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The Ganga Jal Pollution Status: A Brief Review

Pushpendra Kumar Sharma
Reader, CED
Hindustan College of Science and Technology
Farah, Mathura (UP)

Raj Kumar Sharma
M.Tech Scholar, CED
Doon College of Engineering and Technology
Saharanpur (UP)

***Abstract* - This review summary presents experimental findings of some researchers who monitored Ganga River Water (Gangajal) in past, right from Gangotri to West Bengal. The attempt has been made to understand gradual degradation of the Gangajal and its today's pollution level with respect to various purposes of its uses. A lot of monitoring for the assessment of Ganga Jal has been done time to time to study the physico chemical status of this holy river by various researchers. These studies reveal that all is not well and Ganga Jal quality is degrading day by day and the reason behind may be the nostalgic temper of the industries and common man continuing ill practices causing heavy pollution to Ganga. Though there are governmental laws to control river pollutions yet implementation is not up to the mark due to wavering approach that reduces the dominance, strictness and expediency of the laws in India. As far as consciousness to the environmental pollution is concerned it is not only expected from a common man but also from the top level.**

Keywords- Gangajal, physico-chemical status, nostalgic temper, wavering approach, consciousness.

I. INTRODUCTION

Water, a universal solvent is a combination of two gases viz. hydrogen & oxygen in particular fixed ratio. In recent time with rapid industrialization & swift agricultural development, supply of pure and clean water has become an achievement.

Water is vital to all forms of life on earth from the simplest of living organisms to the most complex of human systems. Lack of fresh water to drink, for use in industry, agriculture and for multitude of other purpose where water is essential, is limiting factor perhaps and most important factor hindering development in many parts of the globe. As population increases, the demand of water increases. The fresh water resources are not only distributed unevenly in space and time but also have finite limitation in terms of practical utilization in the world.

Gangajal is regarded as the cradle to Indian civilization. Hence its importance lies in its purity in the development of the nation. The future solution to retain its water quality needs regular assessment through physico-chemical analysis, instrumental monitoring, and strict administrative implementations of governmental laws, public participation, education and awareness. Although primitive measures can be applied but with the rapidity of the development it cannot be practically implemented. Therefore adequate efforts are to be made to achieve the purity of river Ganga for the betterment of the present civilization.

So far water resources like Ganga which has been considered to be the most purest of its form are being exploited by man and industry as well. Pollution of water bodies is increasing steadily due to rapid population growth, industrial growth, urbanization, and increasing living standards & widespread of human activities. Time is perhaps not to far when pure and clear water, particularly in densely populated, industrialized water scarce areas may be inadequate for maintaining the normal living standards.

The actual Ganga so called originates from Devprayag when the Alaknanda river system and Bhagirathi system meets at Devprayag. Alaknanda system joins from Pauri Gharwal and Bhagirathi system from Tehri Gharwal. The tributaries that joins Ganga are Dudhatoli at Vayasghat, Nayar river at Satpuli, Sone-Suswa rivers at Raiwala and river reaches the plains at Hardwar. The Hardwar is named so because this is the place of opening the way to GOD through river Ganga. Ganga passes through 23 class I cities with the population of more than 10 lakhs , 23 class II cities with a population between 50, thousand and one lakhs and 28 towns having less than 50,000 population. The surface run off from areas in which urban and industrial solid waste is dumped is also included in this group of pollutants. It has been estimated that 1400 million litres effluents are being discharged every day into river Ganga.

Due to deforestation in last few years, the rich top soil is carried away every year from the hills to the river and than to the sea. Pollution is not only the problem faced by the river Ganga, silting, habitat destruction and destruction of aquatic life is equally serious, due to siltation the course of the river changes.

Now there is a complete revolution in this branch and the local authorities have released the benefits derived from modern sanitary measure & that is why many of the larger cities are therefore provided with protected water supply and the modern methods of sewage treatment. Therefore in Hardwar district itself there are around fifteen sewage pumping stations situated at different location and a main sewage pumping station including treatment plant at jagjitpur to protect the water quality of river Ganga at this holy place.

