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Assessment of physico-chemical parameters and WQI of Ashwani stream, Solan, Himachal Pradesh, India

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Abstract

The present study was conducted to analyze the physicochemical parameters of water ofAshwani stream,Solan, Himachal Pradesh. The physicochemical parameters provide an insight into the overall quality of water and through their evaluation the water quality index was measured. Total of 9 physicochemical parameters were taken for the study including pH, water temperature, dissolved oxygen, total alkalinity, TDS, total hardness, calcium hardness, magnesium hardness and nitrates concentration. Based on the monthly evaluation of the physicochemical parameters Weighted Arithmetic Water Quality Index (WAWQI) was calculated. The analysis reveals that (WQI =98.56046) water of the stream is not safe for drinking and need some degree of treatment before consumption. It also revealed that some physicochemical parameters like total hardness, calcium hardness, magnesium hardness showed a great fluctuation in their respective values in April month due to sewage disposal in the stream.

Key words : Ashwani stream, Physicochemical parameters, WAWQI, Solan, Himachal Pradesh.

Water plays vital role in all living matter, providing sufficient food supply and productive environment for all living organism. Around 0.3% of the water resources in the world are utilizable[9]. The resources of water include rivers, streams, lakes, reservoirs and oceans.Streams are one of the most important freshwater bodies basically on all type of land masses. They are responsible for irrigating wetlands, transporting vital nutrients over huge distances, washing away impurities and being a source of drinking water for wildlife. Stream can be defined as "a natural water body which consist of water at least or most part of year with suspended and dissolved material in its channel and supporting plant and animal communities in its channel or on its bank"[2].

Physicochemical parameters of water encompass various characteristics that define its chemical and physical properties. These parameters play crucial role in assessing water quality and maintaining the health of an aquatic ecosystem. This indicate the overall quality of

water that whether it is polluted, contaminated or suitable for drinking, recreation and supporting aquatic life. Water quality index is a rating reflecting the composite influence of different water quality parameters. It is a useful presentation of overall quality of water for public or for any intended use as well as in pollution management programs[13] and is a mean by which water quality data is summarized for reporting to the public in a consistent manner[17].

The present study deals with the evaluation of physicochemical parameters and Water Quality Index (WQI) of Ashwani stream, Solan, Himachal Pradesh, India.

Area of study :

Ashwani stream (Fig. 1) is a tributary of Yamuna river in Himachal Pradesh, enters district Solan upstream of village Sadhupul. The catchment area of the stream in district Solan comprises of villages: Kohri, Ded, Galai, Mathia, Shanbar, Andi, Sunnu, Tikri, Bayela,Jalkhara, Dawarli and exits District Solan at village Gaura near Yashwantnagar. The total stretch of Ashwani stream in district Solan is approx. 22km. It meets Giri river at village Gaura in Yashwantnagar in Sirmour district.

The water samples from the stream were collected in sterilized plastic bottles of 1

