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Impact Assessment of Total-Solid, Total-Dissolved-Solid, Total-Suspended-Solid of Water of River Mohand-Rao Flowing in the Doon Valley in Lower Hills of Himalayas

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ABSTRACT *The paper depicts the seasonal variation impact on water quality of Doon-Valley .The study was proposed to analyze various water sample of Mohand-Rao river flowing in the Mohand-Anticline in the lower parts of the Shiwalik hills of Doon Valley . The Total-Solids , Total-Dissolved-Solids , Total Suspended-Solids in the water of river Mohand-rao are analyzed in three different season of the area (i.e Summer, Monsoon,Winter.) .In Doon Valley , the industrial effluents are very low as there are no harmful industries around the study area .The main purpose of analyzing the water of stream Mohand-Rao is to determine the pollution status, as water-quality is a reflection of catchments characteristics such as topography, geology, soil and vegetation .Direct impact include changes in flow regime and habitat type , loss of riparian vegetation , causing major effects on riparian and in – stream habitat and processes , increase in sediment transport from the catchments leading to change in water quality.Therefore, water-quality monitoring is the basic need for the people who rely on river water for their day to usages. In this context, a stretch of 15Km from Dat-Temple to Ganeshpur of the Mohand-Rao river was studied during the year 2004-2005.*

KEYWORDS: TotalSolids, TotaldissolvedSolids, TotalSuspendedsolids, Anticline, Valley, water-quality

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 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 biological. 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.

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 Doon 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).

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.

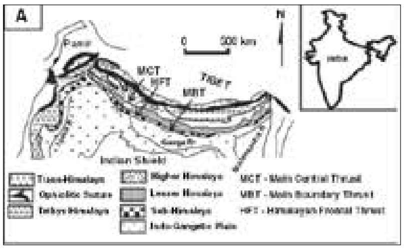

Fig-1 Regional geological map of the Himalaya showing tectonic subdivision

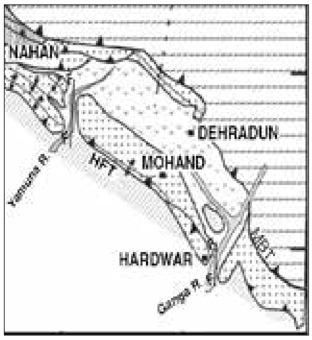

Fig-2 MOHAND ANTICLINE between the two main river of Indo-Gangetic plain along with HIMALAYAN FRONTAL THRUST and the valley of Dehradun

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 Foreland

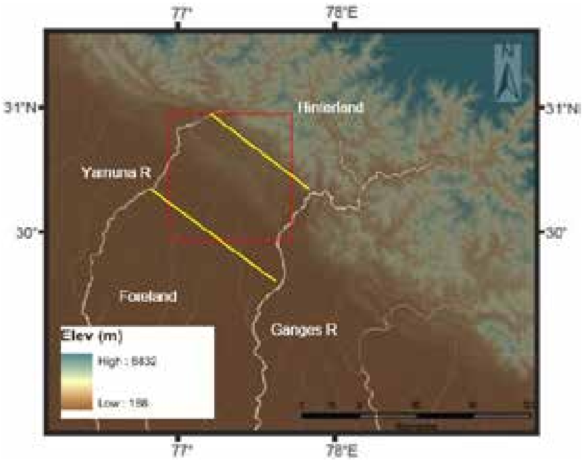

Fig-3 Clipped DEM coverage of Dehradun Basin and Mohand (Red Box), Ganges and Yamuna rivers. Hinterland and Foreland (brown indicating lower lying elevation, rising to white then blue representing the highest elevation. The white lines represents drainage networks in the study region, the yellow lines represent the upstream and downstream ends of the river reaches.

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, throughflow 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.

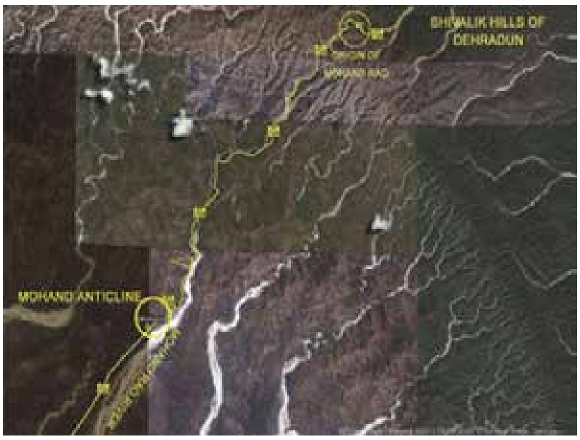

Fig-5 Flowing of the river Mohand-Rao from the Origin i.e Shiwalik hills of Dehradun

Into the MOHAND-ANTICLINE 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 50^0m 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 **B**

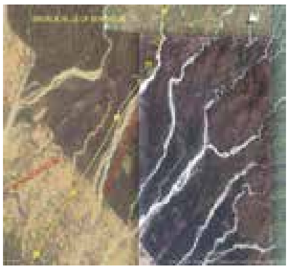

Fig-6 A-Shows the location of flowing of river Mohand-Rao B- Shows the sample stations selected on the river stream Mohand-Rao for the study purpose; S-1,S-2,S-3,S-4,S-5,S-6 are the various sample stations selected for our study on river Mohand-Rao

METHODOLOGY
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 justified. Aquatic ecosystem as a part of the natural environment is balanced both within themselves and other environmental compartments and this equilibrium is subject to natural variations and evolutions as well as variation caused by human interventions.

