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Comparative Study of springs of Almora and Model Generated Values for Selected Stations of Spring Fed River Kosi in Uttarakhand with Reference to Nitrate

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Abstract- The current study is to comparative study the nitrate contamination of springs of Almora and the spring fed river at the selected stations of the stretch. The contaminations levels of Almora springs are ranged between 30mg/l-48mg/l which is above the permissible limit as suggested by BIS is 40-45mg/l whereas the contamination levels of the nitrate in the spring fed river Kosi ranged from 2mg/l-15mg/l. The current study focuses on the dilution of the springs and its contamination after these springs feed the river Kosi. The current study incorporates the nitrate contamination of the springs selected for study and the nitrate contaminations of the selected stations of the river Kosi.The statistical model WASP generated values of nitrate contamination for the river Kosi compares the simulated and observed values and signifies probable contamination level of nitrate in near future of the river.

Keywords- Nitrate, Springs, Contamination, Dilution, Model WASP.

I. INTRODUCTION

Water is needed for the survival of life on this earth and is an vital factor in every sphere of human activity. Man is the main user of water and consumes that for agriculture as well as industry besides using it for drinking and other domestic purposes. This consistent and unplanned use of the resource leaves it polluted and this when enters the open water bodies contaminates them unprescedently. The quality of water is now is matter of major concern for experts all over the world.

The research work emphasises on the springs of Himalayan region and its water quality. The springs of Himalayas were considered to be most untouched source of water from contamination and pollution but with the growing population and urbanisation it remains a matter of concern for this fragile region The springs in mountainous region are either perched or unconfined aquifers where the water flows under gravity hence the discharge is widely affected by rainfall patterns or variability.

The research here is concerned with the comparative study of springs of Almora with the spring fed river Kosi with reference to nitrate. The springs and seeps are the sole source of water in Kumaon region of Indian Himalayas region. People depend on these springs for their domestic uses and about 50 percent of people in Kumaon Himalayas depend on these springs for their daily water requirements. When the matter of Almora, the town depends solely on either these springs or spring fed river Kosi for their daily water requirements.

II. STUDY AREA

The study area is district Almora for studying the springs and river Kosi that has its origin in Kausani of Almora district and flows all over till Ramnagar and merges there into Ramganga. The entire study area is fragile region of Himalayan region. The springs are the only source of water in the region. These springs feed the river Kosi hence the quality of the springs matter for the survival of the population in the area. The springs of Almora can be broadly classified as conventional type open pit type (naula) with slate roofing and as closed tanks with pipe outlet (dhara). The dhara water is protected from external surface contamination, is mainly used for drinking purpos es whereas the naula water is mostly used for other domestic uses such as washing and cleaning. **Meenu Rani Himanshu Joshi et.al (2018)**

Most of the springs of the town are located along the four curved spring lines covering the town with one semi circle each on both the east and west sides of the hill. There is considerable similarity in the locations of the springs on both the sides of hill which indicates possibility of common recharge areas along these drainage lines. Water quality data collected from the selected springs indicate the concentration of nitrates beyond permissible limits of 40 ppm. (fig1) This renders the water unfit for human consumption. It suggests leaching of nitrogen (converted

to nitrates by nitrates by nitrate bacterial action) from domestic wastewater. Similarly the presence of organic matters (reflected in the form of BOD) and coliform bacteria in protected spring waters further indicated groundwater pollution in Almora town. Pooja Rani Sinha, Er.Kireet Kumar (2018)

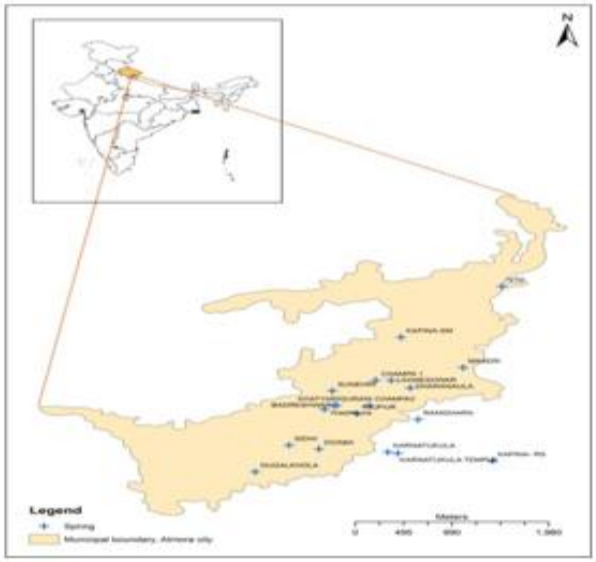

Fig 1. Map of springs of Almora.