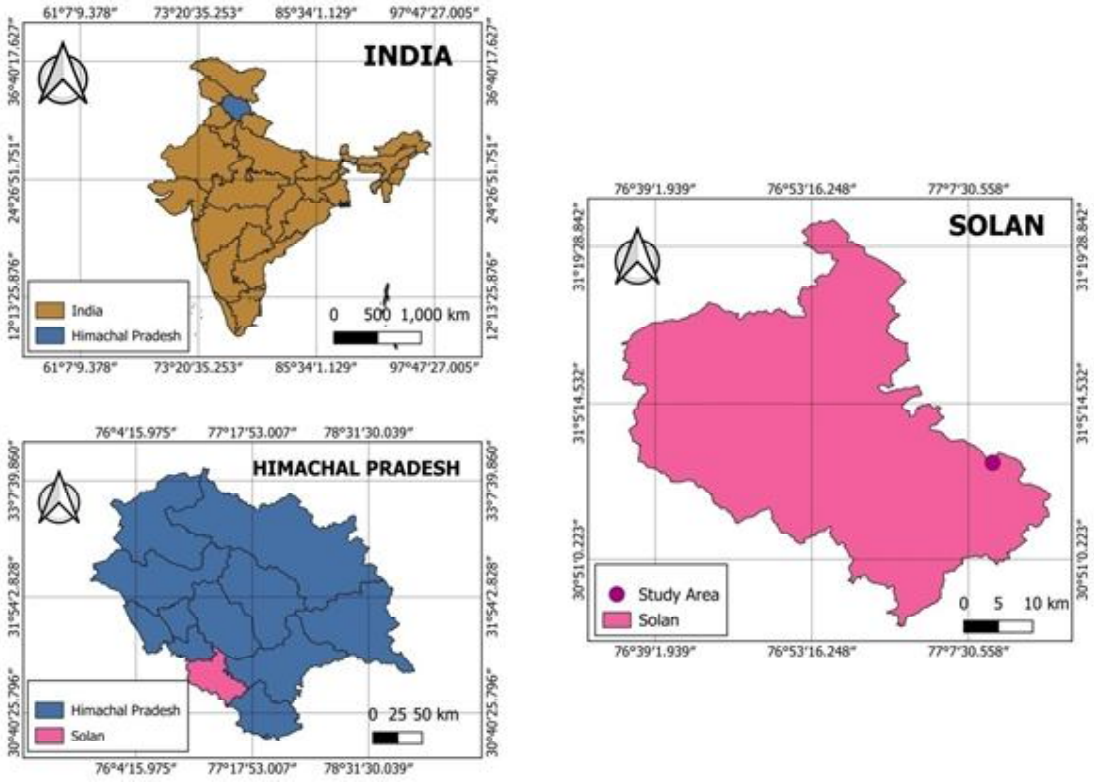

Fig 1. Map showing area of study.

litre capacity during 2023 to 2024. Physico-chemical parameters such as pH, water temperature, Dissolved Oxygen (DO) and Total Dissolved Solids (TDS) were measured at the sampling site using digital probes. Total alkalinity, total hardness, hardness due to calcium and magnesium and concentration of nitrates were analyzed in the laboratory as per APHA[1]. The Weighted Arithmetic Water Quality Index (WAWQI) method was used to asses the quality of water of the stream. The WQI was calculated using following formula:

$$\mathbf{WQI = \Sigma W_n * Q_n / \Sigma W_n}$$

Where, $\mathbf{W_n}$= unit weight for n^{th} water quality parameter

$\mathbf{Q_n}$= quality rating of n^{th}water quality parameter

$$\mathbf{Q_n = 100[V_n - V_{10}]/[S_n - V_{10}]}$$

Where, $\mathbf{Vn}$= Estimated value of the n^{th} water quality parameter of collected sample

$\mathbf{V_{10}}$= ideal value of the n^{th}water quality parameter in pure water

$\mathbf{S_n}$ = standard permissible value of the n^{th}water quality parameter.

It is important to test water before it's use for drinking, domestic,agricultural or industrial purposes and water must be tested by analyzing different physicochemical parameters which entirely hinge on for what purpose we are going to use that water and what extent we need its quality[11].Physico-chemical parameters of water are important symbol of overall quality of water and describe a relationship toward the overall health of an aquatic ecosystem. Monitoring these parameters helps to assure the water safety and environmental health. Different physicochemical parameters viz., water temperature, dissolved oxygen, pH, TDS, total alkalinity, total hardness, hardness due to calcium and magnesium and concentration of nitrates were analyzed in the stream. The range and mean value of different physico-chemical parameters recorded in the stream are given in Table-1.

Water temperature :

Water temperature is an important physico-chemical parameter for water quality analysis, effects various aquatic organism. The water temperature in the stream during the course of present work varied from 15-24.1°C. Water temperature varies with variation in air temperature and it also depends on season, depth and time of the day.

pH :

pH indicates the acidic, alkaline and neutral nature of water and effects the life of plant and animal species of water bodies. During current study pH ranged from 6.5 – 8.8 which shows slightly acidic to alkaline nature of stream water. The huge variation in pH in April month (6.5) was due to addition of sewage water in the stream, which resulted in bad odor of water and decomposition of organic matter by microorganisms which made the water in stream acidic.The maximum pH was recorded in month of December, which may be due to decrease in CO_2 level because of increasing photosynthetic communities. Similar observations were also made by Sharma and Banyal[16] in Man stream, Hamirpur.The study conducted on water quality of Ashwani stream in Shimla showed that value of pHranges from 7.72-8.9 in pre-monsoon season and 7.29-8.2 in post-monsoon indicating the slightly alkaline

nature of stream water[5].

TDS :

Total dissolved solids are useful parameter describing the dissolved matter in water. In the present stream TDS ranged from 140-224mg/l. Chauhan *et al.,*[5] reported high range of TDS *i.e.*, 265-733mg/l in pre-monsoon and 152-570mg/l in post monsoon season in Ashwani stream at Shimla. The study conducted on riverine area of Baddi (H.P.) showed the TDS range between 697.6 -1210mg/l[15].

Total alkalinity :

It is the measure of carbonates, hydroxide content and some other bases in the water. The carbonaceous rocks present in the substratum of the stream, adds bicarbonates to the water, which contributes to the increased alkalinity of the stream[7].The alkalinity at present site ranged from46.7-306mg/l. Chauhan *et al.,*[5] recorded 158.93 mg/l and 68.03 mg/l of alkalinity in Ashwani stream, Shimla during pre-monsoon and post-monsoon, respectively.

