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Seasonal Variational Impact of the Physical Parameters On Mohand Rao River Flowing In the Doon Valley

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Abstract: *The paper depicts the seasonal variational impact on water quality of Doon Valley . Study was proposed to analyze the various water sample of Mohand-Rao river flowing in the Mohand Anticline in the lower parts of Shiwalik hills in Doon Valley for physico-chemical characteristics of water quality parameters such as pH; Temperature; Conductivity; Hardness; Alkalinity; Total Solids; Total Dissolved Solids; Total Suspended Solids..To analyze the physical, chemical, and toxicological parameters of Streams and rivers.*

Keywords: *Anticline, physico-chemical, conductivity, solids, toxicological.*

I. Introduction

The importance of understanding the relationship between man and environment has never been so great as it is realized at present . Industrial and technological advancement being made throughout the world are undoubtedly contributing towards our property but creating problems of depletion of environmental resources and increasing pollution . Therefore, the need for conservations of resources

and environmental protection which are so intimately connected with our survival and sustainable development is being globally recognized. Pollution may be defined as any undesirable change in physical, chemical or biological characteristics of air, land or water affecting the life in harmful way. Pollutant get dispersed in air, water and soil. The dispersion and movement of pollutant in the biosphere is a complex process and it also accumulates within organism and causes toxic effects. Comprising over 80% of the earth's surfaces water is undoubtedly the most precious natural resources that exist on our planet. It is essential for all form of life on our planet-Earth. Owing to increasing industrialization on one hand and exploding population on the other, the demand of water supply have been increasing tremendously. The pollution is objectionable and damaging for varied reasons of primary importance and is possible hazard to the public health. In many countries, legislation mandates assessment of the water chemistry, biota, and physical environment of rivers, many of which have been highly impacted by human activities. Aquatic bodies can be fully assessed by three major components, hydrology, physico-chemical, and biology. A complete assessment of water quality is based on appropriate monitoring of these components. Aquatic quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water in relation to natural quality, human effects and intended uses, particularly which may affect human health and health of the aquatic ecosystem. In recent years non-point sources of pollution are being recognized as a major source of pollution to surface water.

II. Description Of The Study Area

Geology of Area

Dun; Doon: Dhoon in the Sanskrit and Hindi languages means a "Valley" which has not been made by river soil erosion, but is formed by tectonic activity within the earth that causes movements of its crusts, as earthquakes, folds, faults or the like.

The Oxford Dictionary defined it as – "Valley in Shiwalik Hills". There are number of valleys large and small between the Sub-Himalayas and the Shiwalik Hills. "Valley of Doon" is on the North-West part of the Indian states of Uttar-Pradesh. The Doon Valley is situated between the latitude of 30^0 to 30^0 32' and longitude of $77^0$43' to $78^0$24' It is nearly 75Km long from North-West to South-West.

Region of Dun Valley involves two distinct styles and amplitudes of folding. In the Northern part, the overturned SANTAURGARH - ANTICLINE with both limbs dipping steep to moderate was developed as fault propagated fold over the SANTUARGARH –THRUST (ST).

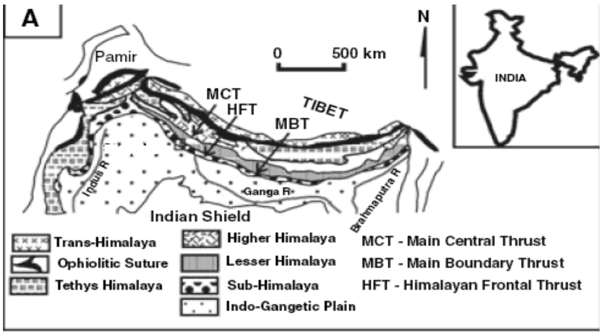


Fig-1 Regional geological map of the Himalaya showing tectonic subdivision

The uplifted hanging wall of the Santuargarh-thrust constituted the dissect Shiwalik and the down faulted footwall formed the pedimented Shiwalik. To the South in the frontal range, the Shiwalik strata were folded into MOHAND – ANTICLINE. MOHAND-ANTICLINE as fault-bend folds over the HIMALAYAN-FRONTAL-THRUST (HFT).

The Garhwal Himalaya geographically forms the central part of the Himalayan tectonic region.

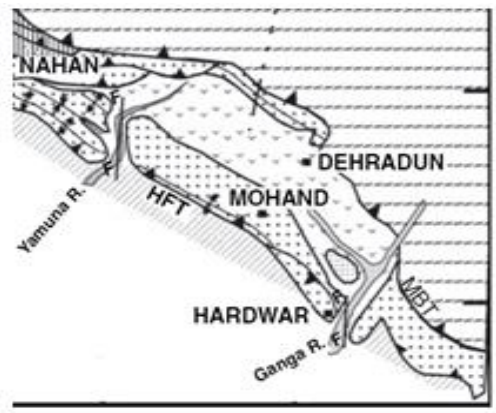


Fig-2 MOHAND ANTICLINE between the two main river of Indo-Gangetic plain along with HIMALAYAN FRONTAL THRUST and the valley of Dehradun

In environment characterized by active tectonic, it is widely accepted that river morphology will be affected by active fault displacement .For example, there is documented evidence of change in channel slope, channel width, channel braiding patterns, grain size distribution trend, and stream power in response to active faults Therefore, river morphology can carry a measurable signature of tectonic activity. Furthermore, it can be hypothesized that fluvial systems are in fact more sensitive to local faulting than raw topographic expression This would mean that young active faults will affect river morphology before they are expressed in the local topography. Therefore, detailed morphological measurements of rivers in tectonic setting could allow for an early detection of faulting which is not yet expressed in the landscape.

The Dehradun region of the Northwest Himalayan foothills is an ideal test case for this hypothesis. In this area, the Ganges and Yamuna rivers flow across an active thrust fault system; this is not yet clearly visible in the landscape. Ganges and Yamuna reaches flowing from the MAIN BOUNDARY THRUST, through the alluvial Dehradun valley and across the suspected active HIMALAYAN FRONTAL THRUST, and 35Km out into the Indo-Gangetic Forel and Hinterland and Foreland (brown indicating lower lying elevation, rising to white then blue representing the highest elevation. The white lines represents drainage networks in the study region, the yellow lines represent the upstream and downstream ends of the river reaches.

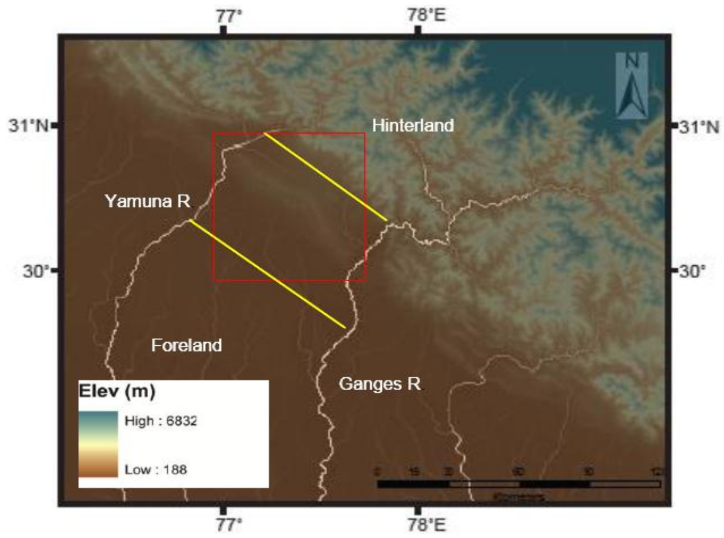


Fig-3 Clipped DEM coverage of Dehradun Basin and Mohand (Red Box), Ganges and Yamuna rivers.

III. Drainage System Of Area

A drainage system is the pattern formed by the streams, river, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. Geomorphologists and hydrologists often view streams as being part of drainage basins. A drainage basin is the topographic region from which a stream receives runoff, through flow and ground water flow. Drainage basins are divided from each other by topographic barriers called watershed. A watershed represents all of the stream tributaries that flow to some location along the stream channel.