III. MATERIALS AND METHODOLOGY

The sampling of the springs of Almora was done by all the precautionary measures suggested by APHA in which water should be allowed to flow into the bottle for sufficient time to displace the contents of the bottle at least three times. Care was taken to ensure that no air bubbles are introduced to the sample while the bottle is being filled, since this could alter the dissolved oxygen concentration.

The sampling container must not be allowed to touch the bottom of the spring catchment since this would cause settled particles to become resuspended and to contaminate the sample. Sometimes, a spring catchment is higher than the surrounding ground and this permits water to be siphoned into the sample bottle. If this is done, water should be allowed to run through the hose for 2 - 3 minutes to rinse it thoroughly before the sample is collected. Siphoned samples are suitable for dissolved oxygen determination provided that the sample bottle is allowed to overflow a volume of at least three times its capacity.

The methodology followed during the study can broadly be divided into three sections i.e. preliminary surveys through field visits, monitoring of springs through sampling and testing for water quality and data analysis. The main aim of the field surveys was to prepare drainage maps and locate springs whereas monitoring of spring water was done for continuous assessment of seasonal variations in its quality. **Ansari M. A., Deodhar, A., Kumar et.al (2015)**

Reasons for occurrence of springs in Almora town is the interbedded impervious rocks like Quartzite and Muscovite Schists within the soil layer. In general it was observed that springs located at lower altitudes (i.e lower boundary of the town) have different chemical characteristics in comparison to the springs located on the ridge of the hill. The water chemistry of springs mainly depends upon the recharge area characteristics, soil and rock composition along the spring lines. **Meenu Rani Himanshu Joshi (2020)**

This research results of a detailed study conducted to monitor changes in spring water chemistry especially nitrate. Cleaning of springs and maintenance of hygienic conditions around these water sources by local people are the most important aspects of any management plan.

This research is expected to provide baseline information to planners and local authorities regarding the water and wastewater in urban catchments of the Himalayan regions. In addition to this the hope is also that this research would generate public awareness regarding the importance of spring water and its quality. Natural water always contains organic and mineral substances in dissolved or suspended form. These substances can enter the natural water from various sources. These sources can be classified in two broad categories i.e natural and manmade.

The important natural sources of these substances are atmospheric precipitation, soils, streams and surface water bodies etc. Water is always used as a medium or a recipient body to take the load of waste generated by the population. This practice is responsible for pollution of natural waters through addition of unwanted chemical and biological substances into it. The springs of Almora is seen to be contaminated with nitrate with 20-45mg/l which is above permissible limit.

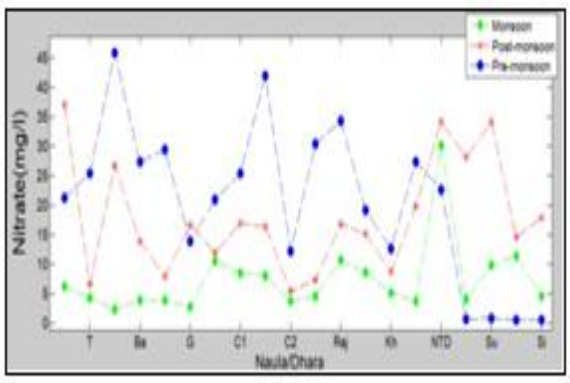

Fig 2. Nitrate contamination for springs of Almora for all the three seasons.

The nitrate vibration in the springs of Almora shows that the contamination of most of the springs that are in the midst of the dense population shows rather higher concentration of nitrate. The nitrate that is present in urban water bodies that is due to putrefaction of proteins which enter the water bodies with waste water. Along with this the leaching as well as runoff from the agricultural fields is observed to be other reason for nitrate contamination in natural water. **Windolf, J., Thodsen, H., Troldborg (2011)**

The trace of nitrogen of mineral origin in natural water is sporadic whereas if nitrates, nitrites sort of waste is found in the water clearly indicates that water is contaminated and intuited with domestic sewage as well as agricultural waste. But in urban areas like Almora possibilities of agricultural waste disposal are rare. Presence of ammonia in water indicate that sometime has already been passed and the water has purified itself to some extent. The highest oxidized form of nitrogen that would be present in water as well as waste water is nitrate nitrogen.

