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Characterization of The Heavy Metal in Municipal and Industrial Waste to Directly Discharge into Upper Stretch of River Ganga from Devoprayag to Haridwar.

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Abstract.

Water is a natural resource to living thing including human and wildlife, food production food security, sustainable devolpment and alleviate the poverty. The river Ganga is a largest river in the world. Himalayas originated the Holy River Ganga and its several tributaries from the Uttarkashi to West- Bangal. The water pollution is the big issue in the world. A systematic study in this paper was carried out to minimize industrial and municipal waste water can substantially reduce Heavy metal(Iron, Manganese, Copper, Nickel, Chromium, Lead, Cadmium, Zinc, etc.) pollution in the River Ganga from Devoparyag to Haridwar. During the month August 2020. The metal can enter the aquatic environment through atmosphere and release from point and non point source. The point of source of metal include municipal sewage sludge and effluent outfall to surface mine drainage. The study conduct to identify the Heavy Metal ion in the study point to river Ganga.

Keyword: The River Ganga. Heavy Metal Iron, Manganese, Copper, Nickel, Chromium, Lead, Cadmium, Zinc, etc.) . of study point.

Introduction:

The River Ganga is the most important river system in India. Die to the copious availability of water throughout the year, it has played a major role in the growth of India civilization and economy. It account for 25% of India water resource. The Ganga is the thirtieth longest river in the world, covering a basin area. The Ganga basin is among the most heavily populated area in the world (According to WHO). The Ganga is one of the mainly essential of all natural resource on

earth. It is important to all living organism, most ecological system, human health food production and economic development. The Ganga is not only a Holy river to the Hindus but also one of the bedorocks of Indian civilization. And it is face a grave threat due to the numerous cremation ritual on its banks over the year, unplanned urban and industrial growth, and sewage and chemical effluents.(Report since 2017) state that about 4.8 billion litres of sewage from 118 town and cites flow into the Ganga daily, in addition to garbage and organic waste. But the functioning capacity of sewage treatment plants is only a billion litres. (According to India's Central Pollution Control Board 2013), pollution level at 80 monitored site on the Ganga have since 2013. The Ganga river pollution is one of the most discussed topic on river water quality in the past few years. The uncontrolled discharge of domestic sewage without treatment excessive pollutant discharge from the industries, agricultural runoff, etc have made the river highly polluted. The water quality of the Ganga river and its major tributaries in some of the polluted stretch in Uttarakhand and Uttar-Paradesh has shown improvement during the Covid -19 lokdown a (study by the Centre for Ganga River Basin Management Agust 2020) and studies has found. The improvement was primarily on account of restricted industrial and tourism activity, closure of Hotels, Restaurant and other commercial establishment, and restriction on bathing and washing clothes in the river during the lockdown period (The Hindu 2020). Where the Ganga enter the UP plain and begin to be contaminated by municipal and industrial effluents, GAP was designed to intercept and divert untreated sewage currently flowing into the river to treatment plant a(report of CPCB). The plan also involve devising low cost sanitation system to latrine or garbage dump and to build electric crematoria that would offer an alternative to disposing the dead by casting the bodies into the Ganga. Although industrial effluent constitute only about 15 % of the waste discharge into Ganga, it is toxicity is cause for concern. So GAP strategy involve identifying the major polluters and attempting to persuade them to clean up their act by offering government loans for the setting –up of treatment plants. Under this program 68 "gross pollutant" were identify from more than 450 major industrial unit (a report of Hydrology 2015). The scheme met instant popular approval because the river is culturally important no Hindus religious ceremony is complete without the use of Ganga Jal. It was on the bank of the Ganga that the earliest and most extensive pockets of urbanisation flourished because of the river relatively steady course. Its northern tributaries, on the other hand, are extremely flood prone. This in turn, led to the Ganga begain exploited especially during the industrial age.

The Ganga river basin is the largest inland river basin of India draining a catchment of about 8,61,404 km2 and an average density 520 persons/Km2. The basin substance more than 300 million people in India (Basant Rai 2013), Nepal, and Bangladesh the basin of river Ganga and cover a long distance about 2,525 km from Gangotari to Bay of Bengal by .