Management of river Ganga Water Quality in urban ecosystem is a complex problem which requires multidimensional data generation for longer periods. In fact planning and design of urban water projects are broadly based on financial consideration rather than by considerations of optional ecological designs. In other words this can be expressed as the expenditure on water treatment, water supply, sewage system, sewage treatment, water supply, sewage system, sewage treatment is kept under fixed limits.

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The patit pawani Ganga is suffering from severe pollution today affecting the human survival in its basin. The script has reached such a level due to various factors such as domestic sewage, industrial effluent discharge, various religious activities and the cremation deteriorate Ganga Jal up to an alarming situation in passage of time and distance causing families living along the river bank vulnerable to various water born diseases.

In India, though all major fourteen rivers e.g. Ganga, Yamuna, Godavari, Gomti, Kosi, Cavery, Ravi, Sone, Chenab, Jhelum, Narmada, Mahi Tapti & Krishna are facing acute water pollution problems yet this review summaries findings of some researchers who monitored Gangajal in past for its pollution level so as to understand the real situation and to take preventive measures accordingly.

II. LITERATURE REVIEW

The importance of safe water supply and disposal of excreta and garbage has been ever mentioned in Rigvedas. Even the emperors of those days took special case on provision of safe water supply before building up towns or camps. It is being said in our epics that river Ganga shall vanish in Kalyuga so, that's what happening now. In Varansi alone about 75000 human bodies are cremated on funeral pyres every year. The number in Hardwar is not less in any respect from other religious places.

Many researchers in past have shown the Ganga jal pollution time to time along with possible causes. Various parameters like heavy metals, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, turbidity etc. have been studied for assessing the instantaneous status of the Ganga Jal. Some most relavent studies are as follows.

Meschkat (1937) reported that river receiving sewage show gradual setting of suspended matters in downstream in calm water zone. Al. (1946) made a study on determination of water quality. Douoroff and Katz (1950) regarded that industrial pollution may lead to lowering of pH, decrease in oxygen, increase in carbondioxide & formation of black sulphide mud.

Klein (1957) stated that since most pollution is of chemical or physical nature, chemical analysis supplemented by physicochemical procedures must play a vital part in the detection of measurement of water pollution. A sudden rise or deletion of the level of physicochemical constituents of a water body indicates the pollution of water body.

Saxena et. al. (1966) based on various physico-chemical parameters of the river Ganga at Kanpur was of the opinion that most of the river stretch was considerably polluted. Ray and David (1966) explained effects of industrial waste and sewage upon chemical and biological composition of fisheries of river Ganga at Kanpur.

Sculphrope (1967) regarded that pH, CO_2, NH_3 are even more critical factors in the survivial of aduatic plants and fishes then the oxygen supply. Verma and Mathur (1971) studied the effects of paper mill wastes on the Hindon river. Hengeveld & Devocht (1982) made a study on the role of water in urban ecology.

Chattopodhya et. al. (1984) made a study on the pollution of river Ganga in Kanpur. Raina et. al. (1984) assessed the water quality of river Jhelum. Kamath (1985) has shown that on warming up of water the D.O. saturation limit is lowered resulting into bubbling out of oxygen and fishes trapped in such zones die of "Gas –bubble diseases". Tiwari and Mishra (1985) studied the water quality of river Ganga at Garhmukhteshwar and calculated the water quality index and reported that the water is severely polluted at Garhmukteshwar.

Trivedi and Goel (1986) have described in detail the chemical & biological methods for water pollution studies. Said water pollution is one of the major environment problems of present time Katyal & Satrke (1989). Sinha et al. (1989) analysed physicochemical characteristics of Ganga water at Kalakankar (Pratapgarh).