Nitrate is treated as in important parameter in drinking water due to its fetal effects on infants. An upper limit of 10ppm is fixed for drinking water by WHO considering the public health implication. The minimum value for the springs of Almora was found in Gurani naula of 3.9 mg/l for monsoon season whereas the highest value was detected for Gurani naula in post monsoon season for 45.85 mg/l.

The dharas as Thapalya, Rajpura, NTD, Sunehri, Dugalkhola, and Ranidhara showed maximum concentration of nitrate as 60 mg/l in post monsoon season, 60.1ppm in post monsoon, 16.7 mg/l, 25.35 mg/l in premonsoon, 42 mg/l in premonsoon, 19.15 mg/l in premonsoon, and 17.85 mg/l in post monsoon respectively.(Fig 2)

The naualas Badreshwar, Gurani, Champa1, Champa 2, Doaba, Dharanaula, Makeri, Kapina, Karnatukula, Lameshwar. The maximum concentration of nitrate is 25.35 mg/l in pre monsoon 45.85 mg/l for pre monsoon, 27.3 mg/l and 29.5 mg/l and 21 mg/l pre monsoon 12.25 mg/l in pre monsoon, 30.5 mg/l in pre monsoon, 34.5 mg/l in pre monsoon 112.65 mg/l, 34.2 mg/l in post monsoon, 28.25 mg/l in post monsoon, 14.5 mg/l in post monsoon season.

In spring water of Almora town, abnormally high concentration of nitrate nitrogen was found. Springs located within the lower boundary of townships e.g Rajpura and Thapalya dhara have nitrates as high as 60 mg/l nitrates values decreased in Ranidhara and Paltan bazaar springs located over the ridge.

The most likely source of nitrogen is the domestic sewage which leaches and infilterates through the septic tanks, cesspools or open drains to the groundwater. Seasonal variations indicating changing nature of nitrogen inputs in different seasons of the year. Pooja Rani Sinha,Kireet Kumar VP Uniyal (2019)

IV. WASP MODEL GENERATED VALUES FOR KOSI RIVER

The model WASP is suggested by EPA for simulating the water quality of the region which incorporates various hydrological, meteorological, and water quality parameters to simulate the data.The paper suggests to analyze the nitrate contamination of the springs of the most populated town of the watershed i.e, Almora and the nitrate contamination of the spring fed river Kosi that flows through the region.

The model WASP suggested by EPA was used to see the contamination levels of nitrate in river Kosi in the region. Four major stations were selected for studying the contamination levels of the river from June 2019-December 2019. The stations selected were on the basis of contamination levels studied for three seasons in the entire stretch of the river with 31 sampling points for entire year from June 2018 to June 2019.The nitrate contamination in Kantli station is very less in comparison to Ramnagar where the river merges finally into Ramganga. The nitrate contamination has no source here in the origin of river.

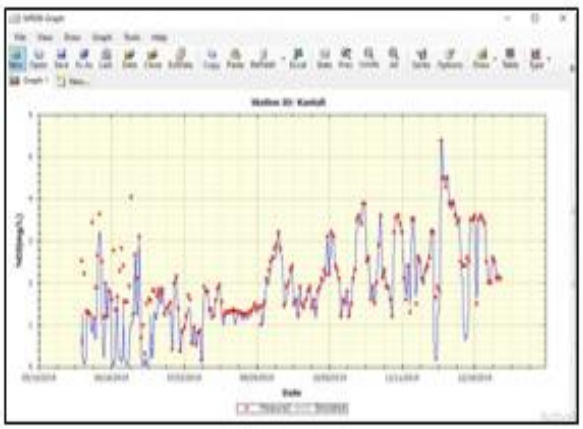

Fig 3. Simualted and observed WASP generated values for station Kantli

Kosi however very minute concentration may be found which might be due to geology and geography in the region (Fig 3.). The nitrate reads here as at maximum 5 mg/l. The permissible limit for nitrate according to EPA is 45 mg/l. The nitrate contamination simulation goes fairly well with the measured values. The concentration of nitrate in the river may be from the spring recharge. The springs of Almora are highly contaminated with nitrate, but since Kantli is the starting point of the river with very scarce population hence the concentration of nitrate is very less.