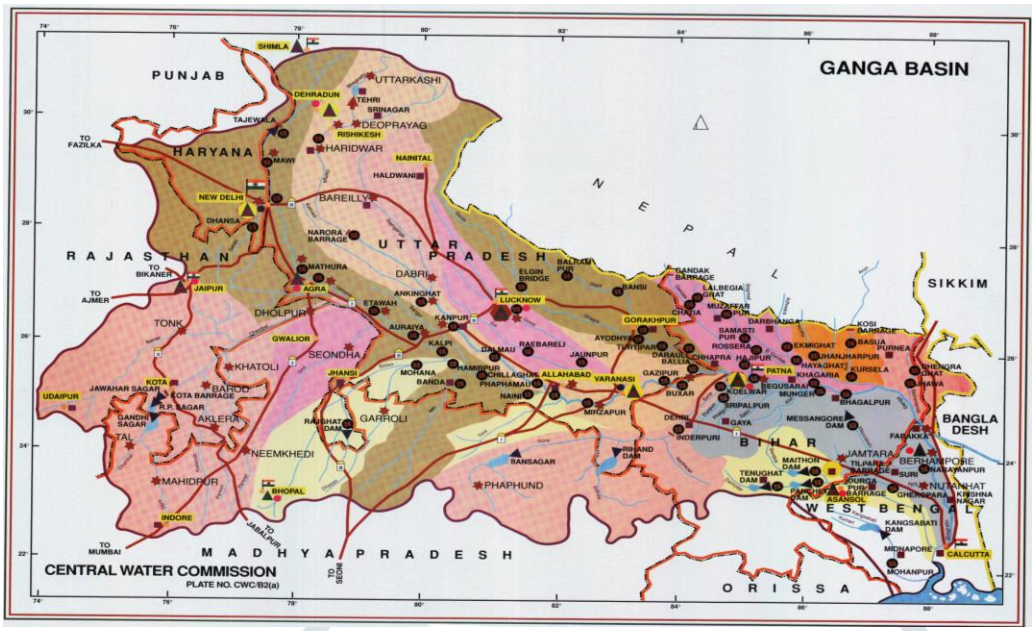

Fig-1 (g. map) The Ganga River Basin

The length of the main channels from the traditional source of the Gangotari glacier in India is about 2550km. after fowing through the Shivalik hills it enters plain at Haridwar. Then it flows southwards, passing through the plain of Uttar Pradesh. After leaving Uttar Pradesh, the Ganga enters Bihar in the Rohtas district. From Bihar in Bengal province and starts flowing south. Nearly 40km below Farakka it is divide into two arms. The left arms flows eastwards into Balngladesh and right arms, called Bhagorati, continues to flow south through West Bengal. The Bhagirati flowing west and south west of Kolkata it is known as Hoogaly.

(A 1984 study prepared by the Central Pollution Control Board) noted three- fourth of the Biological Oxygen Demand (BOD) of the Ganga was from untreated municipal sewage and 88% of this come from 27 class -1 cities. It was this study that formed the basis for GAP, whose first phase was designed to tackle pollution from 25 of these cities, situated in UP, Bihar and West Benhgal. In statistical term, this meant treating 870 million litres a day (mld) of the sewage generate in interception, diversion. Conveyance and treatment of effluents were set up in this cities concerned . Rs 250 crore was set aside in the seventh five year plan alone to finance the project, while the total allocation for the entire scheme was set at Rs. 292crore (A report of NMCG) .

fig. 2 (g.map) The River System of Ganga River

(The government also decided to set up the Ganga project Directorate (GDP)), within the Ministry of and Forests (MEF). The outlay for the first phase of the GAP was subsequently revised to Rs. 385 crore, of which Rs. 300 crore have already been spent to complete 191 scheme . GDP officials assert that of the 70 remaining scheme in the first phase 47 will be completed next year, when work on the second phase also is due to begin. It will involve tackling the pollution from class 2nd cities along the Ganga and its major tributaries. The reported that the lockdown had improved the health of the Ganga river which many project of the Government could not do during the past two decade. The water quality of Ganga river had witnessed visual improvement enforcement of the nationwide lockdown started on March 24 2020 that has led to a reduction in discharge of industrial effluent into. The lockdown was extended for more than seven week, with its 1.3 billion people instructed to stay home in view of the coronavirus out break a (P.R Muduli. A. Kumar. V.V Kanuri. D.R Mishra at al March 2021). With people staying indoors and industries shut during the lockdown period, it is crucial to assess if the water quality in the Ganga River has needed seen a significant improvement. Considering those all aforesaid background, India is the Centre of the attraction for the water related issues and should be closely monitored on a timely basis and all the exiting problem should be addressed immediately(. It is not pertormed, it will be hard for India to achieve a dream of world class health care delivery program in this largest democracy.