Mehrotra et.al. (1990) found that pollution of the river in Varanasi city was due to the domestic sewage effluents & mercury , Lead, chromium and nickel in the sediments of Ganga river at Varanasi due to the several polluting industries, burning of dead bodies at the ghats, use of detergents, as well as insecticides and pesticides used in agriculture.

Tripathi, B.D., et. al. (1991) analyzed the variation of physico-chemical characteristics of Gangajal at Varanasi during the different months of the year at six ghats viz, Shiwala ghat, Rajendra Prasad ghat, Rajghat, Chauki ghat, Assi ghat & Harischandra ghat. The researchers found that the physico-chemical parameters vary with variation in month and site. The concentration of sewage discharged in May & June was found to be higher by Duncan's multiple-range test. The highest pollution load was found at Rajghat and least at Assighat.

Upadhya & Rana (1991) reported that the higher values of pH, B.O.D. and lower values of D.O. create problems for survival of aquatic life. Dhansetran and lakshmanaparumalsamy (1991) has described that excessive presence of impurities can even contaminate the underground water.

Chopra and Patrick (1994) studied the effect of domestic sewage on self purification of Ganga water at Rishikesh. Chopra and Rehman (1995) made a study of physicochemical properties of Ganga canal water at Jawalapur, Hardwar. Kumar (1995) made physicochemical study of Ganga water from Rishikesh to Roorkee.

Rana (1997) conducted a study of some a physico-chemical parameters of Ganga canal with special reference of planktons. Kumar (1997) made a physico chemical and phytoplanktonic study of sitapur pond at Hardwar. Payal (1997) Observed the effects of domestic sewage on the water quality of upper Ganga canal at Hardwar.

Sharan et. al (1997) reported that domestic sewage play a vital role in polluting water bodies. The study has been bone on a sewage treatment plant and an attempt is made to establish a relationship between BOD & COD.

Jain et. al. (1997) carried out physicochemical characterization of municipal waste of Muzaffarnagar city one the quality of river Kali. High value of BOD & COD in the waste effluent is an indication of high degree of organic contamination of their wastes. The important characteristics associated with pollution of the river due to the discharge of there wastes is the heavy depletion of oxygen over a small stretch of the river.

Bhushan (1998) conducted a study on physicochemical & microbiological parameters of Ganga canal during the Kumbha 1998. Sharma and Pande (1998) studied physicochemical characterstics and toxic metals of Ramganga river at Moradabad.

Today water quality of many river systems are getting rapidly degraded due to massive discharge of industrial wastes, domestic sewages, flyash, insecticide, mine drainage, oils & surfactants etc. Most of the rivers including Ganga have been unmindfully used for the disposal of solid wastes far beyond their assimilative capacities & people use this sort of heavily polluted waters unaware of its hazards Melathi et al. (1998). Agarwal (1993) reported the environmental crises of patit pawani Ganga.

Khwaja et.al. (2001) studied effects of tannery wastes on the physicchemical characteristics of Gangajal and its sediments at Kanpur. They reported 10 fold leakage of chromium on downstream Jajamau due to unchecked release of untreated tannery effluent in to Ganga.

Armienta et. al.(2001) found waste generated from tanning industries generally contains much higher concentration of total dissolved solids(TDS), suspended solids, phenols, chromium, chlorides, ammonia, heavy metals, etc.

Zafer and Sultana (2002) collected samples from Bithoor, Bhairoghat and Jajmau at kanpur for the study of various physico-chemical characteristics like temperature,Turbidity,Turbidity,Transparency, pH, Alkalinity, Hardness, Chloride, Phosphate, BOD, COD and DO. A significant seasonal variation was observed in ascending order from Bthoor to Jajmau. pH value indicated alkaline nature of Gangajal at downstreams of industrial discharges.