The 'Garhwal Himalaya' demarcates more or less Western and Eastern boundaries by the rivers Yamuna and Ramganga. The region is mainly covered by the drainage basin of the 'Holy-Ganga' and its tributaries which have carved out stupendous gorges for most part of their length and thus presented one of the best exposed sections of the Himalaya for study. From Shiwalik many river flows through the district Saharanpur, among these are the river Mohand-Rao (district Saharanpur, Uttar-Pradesh). District Saharanpur is situated in the North of Uttar-Pradesh .In the North of district Saharanpur on the Shiwalik Range, there is district Dehradun, in the south there is district Muzzafarnagar and district Haridwar in the east. Yamuna River lies in the west made boundaries with district Karnal and YamunaNagar means the district lies in doab basin of Ganga and Yamuna.

Fig-4 Dendrites pattern of drainage system of river Mohand-Rao from the origin i.e. Dat-Temple

Mohand Rao River originates from near a temple Dat-Temple it is about 18 km in length and flow from Dat-Temple via Iron – Bridge Mohand Village; Khushalipur; Ganeshpur; Tanda-Man-Singh; Biharigarh and then falls in Solani river near Amanatgarh village which then via khedi-Shikhopur; Hasanpur ; Madanpur; Khubbanpur-choli; Bhagwanpur; Roorkee; Landhora; and then falls in Ganga river near Luxor. The location of

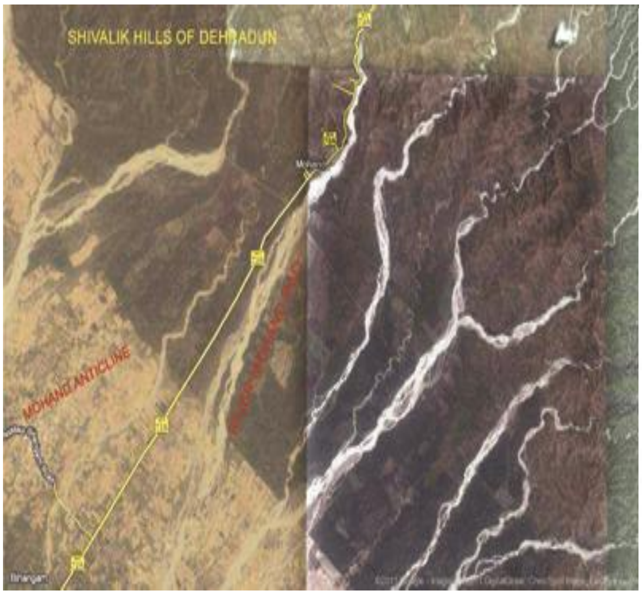
Saharanpur on globe is on latitude $29^0$58’ North and longitude $77^0$33’. The length of the river is 20 km with a width varying between 5 to 100 m. The mean depth of the river is only 0.3 m.

(From the sea-level) =	270.50 meters
Latitude	29^0 58’
Longitude	77^0 33’
Length of river	20 Km
Width of the river	5 to 100 meters
Minimum depth	0.10 meters
Maximum depth	0.50 meters
Mean depth	0.30 meters

Eight samples from each selected centers were taken in three season (summer; winter; Monsoon) 144 samples were the samples of the present studies. On the forest road to Shakumbra Devi about 1Km from forest toll post on the right bank of Mohand Rao river section the main HIMALAYAN FRONTAL THRUST (HFT) is exposed where the middle Shiwalik sandstone is overriding the recent alluvium. The sandstone is steeply about 70^0 dipping due N 21^0 S where as after moving upstream along the Rao for about 500m the dip changes to 35^0 due N 70^0 E forming a fault bend type antiformal structure referred as Mohand antiform. Further the sandstone is continuing with a uniform northerly dip upwards.19Km milestone on Mohand-Dehradun road traversing upstream in the Rao section from this place the boulder conglomerate sequence of upper Shiwalik is encountered that marks the confirmable contact between middle and upper Shiwalik which continue up to Doon valley.

Map of the Study - Area

A



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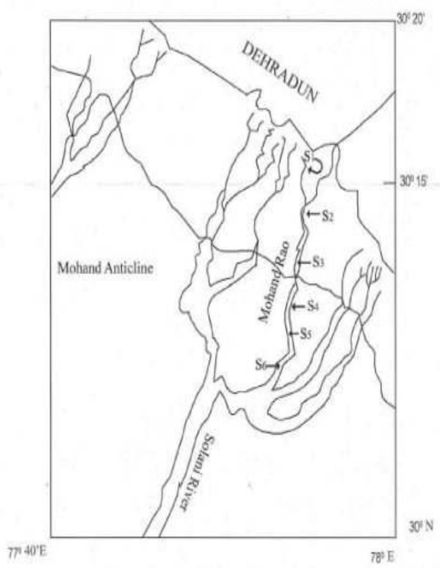


Fig-5 A-Shows the location of flowing of river Mohand-Rao B- Shows the sample stations selected on the river stream Mohand-Rao for the study purpose; S-1,S-2,S-3,S-4,S-5,S-6 are the various sample stations selected for our study on river Mohand-Rao

IV. Methodology

Methodology

Surface water Analysis for Chemical Mass Balance

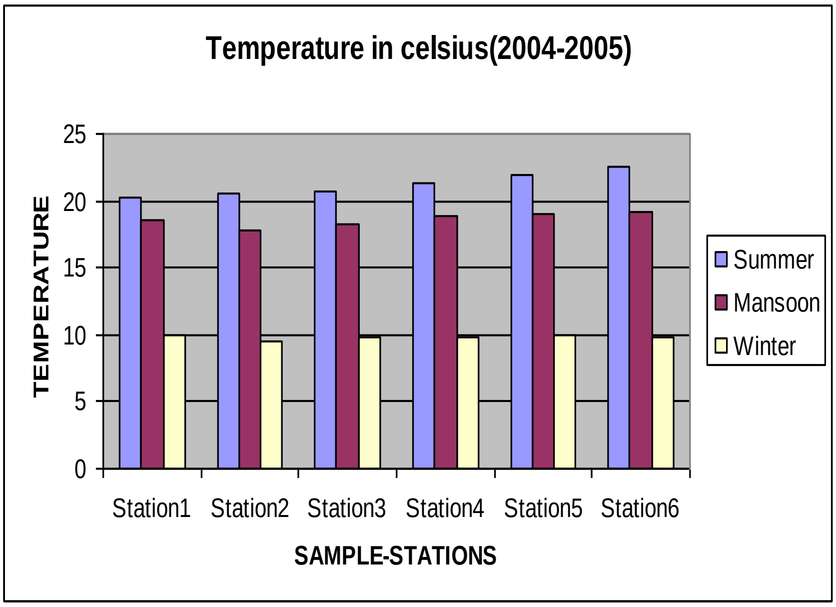
Six surface water samples were collected from selected locations In the present study only major physical parameters were determined by using standard methods.

V. Results

Surface Water Characteristics

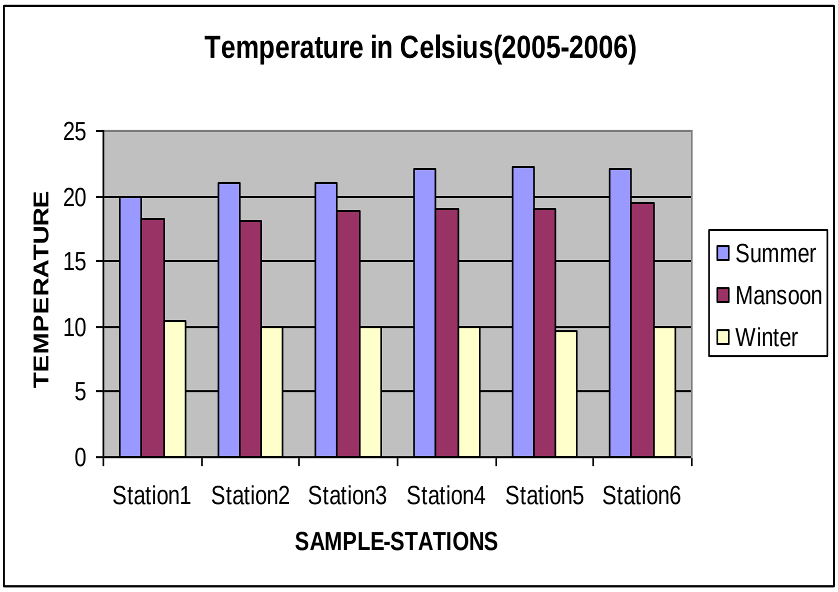
Assessment of water quality today in global terms implies the need for a reference point against which the results of monitoring can be measured and weighted. An attempt is made to define and describe natural water quality to the extent possible and scientifically justifiable. Aquatic ecosystems as a part of the natural environment are balanced both within themselves and other environmental compartments and this equilibrium is subject to natural variations and evolutions as well as variations caused by human interventions. It is the ambition of the present assessment to identify the anthropogenic influences over time against a natural baseline situation.