Heavy Metal:

The metal are characterized by high thermal and electrical conductivity, high reflectivity and metallic luster, strength and ductility, form a biological perspective however, it is more common to use broader definition that says a metal is an element that will give up one or more

electrons to form a cation in an aqueous solution (C.K. Jain 2001). With this definition, there are about 80 elements that can be called metals. The terms heavy metals is less precisely defined. In chemicals terms it can refer to metals with specific gravity greater than about 4 to 5, but more often, simply terms denote metals that are toxic. List of the toxic metals is included Aluminium, Arsenic, Beriyllium, Bismuth, Cadmium, Chromium, Cabalt, Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium , Strontium, Thallium, Tin, Titanium and Zinc. The some of these metals such as Chromium and Iron, are essential nutrients in our diets, but in higher concentration are extremely toxic. Lead is a toxic heavy metal for which there is no safe exposure level for human and wilde life(by CMS Family 2011)

In recent year, fluxes of the many metals from terrestrial and atmospheric source to the aquatic environment have increased considerably. The point of source of metals included municipal sewage sludge and effluents outfall to surface water. The use of detergent also create a possible pollution hazard, since common household detergent product can affect the water quality (D.Poul 2017). Angino et al reported presence of various element, viz, Fe, Mn, Cr, Co, Zn, Sr, and B in most detergents, and direct release to water courses from industrial units and in some areas, acid mine drainage. The non point source of metals included natural weathering of geological materials and anthropogenic source such as runoff from manure and chemicals fertilizer from farm field and irrigation return flow .

The elevated level of trace element in nature water system pose a servere threat to the aquatic environment. Heavy metal are not biodegradable and enter the food chain through a number of pathway causing progressive toxicity due to the accumulation in human and animal organ during their life span on long term exposure to contaminated environment. Despite the presence of trace concentration of Cr, Mn, Co, Cu, and Zn in the aquatic environment, which is essential to a number of life processes, high concentration of these metal become toxic(Amna Nawaz). Therefore it is necessary to analyse the concentration of these metal in aqueous solution like water for water quality management. To estimate such metal in very very small quantities, advance technique and equipment are required. Atomic absoption spectroscopy has been proved itself to be most effective instrument technique for determination of metals in liquid

Description of study Area:

The Ganga is one of the mainly essential of all natural resource on earth. It is important to all living organism, most ecological system, human health food production and economic development. The river Ganga is the most important river systems of India. It originates from the Gangotri glacier at Gomukh in the Himalayan Mountains at 30^{o} 55’ N and 79^{o} 7’ E at an elevation of 7138m above mean sea level in the Uttarkashi district in the state of Uttarakhand (India) (Geography of www wikipidia of uttrakhand) . The Ganga basin lie in the middle of E longitude 73^{o} 2’ to 89^{o}5$^{'}$ and latitude 21^{o} 6’ to 31^{o} 21’. The maximum width and length of about 1024km and 1543km. the entire extent of river Ganga up to its outfall into the bay of Bangal is 2525km.

fig. 3 The Haridwar in 1960

(downloaded fig by G.map)

fig. 4 shoot by location. Rishikesh

The study area to be conduct the water quality of the river Ganga to the three station of monitoring and 22 point of the sampling the total 96km area of the Ganga river is monitoring that is Devoparyag, Rishikesh and Haridwar. The monitoring the municipal, industrial and major STP derectaly discharge into the Ganga River. The Devoparyag is the scared event of merging two visible heavenly river, Alaknanda and Bhagirathi to from the holy Ganga. It believed that a third river, the mathical Saraswati river is underground and meet these two river at the confluence. Rishikesh is a city governed by Rishikesh Municipal Coporation (since October 2017). The river Ganga leave the Sivalik hill in the Himalaya and flow into the plain of northern India. Several temple, ancient and new, are along the bank of river Ganga in Rishikesh. The Ganga emerges from the mountain to touch the plain in Haridwar

Materials and Methods:

In order to study impact of waste discharges on water quality of River Ganga, water samples will be collected from different location from Deoprayag to Haridwar on alternate month for a period of two years by dip or grabsampling method. All the samples was collected from 15 cm depth using standard water sampler in clean narrow-mouth polyethylene bottles fitted with screw caps.