Singh, et.al.((2002) attempted to quantify the impact of urbanization activities on the stream sediment quality taking into consideration a number of important urban centres of the Ganga Plain. They analyzed stream sediments from six urban centres of the Ganga Plain for heavy metals concentrations of Cr, Mn, Fe, Co, Ni, Cu, Zn, Pb and Cd indicating that the stream sediments and urbanization activities had a controlling influence on the accumulation and transportation of anthropogenically originated toxic heavy metals in the rivers of the sacred Ganga Plain. Metal enrichment factors of Cr, Ni, Cu, Zn, Pb and Cd had indicated that these urban centers act as anthropogenic source of heavy metal inputs into rivers of the Ganga Plain.

Tare, V. et.al. (2003) investigated the most polluted Kannauj-Kanpur stretch of Ganga and concluded that despite the implementation of phase I of GAP and its consequent diversion followed by reduction of organic loading in the river, increased both BOD and DO levels in the entire Kannauj –Kanpur stretch, have increased except at Jajmau, because here an aerobically treated effluent was being discharged in the river. The nitrogen levels have also been reported higher in so called stretch.

Kunwar P. Singh et.al. (2004) Studied impact of waste water/ sludge disposal (metals and pesticides) from the sewage treatment plants (STPs) in Jajmau, Kanpur (5 MLD) and Dinapur, Varanasi (80 MLD), on health, agriculture and environmental quality in the receiving/application areas around the industrial city Kanpur and Varanasi in Uttar Pradesh, India. They collected raw, treated and mixed treated urban waste water samples from the inlet and outlet points of the plants during peak (morning and evening) and non-peak (noon) hours and investigated that the STPs sludge had both positive and negative impacts being enriched with high levels of toxic heavy metals and pesticides along with several useful nutrients like N, P, and K making the Gangajal furtile. The STPs sludge had cadmium, chromium and nickel above their tolerance levels for agricultural land application.

Tiwari, et.al. (2004) revealed that untreated industrial discharge contaminates water of Pandu river. Direct dumping of untreated sewage into the Ganga river not only damages the aquatic life but also human health going on a toss as downstream of the river water is the source of drinking water. The multi utility of river water led to development of various cities and towns along the banks of Ganga.

EC and SP. D. Kar et.al. (2005) analyzed 96 samples of Gangajal from West Bengal for pH, Cd, Cr, Pb, Ni, EC, Fe, Mn, Zn, and Cu and found alkaline nature with low conductance along with Pb, Fe, Mn, Zn, Ni, and Cr. Cd and Cu was detected in few samples only with light seasonal variation for Fe, Mn, Cd and Cr. They found maximum mean concentration Cd & Cr in winter, Fe in summer and that of Mn in monsoon. sampling locations also also played important role on the concentrations for Fe, Mn and Cd. They found Fe, Zn & Cu maximum at Palta, Mn & Ni at Berhampore, Pb & Cr at the downstream station, Uluberia with the heavy metals concentration order as Fe > Mn > Ni > Cr > Pb > Zn > Cu > Cd and also the significant positive correlation for conductivity with Cd and Cr of water but negative correlation with conductivity for Mn.

Tiwari, R.K., et.al. (2005) analyzed physic-chemical status of Gangajal to evaluate the impact of sewage pollution in adjoining areas of Patna and Bihar region with respect to BOD TDS, COD, TSS from the outfall drains to the river and found all parameters very high across the bank as compared to the middle stream along with objectionable fecal coli form (MPN). They also investigated that direct discharge of untreated sewage into Ganga deteriorates Gangajal severely.

Bhandari, N.S., et.al. (2008) assessed physico-chemical status of Kosi river at Kosi during 2004 - 2005 in pre, post and monsoon seasons, calculating correlation coefficients between different pairs of parameters & t- test applied for significance and comparing with WHO recommended values. They found appreciable significant positive correlation with pH, Mg, Na, hardness and total suspended solid; and sodium with hardness, EC and sulphate on the other hand negative correlation between potassium with turbidity, Cl^- , EC and hardness. Turbidity and BOD was very high and rest physicochemical parameters were within the highest desirable limit set by WHO.