Temperature of the river Mohand Rao varies according to the three season in the region as in Summer varied maximum while it varied minimum during Winter and is medium in Monsoon thus the temperature of the stream varied with season in the year 2004-2005. Similarly temperature of the stream varied accordingly to station it is maximum at station -6 and minimum at station-1



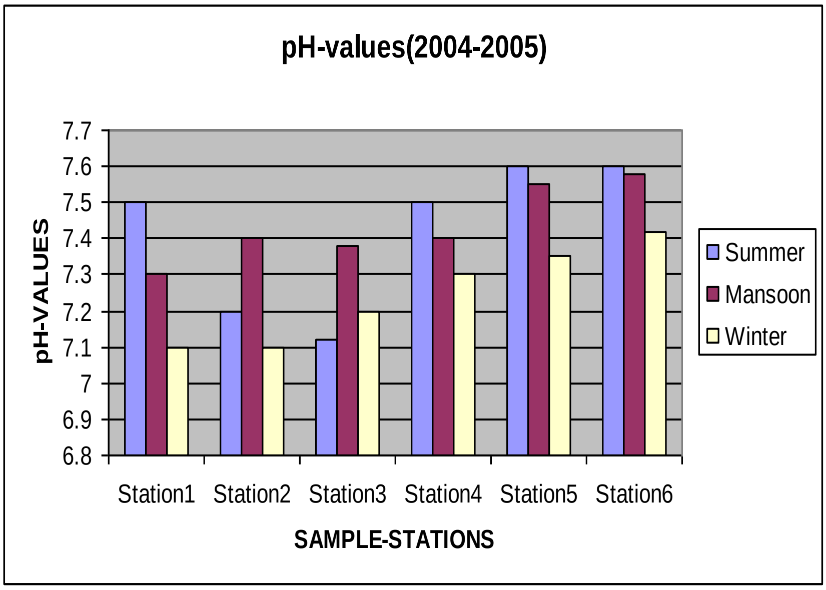
Graph-1: Seasonal variation of Temperature in the year 2004-2005

Same trend of variation in temperature was followed in the year 2005-2006. Temperature of the river Mohand Rao varies according to the three season in the region as in Summer varied maximum while it is varied minimum during Winter and is medium in Monsoon thus the temperature of the stream varied with season in the year 2005-2006. Similarly temperature of the stream varied accordingly to station it is maximum at station -6 and minimum at station-1



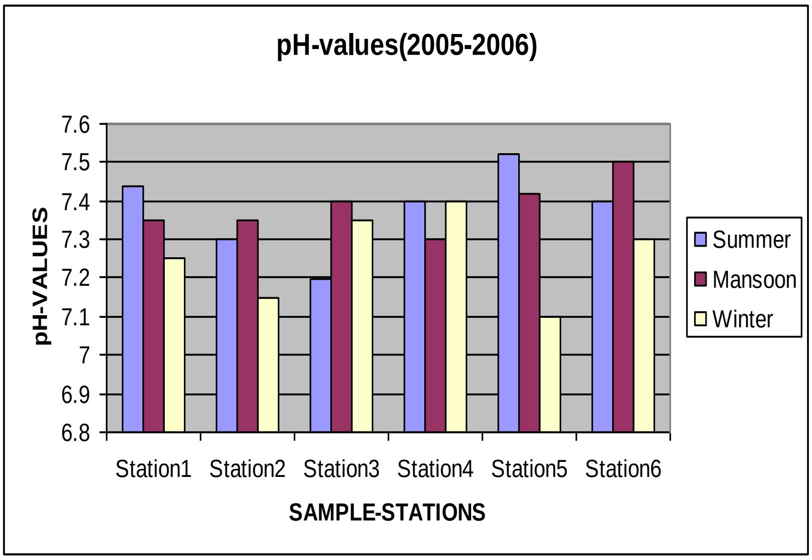
Graph -2: Seasonal variation of Temperature in the year 2005-2006

pH values varied according to the season and station both in 2004-2005. pH value of the stream is maximum at station 6 in summer season and minimium in mansoon although pHvalue is minimium at station 2 & station3 in all the three season .On these two stations the pH value is low in summer & maximum in mansoon . Although at all the six sample stations there is seasonal variation in pH accordingly.



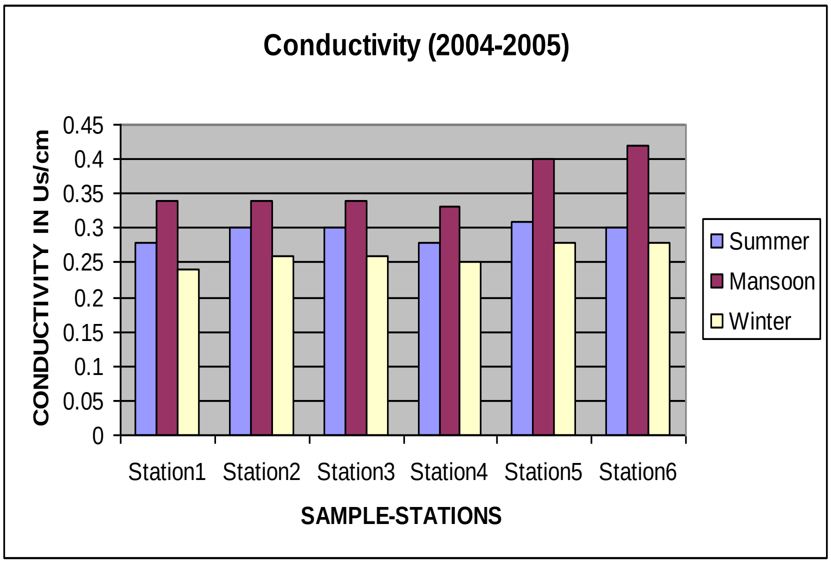
Graph -3: Seasonal variation of pH in the year 2004-2005

In 2005-2006 the value of pH was found to be maximum in the summer at sample station 5 and minimum in winter of the sample station5 . The trend followed by the pH value of the stream gets varied accordingly with the season.



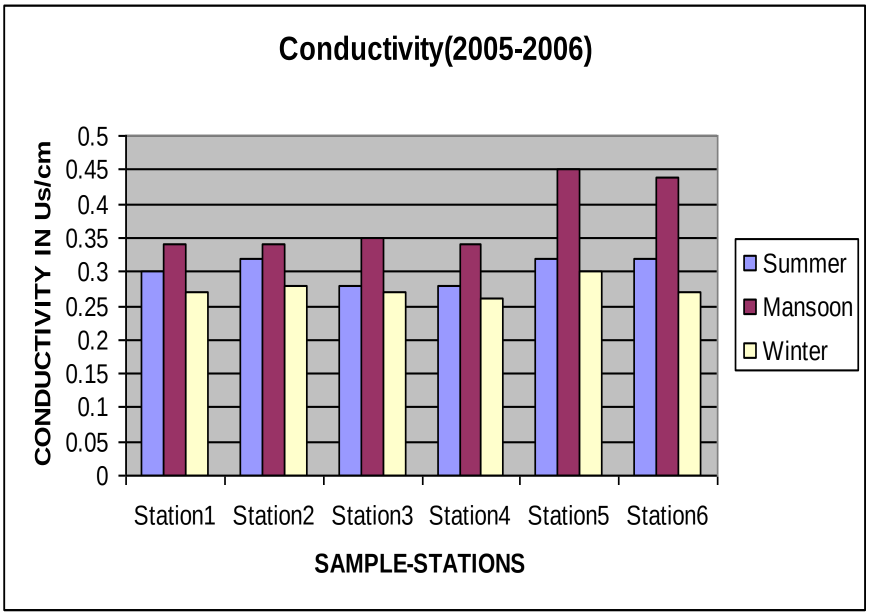
Graph -4: Seasonal variation of pH in the year 2005-2006

In 2004-2005 the conductivity is maximum in monsoon season of sample station-6 although it is minimum in winter season of sample station-1 while in summer season it follows medium trend though the conductivity varies in all the six sample stations accordingly with season.