In the field,. All chemicals and reagents to be used in the analysis will be of analytical grade. Double-distilled water was used throughout the study. All glassware and other sample containers will be thoroughly cleaned and finally rinsed with double-distilled water several times prior to use. The River water sample were collected from twenty location on a alternative of monthly basis using a Hydro-Biostanderd water sample for a period of (Jun 2020 to July 2021). At each station two sample were collected from 1/3 1/2 width of river and upper drain point and lower of the drain point . All sample collected from the upper 15 cm of the water surface and stored in polyethylene HDPE bottles fitted with screw cap. Determination of pH, conductance and temperature was performed on site using portable meter (WTW, Germany). For other parameters, sample were preserved by adding an appropriate reagent and brought to the laboratory in sampling kits maintained 4^{o}C for detailed chemical analysis. The physic-chemical analysis was performed following standard method (APHA, 2005). The accuracy of the method.

The depth integration is used to collect a water sediment sample that weighted according to velocity at each increment of depth. If the depth integrating sample is lowered from the surface to the bed and back at the same rate, each increment of flow in that vertical is sampled proportionality to the velocity. The analyzed water various quality parameter during alternative monthly periods effect of industrial waste, municipal sewage, and agricultural runoff on river water quality. The determination of physical, biological and chemical parameter of surface water at different point.

The open mouth weighted bottle sampler dose not collected by depth integrating method using either a hand held or a cable and reel suspended sampler whenever it is analysis. In such cases, dip sample collected at one or more vertical across the stream are appropriate, however, the sample container should be carefully held just beneath of water surface in order to avoid disturbing the stream bed. The choice of parameter to be tested is closely linked to the objective of the water quality survey programme and to the available manpower and financial resources. The table lists the major ions and physical parameter which will provide considerable information on the quality of water being evaluated. Test results on these parameter may be used for interpretive studies with respect to the Chemical quality of water for domestic and industrial water supplies and other uses. The major ion results may be grouped into the ionic and cationic constituents. The accuracy of the analysis may be determined by comparing the sum of anion in equivalents per million with the sum of the cations in epm (ionic balance). The

In ionic balance determination, calcium, magnesium, sodium and potassium ions from the cataionic group whilen bicarbonate, sulphate and chloride ion from the anionic group.

Result and Discussion:

In India despite the concern relating to water pollution have been addressed, the resources available for prevention of pollution treatment of polluted water and ecological restoration of polluted water bodies are inadequate. From monitoring (studies by CPCB MoEF and universities and institution) it is noted that the most of the river and water resources continue to be plagued by the elevated level highly toxic inorganic and pharmaceutical chemical. The heavy metal characteristic of Ganga River water at different monitoring station the regular water quality affected.

Aluminium:

The aluminium is a silver- white metal, the 13 element in the periodic table. One surprising fact about aluminium is that the most widerspread metal on earth making up more than 8% of the earth core mass its also third most common chemical element on our planet after oxygen and silicon. The aluminium sulphate are used to this day to clean water, for cooking in medicine, in cosmetology in the chemical industry and other sector

Asbestos:

Asbestos is introduced into natural water by the dissolution of asbestos containing mineral and ores and form industrial effluents. The use of asbestos cement pipe in distribution system is a potential source of asbestos contamination of drinking water and river water through the industrial domestic sewage discharge into river. The Asbestos present in the river Ganga in every where site.

Cadmium :

The cadmium is highly toxic when taken by mouth or inhaled and has been implicated in some cases of food poisoning. The most food stuffs contain trace of cadmium. Higher level of cadmium in municipal sewage and waste effluent are associate with iron piping material. The health effect have been demonstrated in industrial worker heaving exposed to cadmium oxide fuel and dust.

Chromium:

Chromium may be present in water as the hexavalent or the trivalent form, although trivalent chromium rarely occur in potable water. Hexavalent chromium enter a water supply through the industrial waste from metal plating bath and from industrial cooling towers where chromate is used to inhibit metal corrosion. The rock and soil contain small amount of chromium.