1. **Nitrate in Kosi Bridge 1-06-2019-31-12-2019:**
Nitrate in Kosi shows variation from that of Kantli. The simulated values range from 0.5 mg/l to 9 mg/l whereas the measured values range from 1 mg/l to 7mg/l. The reason being is the river Kosi after Kantli crosses a few towns as Someshwar which is fairly populated also because Someshwar is a valley region fairly well amount of agricultural as well as population built up is seen in the region. However this could have impacted the quality of water hence we see little increase in the measured values of nitrate. The out layers in nitrate are seen in simulated value for a day or two. (Fig 4)

It is rarely possible to point out the exact sources of nitrate contamination as there are many possibilities for water to have nitrate. The various sources of nitrate may include runoff from the agricultural fields, municipal waste, garbage dumps, septic tanks, animal feed, decaying plant and debris. Nitrate although is not major However this might be a major concern with the increasing population in the stretch.

Geologic formations and direction of ground water flow also may influence nitrate concentration EU i.e Nitrate directives aim to quantify the human effects on nitrogen cycle and methods to promote as well as validate the various methods for sustainable nitrogen management this shows the seriousness of national as well as global effort for the management of nitrate into the region. Concern in the river for the point Kosi since the values range within the permissible limit.

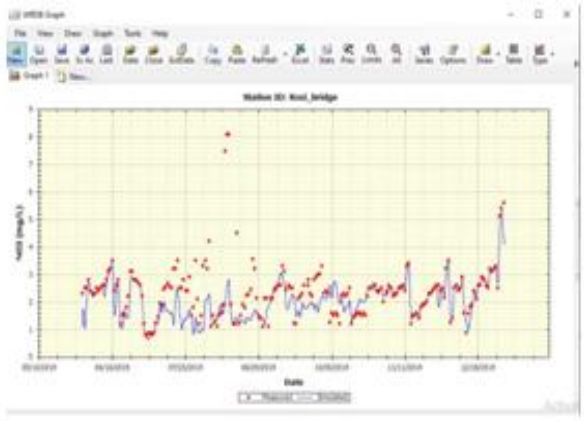

Fig 4. Simulation graph for station Kosi for Nitrate as parameter.

In order to fulfill this EU has identified certain vulnerable areas for establishing the codes of good agricultural practices, national monitoring and reporting indicated by reducing trends in nitrate contamination in the ground water.

Hence effective measures need to be taken in and near Kosi as well since increasing population and open dumps are contaminating the groundwater sources which are above permissible limit in Almora springs. The probable gift for the river Kosi is dilution. The dilution and flow of the river has unable the region to help spare from the devastating effect of nitrate contamination.

2. Nitrate in Kwarab 1-06-2019-31-12-2019:
The fluctuations in the observed values and simulated values were seen because of unpattern and unprecedented rainfall in the region. Thus variations in the meteorological data showed variations in the water quality in the region. The unpredicted rain in winter season resulted in variations in the entire stretch. The outlayers in the simulated and measured graph are depicted because of these variations in hydrometrological data.(Fig 5)

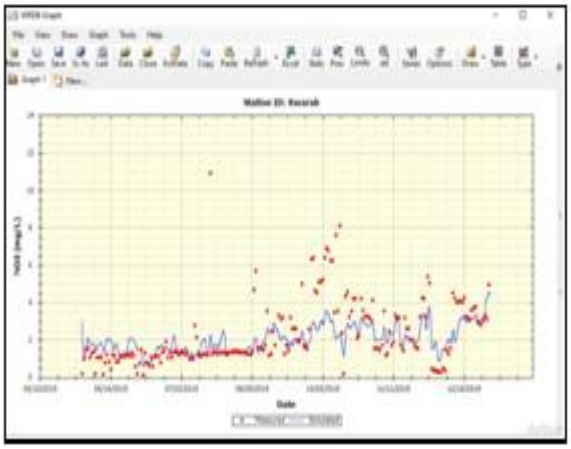

Fig 5 Simulation graph for station Kwarab for Nitrate as parameter.