Beg and Ali (2008) studied Gangajal sediment quality taking upstream and down stream of tanneries discharges in Kanpur and found Cr 30-fold higher in downstream sediment as compared to the upstream and its concentration was above the permissible effect level.

Prasad et al. (2008) collected 9 samples from different locations of Krishna river water to study physico-chemical parameters like pH, EC, TDS, TS, BOD and DO etc in the month of May, 2008 in research lab of DKTE, Ichalkaranji. The researchers compared the results obtained with standards of ICMR and WHO and found most of the parameters of Krishna river water within the permissible limit.

Joshi, D.M., et.al. (2009) studied physico-chemical characterstics of Gangajal at Haridwar (Uttarakhand) during 2007- 2008 determining correlation coefficients to minimize the complexity of large set of data verified by t-test from five sampling stations for winter, summer and rainy seasons. The researchers found significant positive correlation for Free CO2 with Cl^-, TDSD, TSSD; turbidity with Cl^-, EC, TSSD; Clwith EC, Free CO2, TSSD, EC with Cl^-, TDSD, TSSD and negative for DO with Free CO2, COD, and turbidity. Cl^-, EC, TDSD and TSSD.

Joshi, D.M., et.al. (2009)collecting Gangajal samples from five sampling stations for three consecutive seasons, Summer (March to June), Rainy (July to October) & winter (November to February)continuously during 2007- 2008, analyzed the physico-chemical parameters to assess the Gangajal quality at Haridwar. They found that some data like electrical conductivity, total suspended solids, total dissolved solids, pH, sodium &Turbidity were more than the prescribed limit that is why Gangajal found unfit for drinking purpose. The researchers also suggested some ideas for the improvement of Gangajal quality in this particular area.

Joshi, D.M., (2009)assessed Gangajal quality at Haridwar for irrigation purpose collecting samples from 5 stations for winter, summer and rainy seasons during 2007-2008. The researchers studied electrical conductivity, total dissolved salts, magnesium content, sodium percent, sodium adsorption ratio, residual sodium carbonate and permeability index (PI)and found Gangajal in rainy season was not suitable for irrigation purpose because of high TDS.

Rawat, M., et.al. (2009) monitored Fe , Mn , Zn , Cu , Cd , Ni, Pb and, Cr etc. heavy metals concentrations in Gangajal at Panki and Jajmau, Kanpur and found high levels in soil and road dust samples viz. Ni and Pb which were in higher concentration in few samples, whereas Cr was found in higher concentration in all the samples than the recommended values of USEPA and specifications for compost quality contained in the Indian Municipal Solid Wastes (Management and Handling) Rules, 2000. They detected heavy metal contamination in ground and surface water and also in food chain Which is of great concern pertaining to adverse consequences to environment and human health.

Mohammad M. et.al. (2009) studied Buri Ganga pollution level of Bangladesh and concluded that talender ganga was the most populated river of the country, a good portion of urban sewage from Dhaka was also drained into it. They investigated from June 2004 to April, 2005 for water quality parameters like pH, EC, TDS, DO ; Anions ($HCO3^-$,Cl^-, $SO4^{2-}$, $PO4^{3-}$,NO^{3-}) and Cations (Na^+, K^+ , Ca^{2+}, Mg^{2+},NH^{4+}). They investigated that in dry season especially, Buri Ganga had the lowest level of Dissolved Oxygen (DO) concentration about 2-3 mg/l and in areas adjoining to Hazaribagh, Zinzira, Sadarghat, Shutrapur Lalbagh and Kotouali, the Ammonium ($NH4^+$) and Nitrate (NO^{3-}) concentrations were found to be very high crossing the maximum permissible limit. Pollution level was found much higher in dry season than in wet season. The results showed that the water of Buri Ganga was not only unsafe for domestic use, recreational activities , irrigation but also dangerous for various commercial purposes like fisheries, industrial uses round the year.