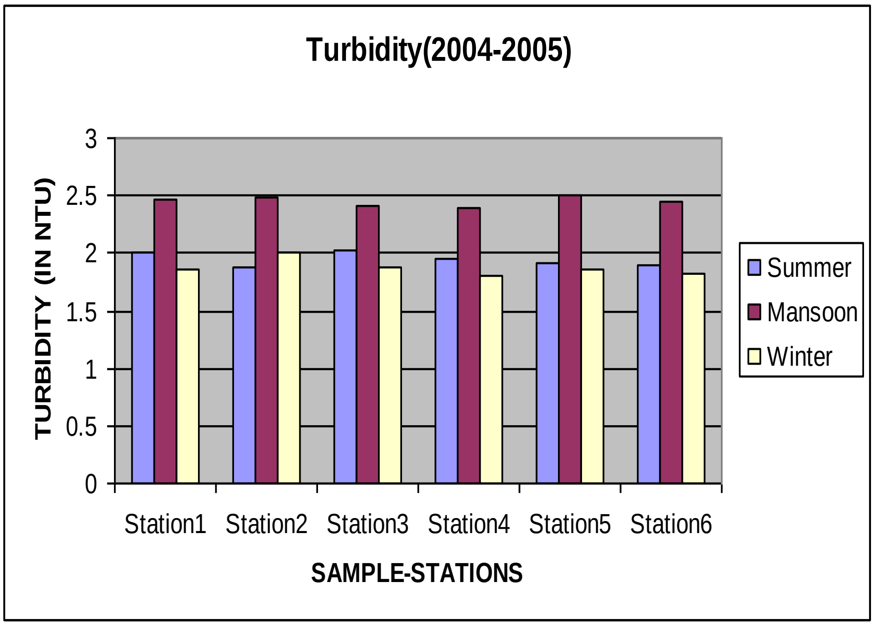
Graph -5: Seasonal variation of conductivity in the year 2004-2005

In 2005-2006 the conductivity is maximum in monsoon season of sample station-5 although it is minimum in winter season of sample station-4 while in summer season it follows medium trend though the conductivity varies in all the six sample stations accordingly with season.



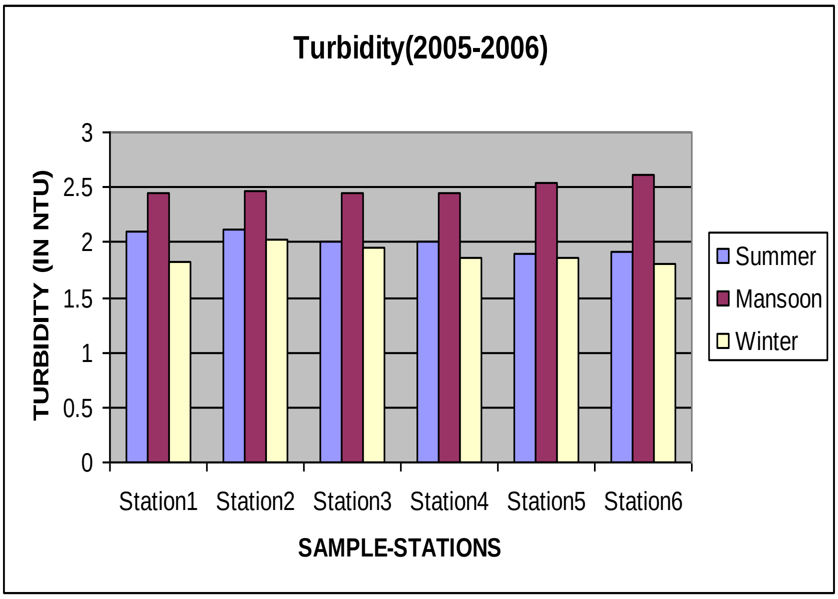
Graph-6:Seasonal variation of conductivity in the year 2005-2006

In 2004-2005 the turbidity value is maximum at sample station-5 of monsoon while it is minimum at sample station-4 in winter season although in summer the turbidity follows median trend. In monsoon the turbidity increases as lots of solids comes into stream along with flow of water coming from the higher mountain.



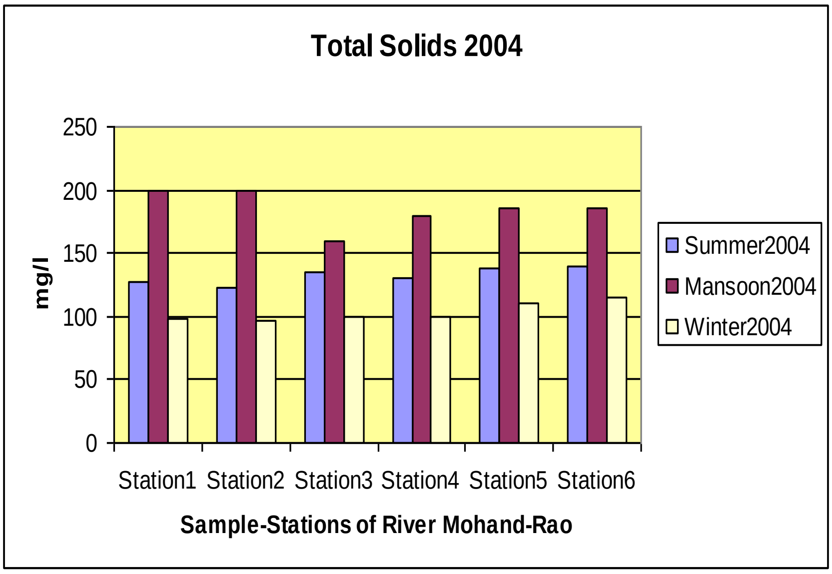
Graph-7:Seasonal variation of turbidity in the year 2004-2005

In 2005-2006 the turbidity value is maximum at sample station-6 of monsoon while it is minimum at sample station-6 in winter season although in summer the turbidity follows median trend. In monsoon the turbidity increases as lots of solids comes into stream along with flow of water coming from the higher mountain.

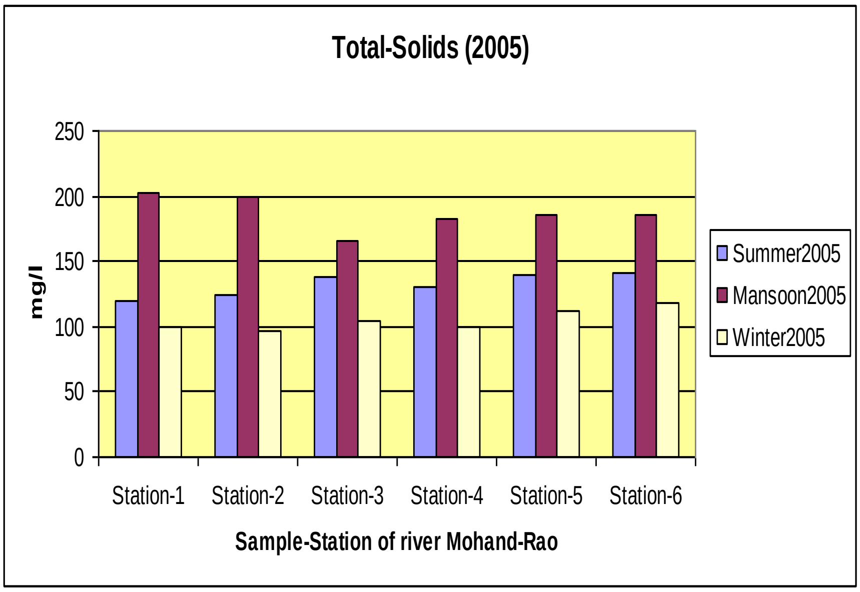


Graph -8: Seasonal variation of turbidity in the year 2005-2006

Water quality analysis results on the distribution of Total-Solids along the stretch of the river , showed an overall increase in the percentage of Total-Solids from year 2004-2005 except station 5 and station 6 during summer season Similar trends was continued in the rainy season without any trend of decrease in any station except station 3 where the solids are gets decreases in rainy seasons , however in winter season Total Solids increases on station 5 and station 6 whereas in the remaining four station a normal trends was observed Figure-9 and Figure-10 shows the variation of Total-Solids along the stretch of the river during the year of 2004-2005