It is the ambition of the present assessment to identify the anthropogenic influence over time against a natural baseline situation.

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 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-7 and Figure-8 shows the variation of total-solids along the stretch of the river during the year of 2004-2005

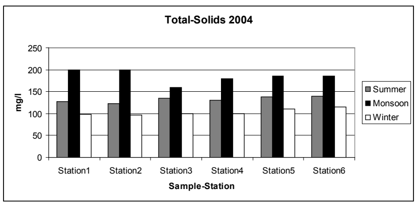

Figure-7 Seasonal Variation of total-solids during the year 2004

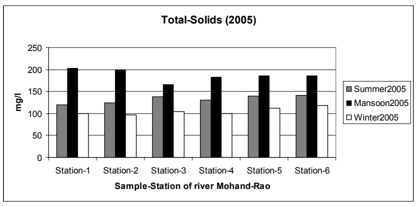

Figure-8 Seasonal Variation of total-solids during the year 2005

Total –dissolved –solids are quite prominent in all the samples. 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 were lower at station 2 while in rainy season Total dissolved solids were lower at station 4 and winter season this Total dissolved solids were lower at station 1 and station 2.

Figure 9 and Figure 10 shows the distribution of Total-dissolved – solids in different seasons along the stretch of the river

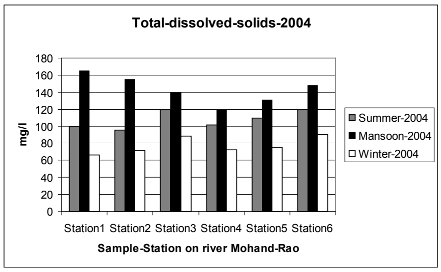

Figure-9 Seasonal variation of total-dissolved-solids during the year 2004

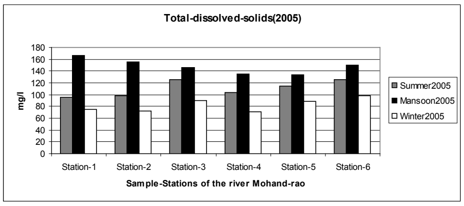

Figure-10 Seasonal variation of total-dissolved-solids during the year 2005

Total Suspended Solids are one of the important physical parameters that is studied to understand the water quality conditions of the stream flowing mostly through hilly area. Here Total-Suspended-Solids 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 the year 2004-2005 In winter the solids gets lowered down the maximum quantity of the Total-Suspended-Solids were found to be at station 4 and station 5.

Figure 11 and Figure 12 shows the seasonal variations of the Total-Suspended-Solids during the year 2004-2005

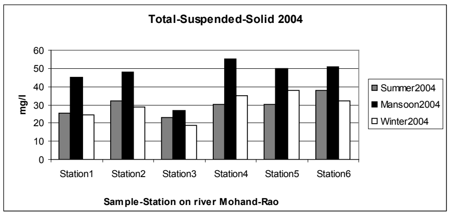

Figure-11 Seasonal variations of total-suspended-solid in the year-2004

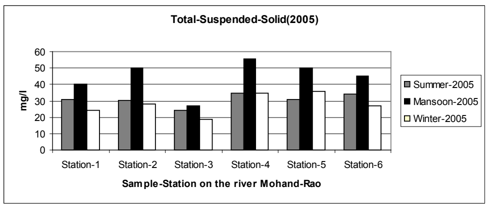

Figure-12 Seasonal variations of total-suspended-solids in the year 2005

During the monsoon all form of Solids ares maximum as they flows into the streams from the above hills. The reason in this case is obvious i.e. during the rainy season the rain water carries lot of sediment along with various kinds of pollutants from the catchment areas and enter the river water due to overland flow. The process of overland flow is the main cause of non-point source of pollution in all river basin.

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 –

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

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

A-Mean of the total solids in the river water at six station accordingly to seasons:

TABLE-1

SAMPLE	SUMMER	MANSOON	WINTER
	Mean SD	Mean SD	Mean SD
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	100.0 0.71
5.	139.00 1.22	185.38 0.99	111.0 1.27
6.	140.50 1.03	185.38 0.56	116.50 1.66
TOTAL=	132.21 7.23	185.8112.91	104.49 7.19

ANOVA- Analysis of variation

SOURCES	df	S.S	M.S.S	F	P
Between Seasons	2	164085.5697	82042.78485	1107.960	<0.001
Between Stations	5	2919.592	583.9184	7.886	<0.05
ERROR	136	10070.5973	74.0485		
TOTAL	143	177075.759			

df→ degree of freedom **F→ Test of Significance**
S.S→ Sum of Square **M.S.S→Mean Sum of Square**
P→ Probability **SD→ Standard deviations**