Trivedi, P., et.al. (2009) collected samples at various bathing ghats at Kanpur before, during and post monsoon for physico-chemical parameters of gangajal i.e. turbidity, Total hardness pH, temperature, Iron, consumption, total alkalinity, Oxygen, Suspended solids to determine Correlation coefficients between different parameters and for checking the significance t-test and compared with WHO. The researchers found significant positive correlation for TA with Cl^-, Mg^{+2}, Ca^{+2}, TH, TDS, fluoride and OC and significant negative correlation between SS with chloride, Mg^{+2}, TDS, fluoride and OC. All the physico-chemical parameters obtained on the higher side except turbidity while $NO3^-$, Cl^- and F^- were less than the values recommended by WHO.

Trivedi, P., et.al. (2010) studied seasonal variations in physico– chemical parameters of ground water, surface water, and filtration plant treated water of Kanpur cityduring April –December, 2008 and January – March, 2009 and reported all physico- chemical parameters within desirable limit prescribed by WHO except turbidity being on higher side. For all seasons the surface water samples in Gangajal showed higher values of TA ,pH, TDS, turbidity TH, Ca^{+2}, Cl^-, Mg^{+2}, $NO3^-$, $SO4^{-2}$ than other sampling sites like Canal, Gangajal and ground water samples at Postal Station Pump and at water filtration &Treatment plant. They observed that the value of pH in summer, Turbidity in all seasons, Total dissolved solids in winter ,Total alkalinity in spring, autumn and winter were within the highest desirable limit. Various reasons such as presence of more than WHO prescribed extent of pollution limit for drinking water may be responsible for quality deterioration in GW for all seasons. The researchers observed that after treatment in filtration plant the quality of surface water is highly improved & becomes free from all contamination. During all seasons monsoon, autumn, spring and summer seasons, the filtrated water is better than ground water at PSP . they also reported that in monsoon the Ganga water has better characteristics than that in winter. Similarly in winter ground water is better than that in summer. After treatment in filtration plant the quality of surface water has become better than that of Ground water.

Ekin B.A. and Das, S. (2010) surveyed willingness to pay for improvements in the capacity and technology of a sewage treatment plant (STP) among 150 residents of Chandernagore municipality randomly selected on the banks of River Ganga and the majority was ready to pay higher monthly municipality taxes to enhance STP capacities usedso as to reduce water pollution followed by environmental and health risks which are currently a threat to the sustainability of the country's economic, cultural and religious values which this sacred river generates.

Srinivasa, S. et.al.((2010) performed environmental geochemical studies between Jajmau (Kanpur) and Unnao the two cities prominent for leather processing clusters along the banks of river religious Ganga and found the soil extremely contaminated due to many years of random and frequent dumping of hazardous waste material and free discharge of effluents by various industries like cotton and wool textile mills, tanning and leather manufacturing industries, huge fertilizer factories and a number of arms factories. Leaching caused toxic metals in ground waters. The detected levels of total metal contamination in several samples were found to exceed the international threshold values specially Cr and Zn.

Namrata, S. (2010) collected wastewater samples from six different ghats so named as shiwala ghat,Raj ghat, Assighat, Rajendra Prasad ghat, Harischandra ghat & Chauki Ghat and analyzed physico-chemical properties viz. DO, BOD, COD, chloride, temperature, Electrical conductance, pH, alkalinity, acidity, phosphate, nitrate & chloride assessing effect of pollution of GangaJal on different ghats of river Ganga at Varanasi finding shiwala ghat least polluted & Rajghat the most polluted one. Though till 1940 the Ganga basin was not very much anthropocentric but after independence in 1947 agricultural, industrial & sewage wastes dumped in in Ganga and as a result Gangajal degraded because of various developmental activities & population explosion.