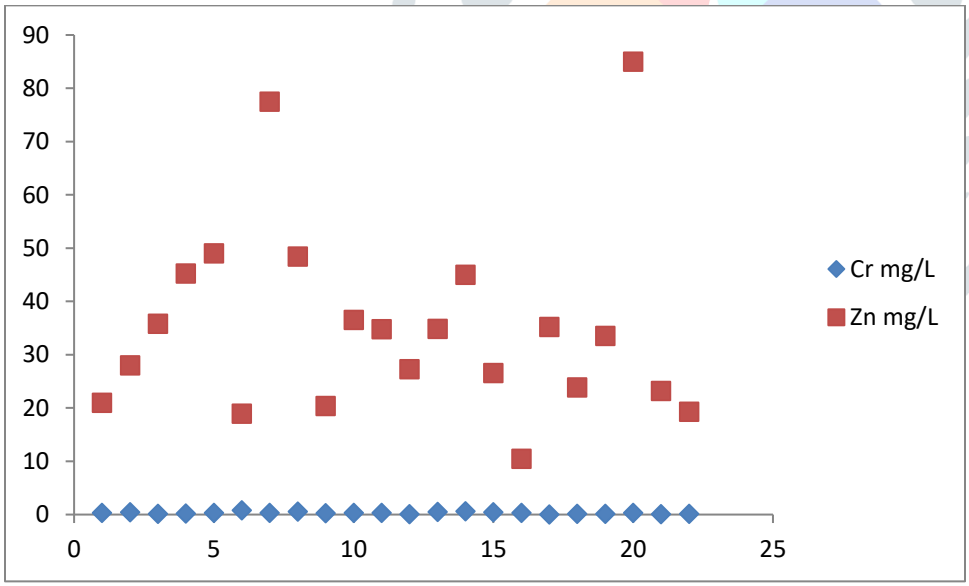

Chart 1 showing value of the zn and cr post Monsoon

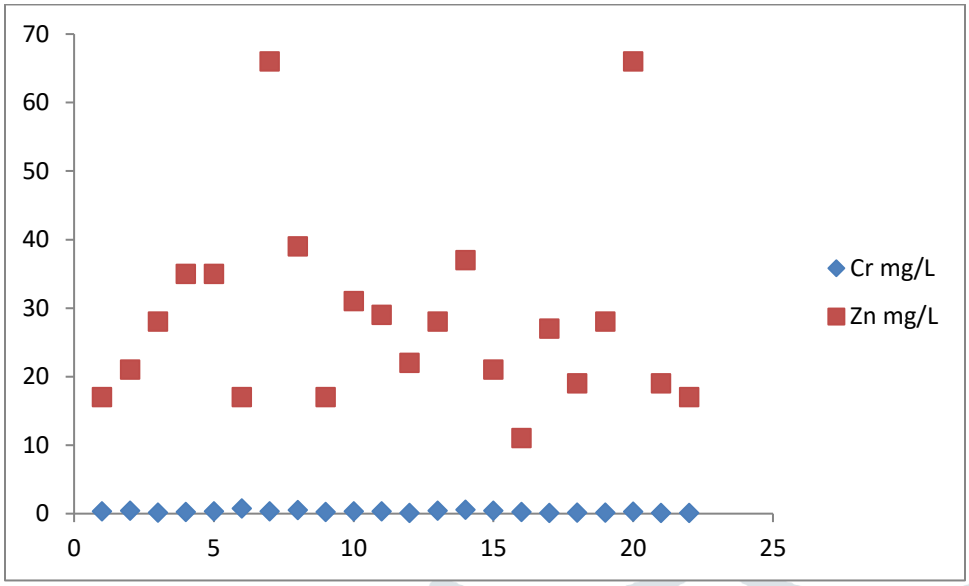

Chart 2 showing Cr and Zn value of post mounsoon

Copper:

The copper may occur in natural water, waste water and industrial effluents as soluble copper salts or as precipitated copper compound on suspended solids. Trace amount of copper are necessary for normal body metabolism and its absence is know to cause nutritional anemia in children. Large oral dose of copper can cause emesis and may eventually result in liver damage.

Iron:

The natural water contain variable but minor amount of iron despite its universal distribution and abundance. It a major constituent in pyroxenes, amphiboles, mice (silicate), pyrite and chalco-pyrite(sulphide), mahnetite and haematite (oxide). Iron is an essential element in human nutrition. Iron ingestion in large quantities result in a condition of heamochromatosis (normal regulatory mechanism do not operate effectively).

Lead :

The lead is important ore is Galena. Other ore minerals are anglesite cerussite, pyromorphite and mimetestite. Lead in high dose has been recognized for centuries as a cumulative general general metabolic poison. Some of the symptoms of acute poisoning are tiredness, lassitude, slight abdominal discomfort, irritability, anaemia and in the case of children, behavioural changes.