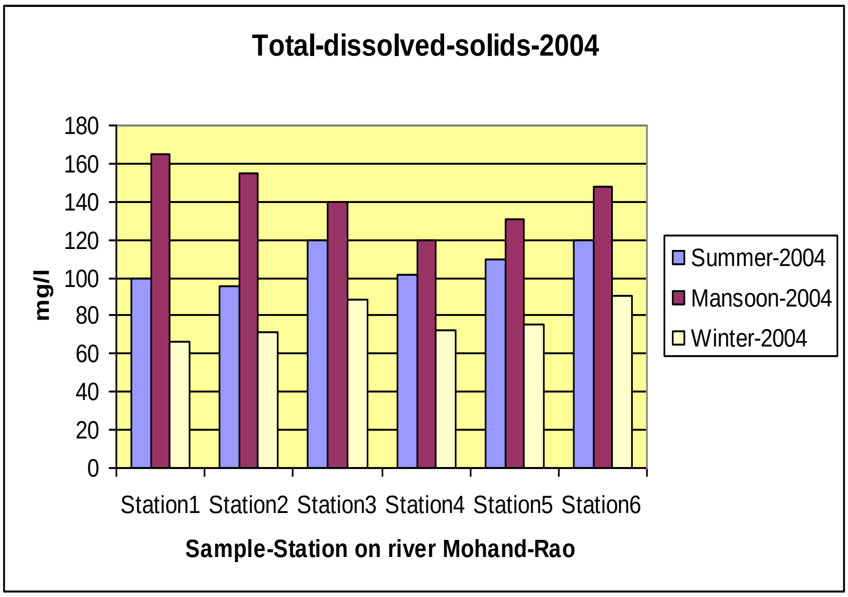


Graph-9 Seasonal Variation of Total-Solids during the year 2004-2005

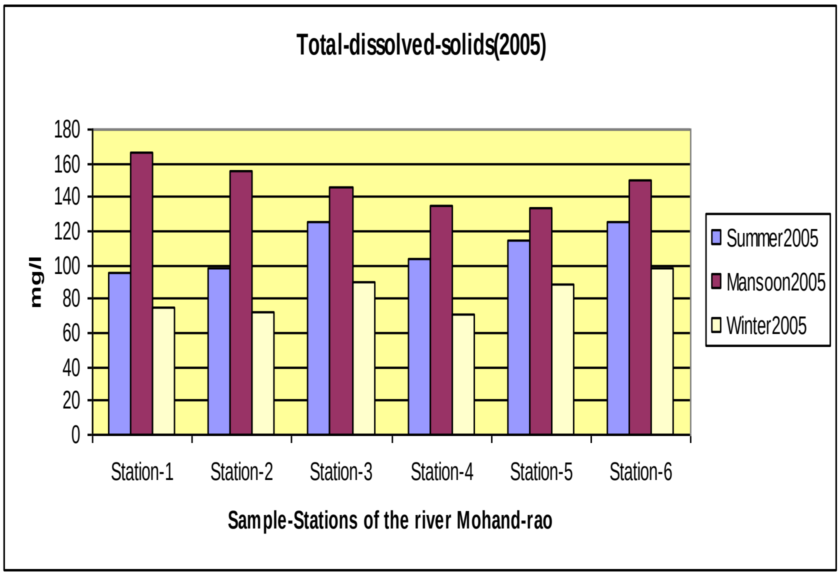


Graph-10 Seasonal Variation of Total-Solids during the year 2005-2006

Total –dissolved –solids are quite prominent in all the sample . The percentage was less during the Summer and winter months . Total dissolved solids showed a considerable increase during the rainy season followed by drastic decline during winter season In summer season Total dissolved solids are lower at station-2 while in rainy season Total dissolved solids are lower at station-4 and winter season this Total dissolved solids are lower at station-1 and station- 2 Figure 11 and Figure 12 shows the distribution of Total-dissolved – solids in different seasons along the stretch of the river.