3. Nitrate of Ramanagar1-06-2019-31-12-2019:
Nitrate is at maximum level at Ramnagar station. The measured values although shows till 15 mg/l the simulated values which is blue graph line shows variation from 3mg/l -6 mg/l. Here the variation is seen in between the simulated as well as observed value. The Ramnagar barrage where the dilution of water is at ma ximum, yet we see the level of nitrate to be at ma ximum range in comparison to any station value. The Ramnagar barrage collects all the water from the river and drains away all the solid waste coming in the region et.al Wagenschein, D. and Rode (2008).

The contamination level has increased due to carrying away of solid waste dumps that is abundant in the region. The increased value signifies that nitrate (NO3) is a compound of nitrogen and oxygen found in nature and in many food items in our diet. As in the concentration of nitrate in the groundwater is generally less but it increases due to various reasons. The main intake of nitrate for individuals is generally from food rather from water.

Vegetables such as spinach, lettuce, beets and carrots contain significant amounts of nitrate. Drinking water normally contributes only a small percentage of our total

nitrate intake. Although low levels of nitrates may occur naturally in water, sometimes higher levels, which are potentially dangerous to infants, are found.

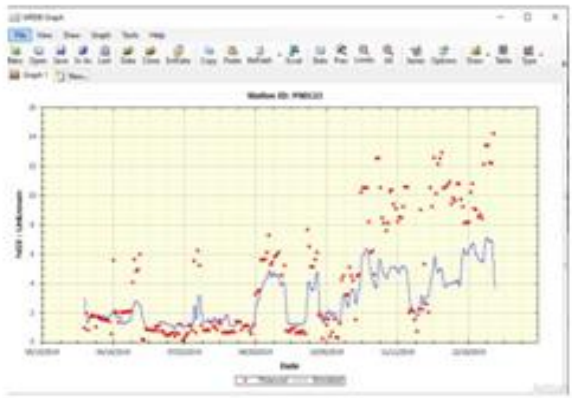

Fig 6. Simulation graph for station Ramnagar for nitrate as parameter.

Illinois has adopted a drinking water standard for nitrate of 10 milligrams per liter (10 mg/L) as N (nitrogen). This standard is mandatory for public water supplies and is used as a guide for private water supplies. The U.S. Environmental Protection Agency also uses 10 mg/L as N as a mandatory national standard for public supplies under the Safe Drinking Water Act. The 10 mg/L standard expressed as nitrogen (N) is equivalent to 45 mg/L e xpressed as nitrate.(Fig 6)

V. CALIBRATION STATISTICS

The calibration statistics of the values of the river Kosi for the selected station was generated with the all required constraints and variables of the model. The statistics was generated by the model according to the daily value samples fed into the model. The more the index number near to the value 1 specifies the values to be more agreeing the values of simulated and measured values hence agreeing more with the values generated with the data.

Table 1. Measured values of WASP model for Kosi river.

Station	Mean	Median	5%	95%
PS120	2.097	2.00	.914	3.694
PS121	2.372	2.450	1.175	3.500
PS122	2.285	1.655	.364	5.852
PS123	4.343	3.485	.435	12.130

Table 2. Observed values for nitrate generated by model WASP.

Station	Mean	Median	5%	95%
PS120	1.878	1.84	.185	3.659
PS121	2.026	2.107	1.002	3.097
PS122	2.042	2.002	1.085	3.026
PS123	2.863	2.728	1.028	6.126

The more the warm up data for the model the more precise would be the prediction of the model generated values. Since the region is remote and fragile very less amount of work is done in the region resulting in scarcity of the warm up data. The simulation obtained is generated for the six months daily sampling for the all the four station which stands out to be a tedious task to be accomplished.

Table 3. Simulated/Measured statistics generated by model WASP.

Measured/ \Simulated values for station	R^2	Mean/abs error	RMS error	Normal RMS error	Index of aggrement
PS120	.71	.260	.602	.277	.90
PS121	.30	.495	.925	.406	.68
PS122	.46	.843	1.353	.578	.65
PS123	.82	1.973	2.924	.675	.75

VI. CONCLUSION

The research states the variability of the concentrations of nitrate in the springs of Almora to the spring fed river Kosi. The concentration of nitrate for most springs of Almora ranged between 20mgl-45mg/l whereas the nitrate contamination for all the four selected stations along the Kosi river stretch was in between 2-15mg/l. The dilution of nitrate contamination could be one probable reason for the decrease in concentration of nitrate of spring fed river Kosi.

The second probable reason could due to unpattern rainfall in the region. The unpatterened rainfall results in scattered rainfall in winters as well as summers including the monsoon season.

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