Manganese:

The Manganese found in the ground water as the form of divalent ion (Mn++) due to surface oxygen of river. The surface water may contain combination of manganese in various oxidation state as soluble complex or as suspended particles. The occurrence of manganese in water present more of an economic problem than a potential health hazard. Manganese cause dark

stain in laundry and on plumbing fixture, tends to deposit in water line, and impart an objectionable task to beverage such as coffee and tea. Manganese in natural water rarely exceed 1mg/L, but level of 0.1 mg/L are sufficient to cause taste and staining problems.

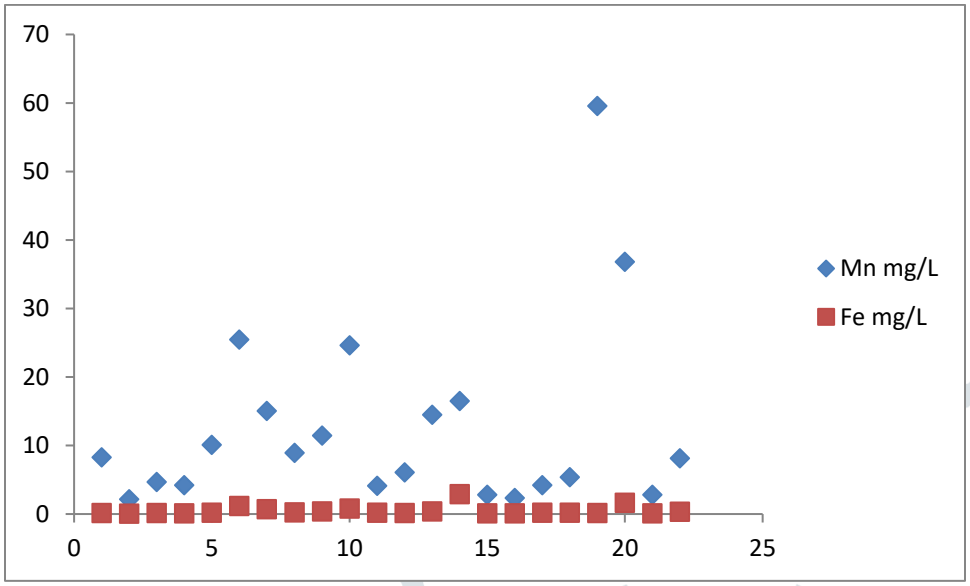

Chart 3 showing the Value Of Mn and Fe pree Mounsoon

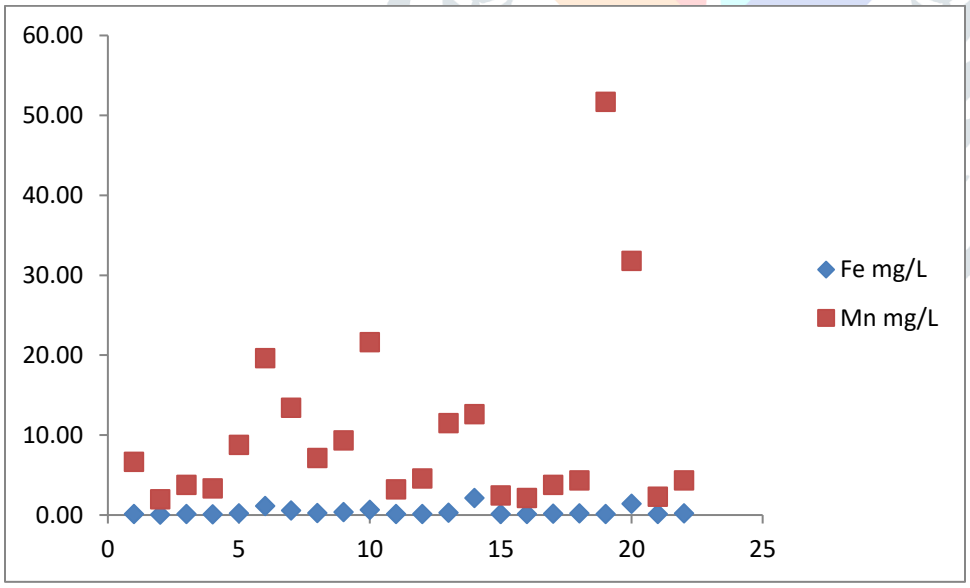

Chart 4 showing fe and Mn in post mounsoon

Nickel:

Many nickel salts are water soluble, therefore contamination of water can arise, Granierite, nickeliferous and pentlandite are the important source minerals. It is found in the natural water, its often present is industrial waste water as a corrosion product of stainless steel and nickel alloys product of stainless steel and nickel alloys and form metal plating bath, nickel is considered

relatively nontoxic element. The toxicity nickel to aquatic life indicate that tolerance vary widely and are influence by species, pH , synergetic and other factor.