Total hardness :

The total hardness of the water sample varied between 150-498mg/l, during present study. The greatest fluctuation in hardness of water was seen in April month (498mg/l) which may be due to addition of sewage water into the stream. The hardness due to calcium and magnesium ranged from 110-304mg/l and 40-194mg/l, respectively.The mean value of total hardness (274mg/l) was higher than permissible limit as per Bureau of Indian Standards (BIS)[3] for drinking water quality standards. Also, Chauhan *et al.,*[5] recorded high value of total hardness in Ashwani stream, Shimla during pre-monsoon (232.89mg/l) and low value in post monsoon (114.36mg/l) due to dilution caused by surface run-off.

Dissolved Oxygen :

Dissolved Oxygen (DO) is the concentration of oxygen dissolved in the water. Its presence is important to support variety of aquatic life and the effect of waste discharge in a water body is largely determined by oxygen balance of the system[14]. The values of DO ranged from 4.1-7.1 mg/l in the present study. The mean value of DO was 6.0 mg/l. The highest value (7.1 mg/l) was recorded in month of December and minimum value (4.1 mg/l) in month of April. The amount of DO was lowest in month of April due to the sewage discharge in the water body. Chauhan *et al.,*[5] recorded DO range between 2.1-9.1 mg/l in pre-monsoon and 3.2 – 11.9 mg/l in post-monsoon in Ashwani stream, Shimla.

Nitrates :

Agricultural wastes leads to addition of nitrates in water body and is considered to be the indicator of pollution[10]. Nitrogen enrichment in aquatic ecosystem leads to deterioration ofits water quality and contributes to eutrophication and if nitrate concentration in drinking water is more than 45mg/l, it can lead to human and animal health problems[8]. Enhanced nitrogen mobilization through crop cultivation, animal husbandry, industrial and municipal waste water discharges and fossil fuel combustion harms the aquatic environment and affects human, animal and ecosystem

health[12].Theconcentration of nitrates during present investigation ranged from0.051-12.48mg/l. The high value of nitrates in the current stream may be due to addition of sewage water into the stream. The study conducted by Chauhan *et al.,*[5] on Ashwani stream in Shimla district showed values of nitrates ranged between 1.2to 28.5mg/l in pre-monsoon and 0.12to 13.3 mg/l in post-monsoon.

Table-1. Showing range and mean value of different physico-chemical parameters recorded in the stream

Parameters	Range	Mean value
Water temperature (°C)	15-24.1	19.04
pH	6.5-8.5	8
TDS (mg/l)	140-224	159.6
Total Alkalinity (mg/l)	46.7-306	143.7
Total Hardness (mg/l)	150-498	274.4
DO	4.1-7.1	6
Hardness due to Ca^{+2} (mg/l)	110-304	187.8
Hardness due to Mg^{+2} (mg/l)	40-194	80.5
Nitrates (mg/l)	0.051-12.48	4.178

Calculation of WAWQI :

Weighted Arithmetic Water Quality Index (WAWQI) was used to analyze the water quality of the stream. Water quality standards for drinking water given by BIS[3] and WHO[18] have been used for analysis (Table-2). The calculated value of WQI of current stream is 98.56046 (Table-3).

Table-2. Water quality standards for drinking water given by BIS and WHO.

Parameters	BIS	WHO
pH	6.5-8.5	6.5-9.2
TDS	500	500
Total Alkalinity	200	-
Total Hardness	200	-
DO	5	-
Calcium	75	100
Magnesium	30	150
Nitrates	45	45

Table-3. Calculation of WQI.

Parameter	S_n (BIS)	$1/S_n$	$K=1/(\Sigma 1/S_n)$	$W_n=K/S_n$	V_0	V_n	V_n/S_n	$V_n/S_n*100=Q_n$	W_n*Q_n
pH	8.5	0.117647	2.509184	0.295198	7	8	0.66	66	19.48307
TDS	500	0.002	2.509184	0.005018	0	159.6	0.3192	31.92	0.321554
Alkalinity	200	0.005	2.509184	0.012546	0	143.7	0.7185	71.85	1.809496
Total Hardness	200	0.005	2.509184	0.012546	0	274.4	1.372	137.2	3.455293
Ca^{2+}	75	0.013333	2.509184	0.033456	0	187.8	2.504	250.4	16.81643
Mg^{2+}	30	0.033333	2.509184	0.083639	0	80.5	2.683333	268.3333	45.052
Nitrates	45	0.022222	2.509184	0.05576	0	4.178	0.092844	9.284444	1.039212
DO	5	0.2	2.509184	0.501837	14.6	6	0.895833	89.5833	49.9562
		$\Sigma 1/S_n=$ 0.398536		1					$\Sigma W_n*Q_n=$ 98.56046