Mean of the total solids during summer observed to be 132.21 which was maximum at 140.50 at station -5 and minimum at 123.28 at station-1 .Similarly in monsoon total solids is observed to be 185.81 which was maximum at 201.08 at station-1and minimum at 162.50 at station-3 .Now during winter total solids is observed to be 104.49 which was maximum at 116.50 at station -6 and minimum at station-2 at 96.92

ANOVA- Analysis of above data reveals that the significant differences regarding mean of total solids was observed between the season as well as station(=<0.001)

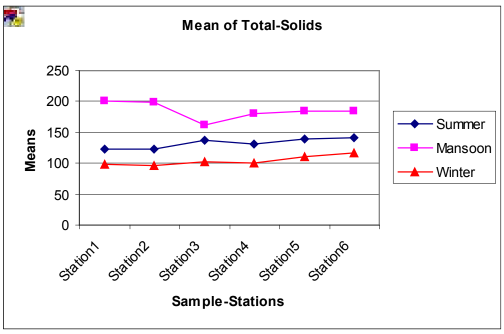

Figure-13: Means of the total-solids of six different sample-stations of River Mohand-Rao

B-Mean of the total- dissolved-solids in the river water at six station accordingly to seasons:

TABLE-2

SAMPLE	SUMMER	MANSOON	WINTER
	Mean SD	Mean SD	Mean SD
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
TOTAL	109.06 11.03	145.56 13.46	79.80 10.02

ANOVA- Analysis of Variation

Source	df	S.S	M.S.S	F	P
Between Season	2	104214.1533	52107.0766	576.8109	<0.001
Between Stations	5	7060.4791	1412.0958	15.6315	<0.001
ERROR	136	12285.7576	90.3365		
TOTAL	143	123560.39			

df→ degree of freedom **F→ Test of Significance**
S.S→ Sum of Square **M.S.S→Mean Sum of Square**
P→ Probability **SD→ Standard deviations**

Mean of the total dissolved solids during summer observed to be 109.06 which was maximum at 122.50 at station -3& station-6 and minimum at 96.75 at station-2 .Similarly in monsoon total dissolved solids is observed to be 145.56 which was maximum at 165.63 at station-1and minimum at 127.63 at station-4 .Now during winter total dissolved solids is observed to be 79.80 which was maximum at 94.50 at station -6 and minimum at station-1 at 70.52

ANOVA- Analysis of above data reveals that the significant differences regarding mean of Total-Dissolved-Solids was observed between the season as well as station (=<0.001)

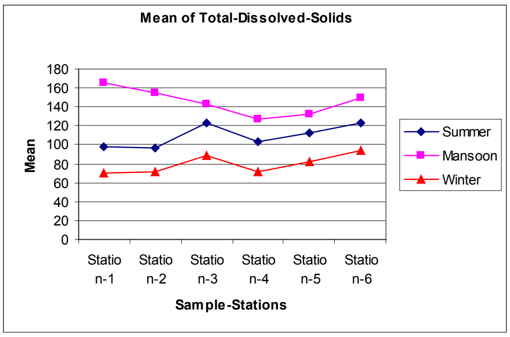

Figure-14: Mean of total-dissolved-solids of water of river Mohand-Rao

C-Mean of the total-suspended- solids in the river water at six station accordingly to seasons:

TABLE-3

SAMPLE	SUMMER	MANSOON	WINTER
	Mean SD	Mean SD	Mean SD
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
TOTAL	30.61 3.86	45.30 9.21	28.77 6.25

ANOVA- Analysis of Variation

Source	df	S.S	M.S.S	F	P
Between Season	2	7883.0721	3941.5361	299.791	<0.0001
Between Station	5	4872.1349	974.42698	74.114	<0.001
ERROR	136	1788.0716	13.1476		
TOTAL	143	14543.2786			

df→ degree of freedom **F→ Test of Significance**
S.S→ Sum of Square **M.S.S→Mean Sum of Square**
P→ Probability **SD→ Standard deviations**

Mean of the total suspended solids during summer observed to be 30.61 which was maximum at 36.00 at station -6 and minimum at23.55

at station-3 .Similarly in monsoon total suspended solids is observed to be 45.30 which was maximum at 55.38 at station-4and minimum at 26.92 at station-3 .Now during winter total suspended solids is observed to be 28.77 which was maximum at 37.00 at station -5 and minimum at station-3 at 18.68

ANOVA- Analysis of above data reveals that the significant differences regarding mean of total-suspended-solids was observed between the season (=<0.0001) as well as station (=<0.001)

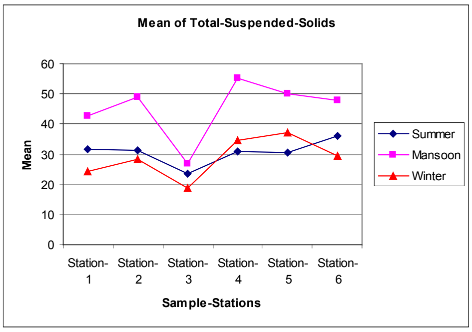

Figure-15: Mean of total-suspended-solids of water of river Mohand-Rao

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