Zinc:

The major source of zinc is sphalerite, smithsonite, hemimorphite and franklinite. Zinc is an essential element for both animal and human and is necessary for the functionite of various enzyme system. Symptoms of zinc toxicity in human included vomiting, dehydration, electrolyte imbalance, abdominal pain, nausea, lethargy, dizziness and lack of muscillar co-ordination. Acute renal caused by zinc chloride been reported. The high concentration of zinc in water act as stomach irritants but the effect are temporary..

Conlusion:

It was concluded from the present study of the Heavy Metal parameters of the river Ganga. Were varied at 22 study point. Devoparyag to Haridwar total distance of the Ganga river was 96 Km. The study suggested that the industrial and domestic sewage indirectly discharge into Ganga river by draining point and the water of the river Ganga is mostly effected by the increasing population of river bank, therefore these alteration contribute the water pollution of River Ganga.

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References :-

CPCB report 2020, 2019 . Basin water pollution.

CPCB report during covid-19 lockdown 2020. On water quality.

The Ministry of Science & Technology report by PIB Delhi 2021 feb.

Pardeep Majumdar. Sneha santy (jun 2020) water quality Ganga River around the industrialized.

NMCG report 2019.

D. Poul 2027 Research on Heavy Metals of Ganga River.

B.D Tirpathi can Ganga be saved what must done to clean up Indias Holy River.

Annual Report 2017-2018 Ministry of Water Commision.

Report of Hydrology 2015.

Agarwal Agarwal, D. K., Gaur, S. D., Tiwari, T. C., Narayanswami, N. and Marwah, S. M. (1976), Physico-chemical characteristics of Ganges water at Varansi, Indian J. Environ. Hlth., 18, 201-206.

APHA (2005), Standard Methods for the Examination of Water and Waste Waters, American Public Health Association, Washington, DC.

Bilgrami, K. S. and Dutta, M. (1985), Ecology of River Ganges, Impact of Human Activities and Conservation of Aquatic Biota (Patna to Farakka), Allied Press, Bhagalpur, India.

CBPCWP (1984), CBPCWP (1984), Basin, Sub-Basin Inventory of Water Pollution. The Ganga Basin, Part I and II, CBPCWP, New Delhi.

Calcutta Metropolitan Development Authority (1978), Water Quality of the Hooghly Estuary, 1976-77, Calcutta.

Calcutta Metropolitan Development Authority (1979), Water Quality of the Hooghly Estuary, 1977-78, Calcutta.

Calcutta Metropolitan Development Authority (1981), Water Quality of the Hooghly Estuary, 1979-80, Calcutta.

Calcutta Metropolitan Development Authority (1982), Water Quality of the Hooghly Estuary, 1979-80, Calcutta.

Calcutta Metropolitan Development Authority (1982), Water Quality of the Hooghly Estuary, 1980-81, Calcutta.

Chandra, S. and Krishna, G. (1984), Effect of tannery waste disposal on the quality of the river Ganga at Kanpur, Poll. Res., 2, 63-64.

Chattopadhya, S. N., Routh, T., Sharma, V. P., Arora, H. C. and Gupta, R. K. (1984), A short term study on the pollutional status of river Ganga in Kanpur region, Indian J. Environ. Hlth., 26, 244-257.

CPCB (2017), Central Pollution Control Board Report, Identified and priority drains in phase / segment wise, Personal Communication (2017).

David, A. and Ray, P. (1960), Some measurements of toxicity of tannery and textile wastes and their components to fish bioassay, Ind. J. Fish., 7, 423-442.

Dutta, S. C. (1984), Perils of pollution in the metropolis, Sci. & Culture, 50(6), 178-181.

Ghosh, B. B., Mukhopadhyay, M. K. and Bagchi, M. M (1985), Status of zinc pollution in the Hooghly estuary and the related toxicities to fish and fish food organisms, Proc. National Seminar on Pollution Control and Management.

Handa, B. K. and Bhatia, S. S. (1993), Quality of Ganga river and its tributaries for irrigation use in U.P., Seminar on Ganga in the Service of Nation, Sep. 12-13, UOR, Roorkee.