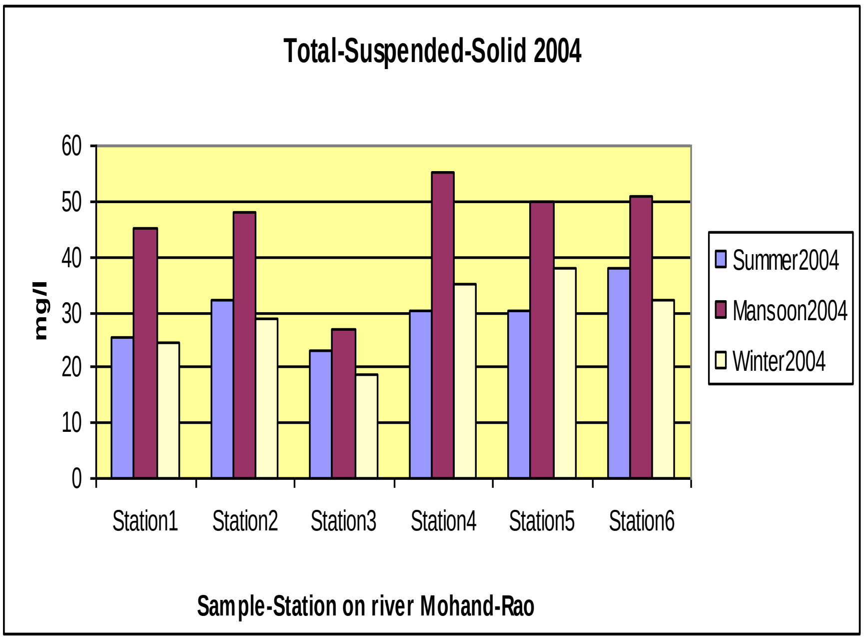


Graph-11 Seasonal variation of Total-Dissolved-Solids during the year 2004 -2005

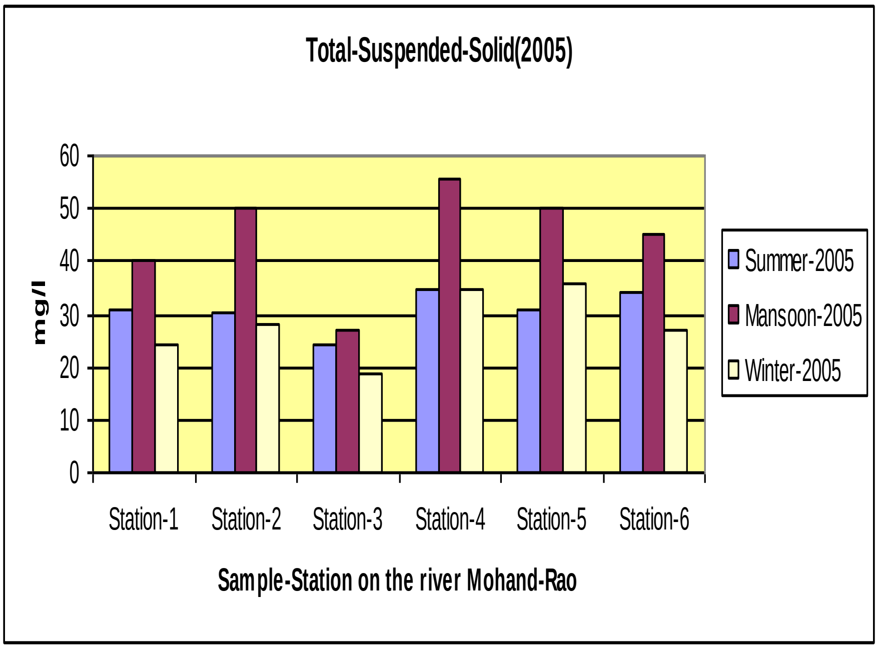


Graph-12 Seasonal variation of Total-Dissolved-Solids during the year 2005-2006

Total Suspended Solids are one of the important physical parameters that studied to understand the water quality conditions of the stream flowing mostly through hilly area ..Here Total-Suspended-Solids are gets varied in the summer season it is maximum on station-6 although it gets varied from station 1 to station 6. In monsoon season it gets maximum as lots of solids flows through stream with pressure from the above hilly places from where the river originated, although it is maximum at station 4 .In winter the solids gets lowered down the maximum quantity of the Total-Suspended-Solids are found to be at station 4 and station 5 Figure 13 and Figure 14 shows the seasonal variations of the Total-Suspended-Solids during the year 2004-2006

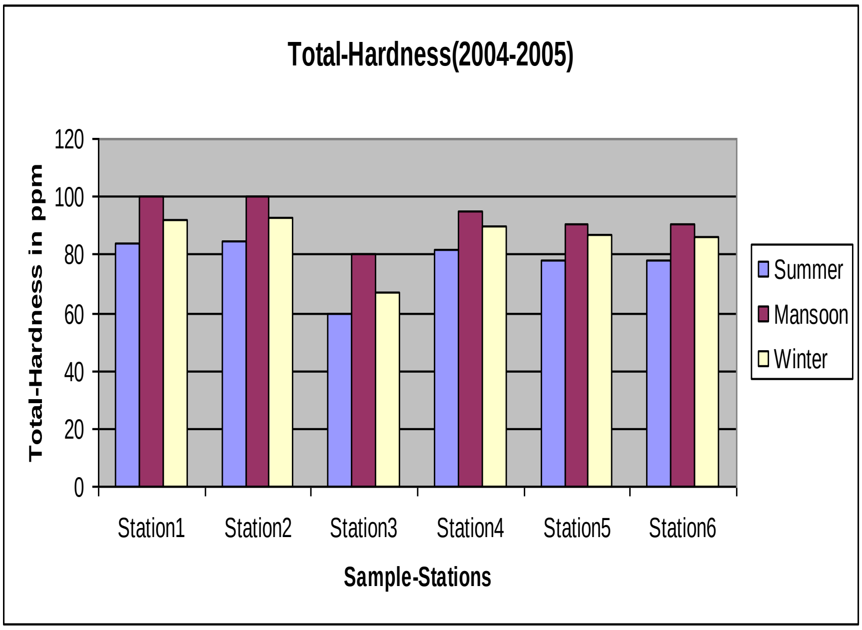


Graph-13 Seasonal variation of Total-Suspended-Solid in the year-2004-2005



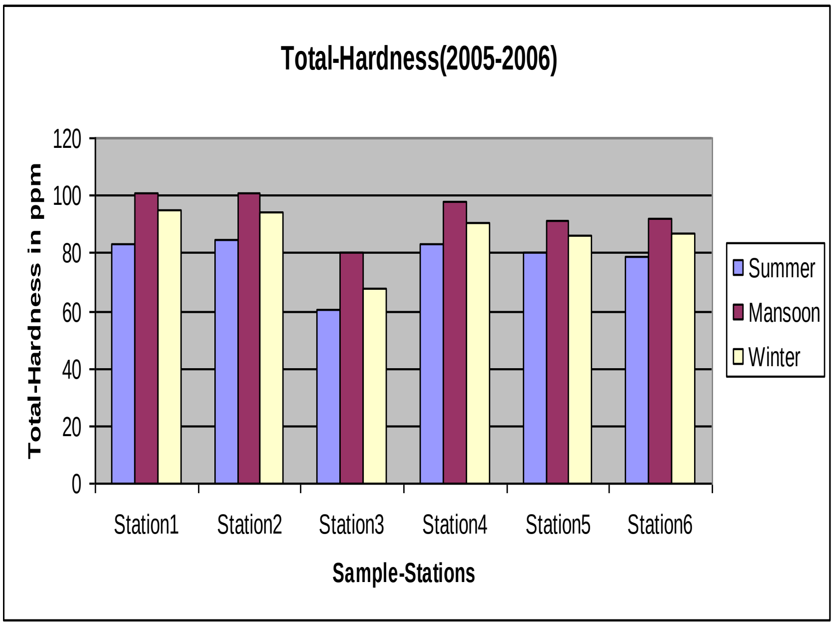
Graph-14 Seasonal variation of Total-Suspended-Solids in the year 2005-2006

Total-hardness of the stream Mohand-rao is maximum in monsoon at station-2 as most of the ions comes into the stream from the upper hills of Himalayas while it is minimum in the summer at station-3 although the Total-Hardness varied in the year 2004-2005 seasonally.



Graph-15 Seasonal variation of Total-Hardness in the year 2004-2005

In the year 2005-2006 the Total-Hardness followed the similar trend as in the previous year means maximum in mansoon at station-2 while minimum in summer at station-3.



Graph-16 Seasonal variation of Total-Hardness in the year 2005-2006

Hardness in water is defined as concentration of multivalent cations. Multivalent cations are cations (positively charged metal complexes) with a charge greater than 1+. They mainly have the charge of +2. These cations include Ca2+ & Mg2+. These ions enter a water supply by leaching from minerals within an aquifer. Common calcium-containing minerals are calcite and gypsum. A common magnesium mineral is dolomite (which also contains calcium). Rainwater and distilled water are soft water, because they contain few ions.

VI. Discussion

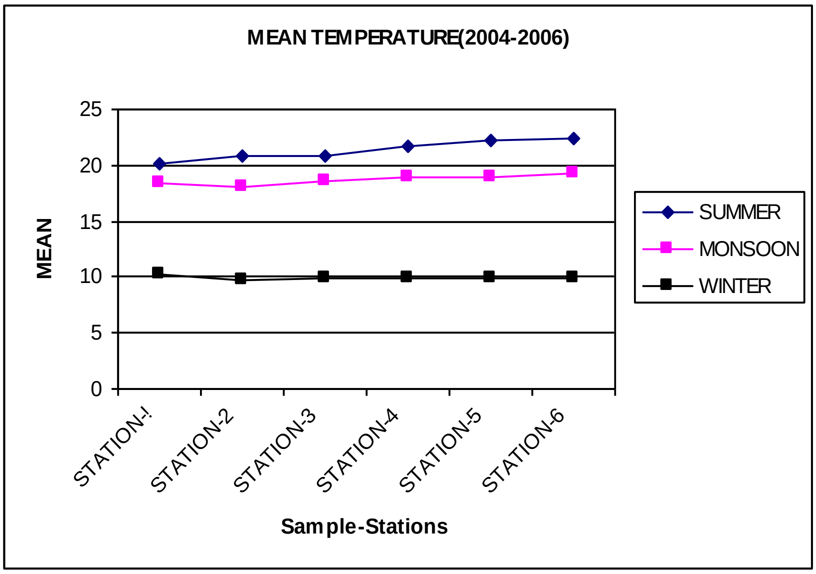
The above result so obtained from the chemico-physical analysis of the water of flowing stream in the hilly areas of Himalayas .These data's so obtained are gets involved to determine the STANDARD DEVIATION (S.D) in statistical data analysis –

$$S.D=\sqrt{n\sum x^2}/n-1-\sqrt{(\sum x)^2}/n-1$$

On this formula of standard deviations the mean and Analysis of variation were calculated ,hence whole data analysis depends upon the above stated formula.

