Hyderabad, India. II. Distribution of Unicellular and Colonial forms. *Hydrobiol.* **24**(4): 556-566.