Jain, C. K. (1999), Adsorption of zinc on bed sediments of river Ganga, Technical report, CS(AR)9, National Institute of Hydrology, Roorkee, India.

Jain, C. K. (2002), A hydro-chemical study of a mountainous watershed: the Ganga, India, Water Research, 36, 1262-1274.

Krishna Murti, C. R. (1991), Some physical features of the Ganga basin. In: Krishna Murti C. R., Bilgrami, K. S., Das, T. M. and Mathur, R. P. (editors), The Ganga - a scientific study, The Ganga Project Directorate, New Delhi, India.

Lebreton, L.C.M., Zwet, J.V., Damsteeg, J.W., Slat, B. and Andrady, A., (2017), J. Reisser, Nat. Commun., 8, 1-10.

Mathur, A., Sharma, Y. C., Rupainwar, D. C., Murthy, R. C. and Chandra, S. (1987), A study of river Ganga at Varanasi with special emphasis on heavy metal pollution, Poll. Res., 6, 37-44.

Mishra, V. B., Mishra, S. K. and Upadhyay, S. N. (1992), Theme Paper Presented at Seminar on Pollution Control in River Cities of India - A Case Study of Ganga at Varansi, Jan. 14-17, Sankat Mochan Foundation, Varanasi.

Nandy, A. C., Bagchi, M. M. and Majumdar, S. K. (1980), Ecological changes in the Hooghly estuary due to water release from Farakka barrage, Mahasagar, 16(2), 209-220.

NEERI (1970), National Environmental Engineering Research Institute, Annual Report, 1969-70.

Pande, P. K. and Pande, G. N. (1980), Physico-chemical characteristics of river Ganga at Kanpur, J. Inst. Engrs., 61, 28-30.

Paul, S., Ghosh, S., Oglesby, R., Pathak, A., Chandrasekharan, A. And Ramsankaran, R. (2016), Sci. Rep. 6, 1-10.

Rao, S. N., Chaubey, R. and Srinivasan, V. K. (1990), Ganga water quality in Bihar, Indian J. Environ. Hlth., 32, 393-400.

Ray, P. and David, A. (1966), Effects of industrial wastes and sewage upon the chemical and biological composition and fisheries of the river Ganga at Kanpur, Env. Health, 8, 307-339.

River in India: A Reality Check, The Hindu, 5th June 2019.

Saxena, K. L., Chakrabarty, R. N., Khan, A. Q., Chattopadhya, S. N. and Chandra, H. (1966), Pollution studies of the river Ganges near Kanpur, Env. Health, 8, 270-285.

Sehgal, J. R. and Siddiqi, R. H. (1969), Characterization of wastewater from Kanpur city, Env. Health, 11, 95-107.

Sengupta, B., Laskar, S., Das, A. K. and Das, J. (1988), Inorganic pollutants of Ganga water in the region of Berhampore to Katwa, West Bengal, Indian J. Environ. Hlth., 30, 202-208.

Shukla, S. C., Tripathi, B. D., Kant, R., Deepa Kumari V. and Panday, V. S. (1989), Physico-chemical and biological characteristics of river Ganga from Mirzapur to Ballia, Indian J. Environ. Hlth., 31, 218-227.

Singh Singh, J. P., Yadava, P. K. and Singh, L. (1988), Pollution status on Sangam and its adjoining rivers before Kumbh Mela at Allahabad, Indian J. Environ. Prot., 8 (11), 839-842.

Singh, J. P., Yadava, P. K. and Singh, L. (1989), The assessment of water quality of Sangam and its adjoining rivers Ganga and Yamuna after Mahakumbh Mela at Allahabad, Indian J. Environ. Prot., 9 (5), 372-375.

Sinha, A. K., Srivastava, R. K., Pande, D. P. and Modak, D. P. (1989), Water quality characteristics of Ganga river from Kare-Manikpur to Phaphamau - A case study, Indian J. Environ. Prot., 9 (11), 845-852.

Sinha, A. K., Srivastava, S. and Srivastava, K. N. (1993), Quality of river Ganga water in Rae-Bareli district, Proceedings of the Seminar on Ganga in the Service of Nation, Sep. 12-13, UOR, Roorkee.

Upadhyay Upadhyay, R., Dubey, A. P. and Pande, G. N. (1982), Monitoring of pollution at Sangam during Ardha Kumbha, Poll. Res., 1, 1-2.