Table-4. Water quality index and its status according to Chatterjee and Raziuddin(2002)

S.No.	Water index level	Water quality status
1	0-25	Excellent water quality
2	26-50	Good water quality
3	51-75	Poor water quality
4	75-100	Very poor water quality
5	>100	Unsuitable for drinking

As from above water quality index (table.4) given by Chatterjee and Raziuddin[4] the water quality index of the water sample lying between 75-100, indicates that the water quality of the stream is very poor.The parameters like pH, TDS, alkalinity and nitrates were under the permissible limits but total hardness, Ca^{+2} concentration, Mg^{+2} concentrations were above the permissible limit. Also, study conducted on water quality of Ashwani stream, Shimla city showed that the values of TDS and Total hardness were above the permissible level[5].

The results indicate that the water in Ashwani stream is not safe for drinking. The parameters like total hardness, calcium and magnesium show huge variation in the month of March and April. The main reason behind this is the various anthropogenic activities and the sewage disposal in the stream which resulted in the change of color and bad odour

of the stream water. Alkalinity and pH also show huge variation in the month of April which may be due to organic matter decomposition by microorganisms which was deposited in water due to sewage disposal.

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References :

1. APHA (1998). Standard methods for examination of water and wastewater. 20th ed. American Public Health Association, Washington, D.C.
2. Armantrout N.B. (1998). Glossary of Aquatic Habitat Inventory Terminology. American Fisheries Society.
3. Bureau of Indian Standards (BIS) (2012). Indian Standard Specification for Drinking Water (IS – 10500 – 2012). Indian Standards Institution, New Delhi.
4. Chatterjee, C. and M. Raziuddin (2002). *Nat. Environ.Pollut. Technol*., *1*(2): 181–189.
5. Chauhan S., M. S. Rishi and N. Sidhu (2015). *J. Environ. Earth Sci., 5*(19): 58-66.
6. Daniel, T. C., A. N. Sharpley and J. L. Lemunyon (1998). *J. environ. Quality, 27*: 251-257.
7. Giller, P. S. and B. Malmqvist, (1998). The biology of streams and rivers. Oxford University Press.
8. Gupta S., R.C. Gupta, A. B. Gupta, S. Eskiocak, E. V. S. Prakasa Rao, K. Puttanna, A. (2010). Pathophysiology of Nitrate Toxicity in Human and its Mitigation Measures, In: ING Bulletins on Regional Assessment of Reactive Nitrogen, Bulletin No. 20 (Ed. N. Raghuram), SCON-ING, New Delhi, 1-4and 1-78.
9. Kılıç Z. (2020). *Int. J. Hydro., 4*(5): 239 241.
10. Kumar S., S. Jain and D. V. Singh (2022). *J. Exp. Zool. India, 25*(1): 539-546.
11. Patil P.N., D. V. Sawant and R. N. Deshmukh (2012). *Int. J. Environ. Sci., 3* (3): 1194-1198.
12. Prakasa Rao, E.V.S., K. Puttanna, K. R. Sooryanarayana, A.K. Biswas, J.S. Arunkumar (2017) Assessment of Nitrate Threat to Water Quality in India. pp. 323-333. Editor(s): Yash P. Abrol, Tapan K. Adhya, Viney P. Aneja, Nandula Raghuram, Himanshu Pathak, Umesh Kulshrestha, Chhemendra Sharma, Bijay Singh, The Indian Nitrogen Assessment, Elsevier. https://doi.org/10.1016/B978-0-12-811836-8.00021-5.
13. Ramakrishnaiah, C.R., C. Sadashivaiah and G Ranganna, (2008). *E-Journal of Chemistry*, *6*(2): 523-530.
14. Saksena D.N., R.K.Garg and R. J. Rao (2008). *J. Environ. Biol.,29*(5): 701-10.
15. Sethi V., Y. K. Walia, V. Rana and D. Gautam (2022). *Eco. Env & Cons., 28* (August suppl.Issue), S167-S172.
16. Sharma, S. and H. S. Banyal (2023). *J. Env. Bio-Sci. 37*: 61-67. https://doi.org/10.59467/JEBS.2023.37.61.
17. Sivaranjani S., R. Amitava and S. Singh (2015). *Int. J. Biores. Sci., 2*(2): 85-94.
18. WHO (2011). Guidelines for drinking water quality, World Health Organisation, 3rd edn, vol 1. Recommendations. Geneva, Switzerland, 515.