Table-1:-Mean of Temperature in the river at six sample-stations accordingly to season Sample

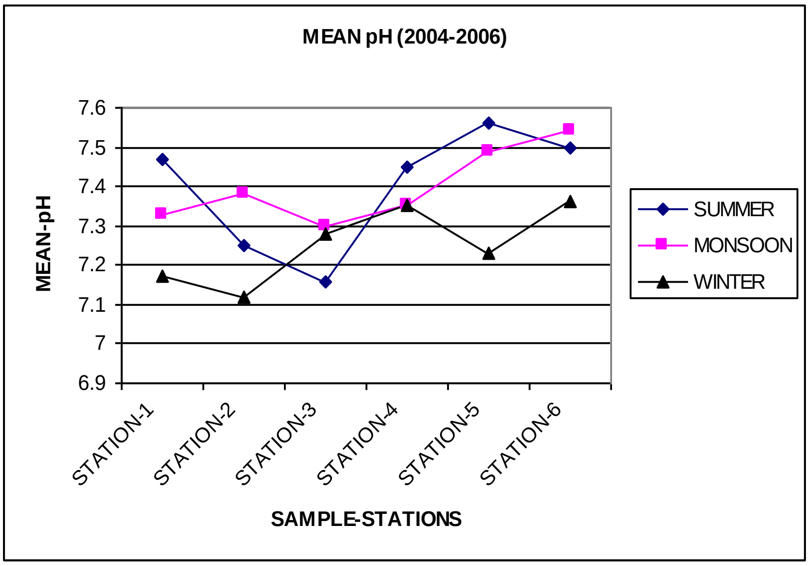
Sample Station	SUMMER		MANSOON		WINTER	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	20.10	0.16	18.35	0.16	10.23	0.24
2.	20.75	0.30	17.99	0.17	9.70	0.23
3.	20.85	0.17	18.54	0.32	9.90	0.13
4.	21.67	0.38	18.93	0.26	9.90	0.15
5.	22.15	0.33	18.99	0.19	9.85	0.31
6.	22.31	0.31	19.32	0.20	9.86	0.14



Graph-17: Mean Temperature at different Sample Station in three different Season in the year – (2004-2006)

Table-2:- Mean pH in the river at six Sample-Stations accordingly to Season Sample

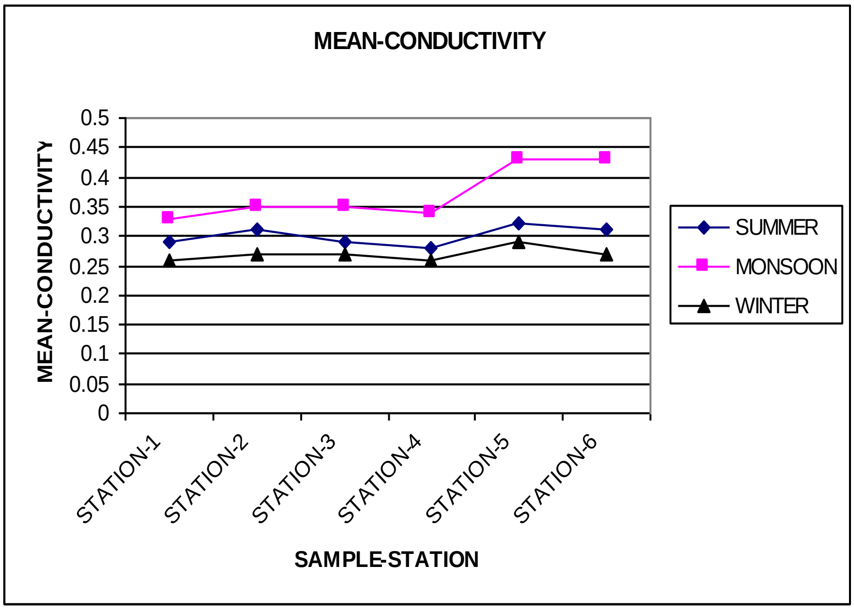
Sample Stations	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	7.47	0.02	7.33	0.07	7.17	0.14
2.	7.25	0.09	7.38	0.11	7.12	0.07
3.	7.16	0.06	7.30	0.02	7.28	0.08
4.	7.45	0.09	7.35	0.06	7.35	0.07
5.	7.56	0.08	7.49	0.11	7.23	0.14
6.	7.50	0.12	7.54	0.05	7.36	0.12



Graph-18: Mean pH at different Sample Station in three different Season in the year – (2004-2006)

Table-3:-Mean Total Conductivity in the river at six Sample-Stations accordingly to Season Sample

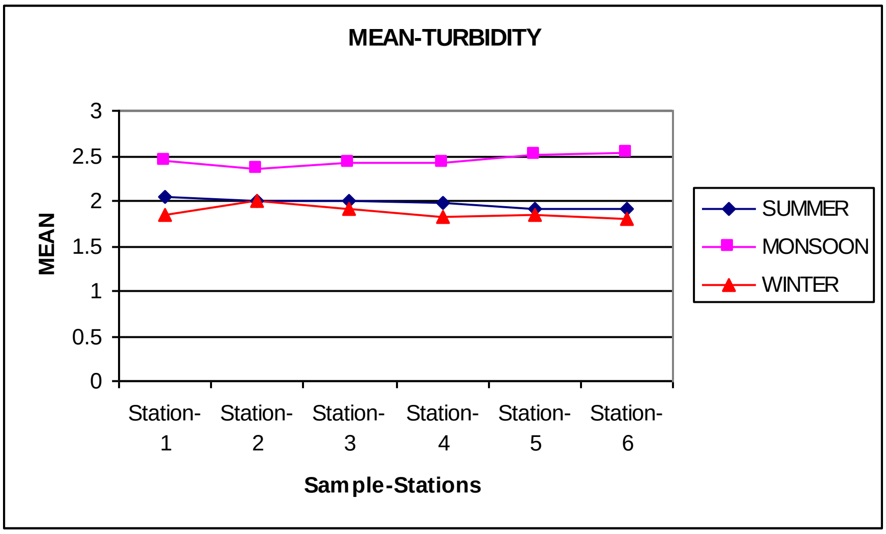
Sample Station	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	0.29	0.01	0.33	0.04	0.26	0.01
2.	0.31	0.01	0.35	0.04	0.27	0.05
3.	0.29	0.01	0.35	0.04	0.27	0.03
4.	0.28	0.02	0.34	0.04	0.26	0.01
5.	0.32	0.03	0.43	0.01	0.29	0.01
6.	0.31	0.02	0.43	0.03	0.27	0.03



Graph-19: Mean Conductivity at different Sample Station in three different Season in the year – (2004-006)

Table-4:-Mean Total Turbidity in the river at six Sample-Stations accordingly to Season Sample

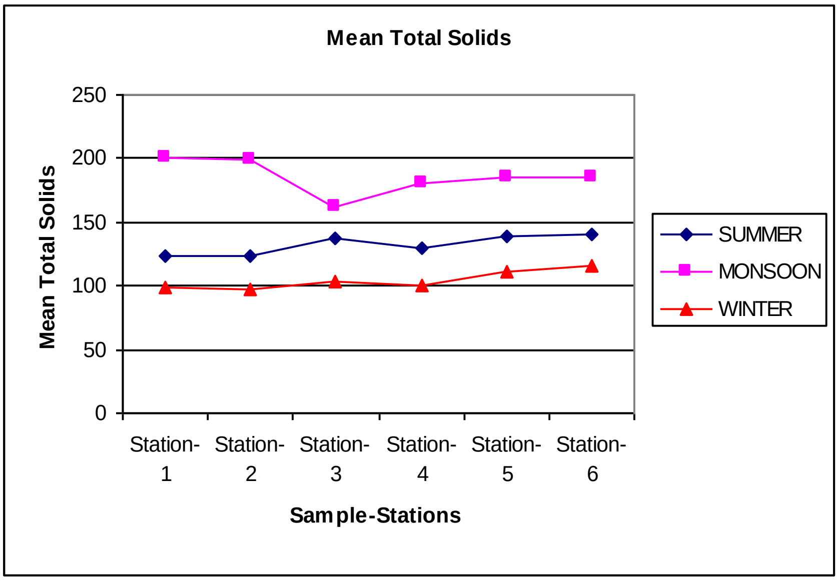
Stations	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	2.05	0.12	2.45	0.01	1.84	0.07
2.	2.00	0.11	2.35	0.34	2.01	0.10
3.	2.01	0.05	2.43	0.01	1.91	0.10
4.	1.98	0.08	2.42	0.07	1.82	0.13
5.	1.91	0.03	2.52	0.03	1.85	0.04
6.	1.91	0.03	2.53	0.08	1.81	0.04



Graph-20: Mean Turbidity at different Sample Station in three different Season in the year – (2004-2006)

Table-5:-Mean Total Solids in the river at six Sample-Stations accordingly to Season Sample

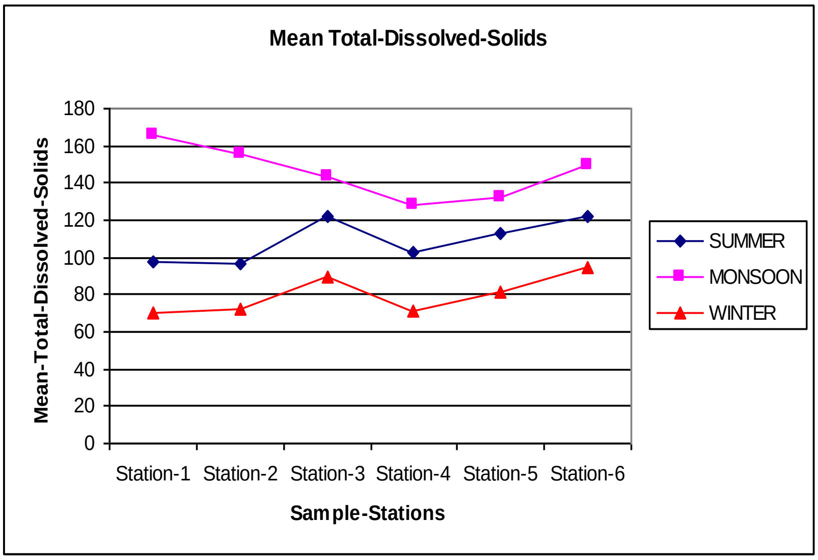
Sample Stations	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	123.28	3.27	201.08	1.10	99.25	0.94
2.	123.50	1.66	199.54	0.83	96.92	0.53
3.	136.75	1.37	162.50	2.60	103.26	3.34
4.	130.25	0.83	181.00	1.22	100.00	0.71
5.	139.00	1.22	185.38	0.99	111.00	1.27
6.	140.50	1.03	185.38	0.56	116.50	1.66



Graph-21: Mean Total-Solids at different Sample Station in three different Season in the year – (2004-2006)

Table-6:- Mean Total Dissolved Solids in the river at six Sample-Station accordingly to Season Sample

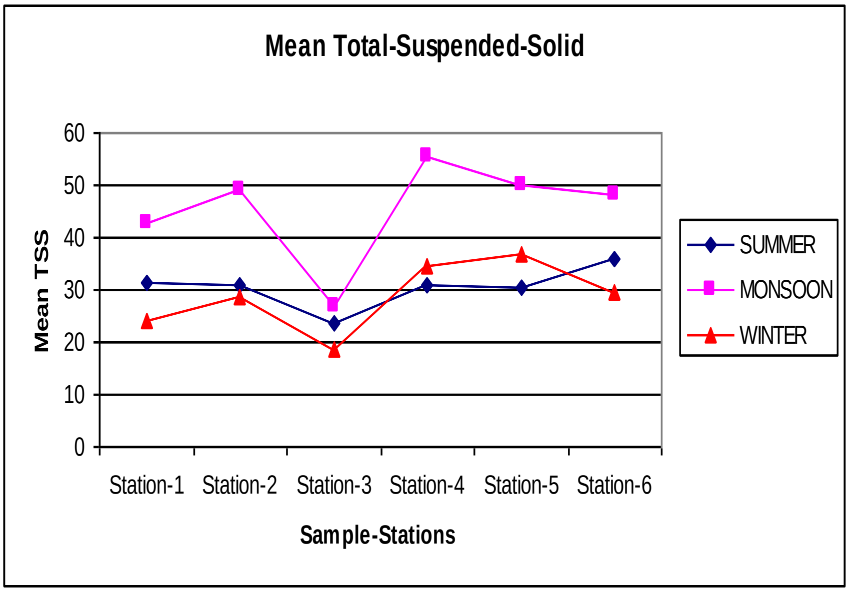
Station	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	97.51	2.51	165.63	0.66	70.52	4.48
2.	96.75	1.39	155.50	0.87	71.75	0.97
3.	122.50	2.60	143.00	3.08	89.00	1.22
4.	102.60	0.79	127.63	7.70	71.50	0.87
5.	112.50	2.66	132.50	1.66	81.50	6.54
6.	122.50	2.62	149.10	1.10	94.50	3.57



Graph -22: Mean Total-Dissolved-Solids at different Sample Station in three different Season in the year – (2004-2006)

Table-7:- Mean Total-Suspended- Solids in the river at six Sample-Station accordingly to Seasons Sample

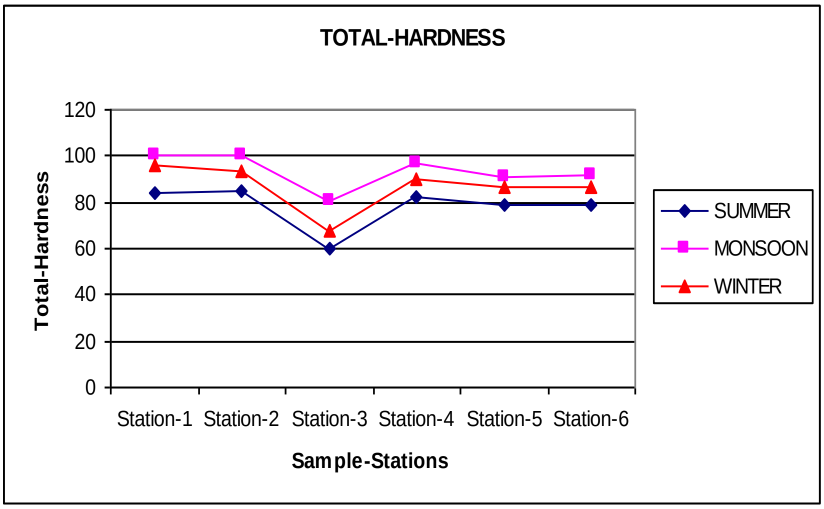
Stations	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	31.50	0.54	42.53	2.49	24.29	0.36
2.	31.11	1.09	49.00	1.22	28.43	0.49
3.	23.55	0.51	26.92	0.19	18.68	0.30
4.	31.00	1.22	55.38	0.86	34.71	0.65
5.	30.50	1.22	50.00	0.71	37.00	1.22
6.	36.00	2.12	48.00	3.08	29.50	2.60



Graph -23: Mean Total-Suspended-Solids at different Sample Station in three different Season in the year – (2004-2006)

Table-7:- Mean Total-Hardness in the river at six Sample-Stations accordingly to Season Sample

Station	Summer		Monsoon		Winter	
	Mean	S.D	Mean	S.D	Mean	S.D
1.	83.80	0.45	100.27	0.57	96.18	2.50
2.	84.64	0.65	100.40	0.46	93.50	0.87
3.	60.26	0.62	80.21	0.57	67.53	0.83
4.	82.52	0.86	96.50	1.66	90.25	0.61
5.	79.10	1.12	90.75	0.68	86.75	0.69
6.	78.50	1.22	91.35	0.89	86.51	0.85



Graph -24: Mean Total-Hardness at different Sample Station in three different Season in the year – (2004-2006)

VII. Conclusions

(1) Water quality analysis of alkali and alkaline earth metals show that water of the studied river is very good for drinking purpose

(2) Study also revealed that there is an increase in measured parameters from year 2004 and 2005 which may need a long term monitoring station for further conclusion.

(3) A clearcut impact of manmade disturbance is evident in certain stations which showed a declining trend of water quality.

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