Pandey, J. et al (2010) sampled mid stream sub surface water fortnightly of 20 km stretch of Ganga at Varanasi and analyzed for heavy metals concentration reporting trend as Zn> Ni> Cr> Pb> Cu> Cd beyond WHO maximum admissible concentratios (MAC) alarming that use of GangaJal for drinking purpose may lead to potential health risk in long run.

Agarwal Animesh et.al. (2011) studied pollution effect by different industrial and domestic activities in River Gagan (India) during summer, winter & rainy season determining alkalinity, B.O.D. and C.O.D. There was a good correlation in between alkalinity & BOD and alkalinity & COD.The research could be used as a tool to determine the value of various physicochemical parameters and theoretically prove the pollution extent.

Vinit Kumar et.al. (2011) collected ten samples from various stations during January to June; 2010 from the river Yamuna, the largest tributary of the river Ganga and found certain stretches most polluted due to various urban centers situated on the banks of Yamuna River withdrawing fresh river water for various purposes and disposing off their wastes. They monitored various physico-chemical parameters like Temperature, conductivity, DO, BOD, COD, alkalinity, total hardness, Cl^- and F^- and indicated Yamuna River to be moderately polluted in their study reach.

Maheshwari et. al. (2011) assessed Yamunajal for physico-chemical status during winter and summer seasons to investigate the effects of industrial wastes, domestic sewage and agricultural runoff on the river on most polluted area surrounded by many chemical, fertilizers and leather industries i.e. between the Kailash Mandir and Taj Mahal at Agra. They found main cause of pollution the direct discharge of industries untreated toxic waste into the Yamuna River. They compared DO, BOD, COD, pH, total suspended solid, total dissolved solids, Alkalinity, Turbidity, Hardness, Chloride contents, sodium, calcium, Electric Conductivity with the standard limits of WHO showing winter season water to be more suitable for domestic purpose.

Madhab Borah et.al.(2011) collected samples from pond and river in and around Lumding (Assam) and analyzed for temperature, pH, conductance, TS, TDS, TSS, turbidity, hardness, total alkalinity, DO, COD, F^-, $NO3^-$, $HCO3^-$, Cl^-, $SO4^{2-}$, Na^+, K^+, Ca^{2+}, Mg^{2+},Fe^{3+} and observed many of the parameters bearing positive and some negative correlation.

Srivastava Anukool et. al. (2011) studied current physico-chemical status and sewage pollution indicator bacteria along with their Spatial, Seasonal and Temporal variation at whole stretch of river Gomti at Lucknow during pre, post & monsoon seasons of the year 2008 and 2009 determining temperature, Total Solids, Total Dissolved Solids, Total Suspended Solid, Conductivity, pH, COD, BOD, DO, Total Coli (TC), Faecal Coli (FC) and Faecal Streptocoli (FS) for suitability of the water for various uses like drinking and other domestic applications. The researchers concluded that large number of drains in Lucknow city and industrial discharge are mainly responsible for pollution in river Gomti.

Khare, R. et.al. (2011) collected samples of Gangajal from different locations at Kanpur & its nearby area during pre monsoon season of 2010 and determined correlation coefficient and its significance was checked by t-test.Various physico-chemical analysis like total hardness, temperature, ph, turbidity, suspended solids, oxygen consumption were found within the permissible limits set by WHO during pre monsoon, monsoon & post monsoon seasons. While F^- ,Cl^- , I^- & $NO3^-$ were lesser where as turbidity value was higher than that prescribed by WHO.

Johri, Reeta., (2011) monitored physico chemical status of Gangajal between Bithoor and Jajmau reach of about 24 Km length at various bathing ghats in vicinity of kanpur, Uttar pradesh. They investigated different category fish fauna at various ghats as per different pollution level. The study revealed that Gangajal was was not very much fit for both drinking and bathing purposes. It could only be used for irrigation in fields but after a little treatment. The low values of dissolved oxygen affected potability of water and caused mortality of fish and other aquatic animals in

Bithoor, Permat and Jajmau, respectively. The magnesium toxicity caused nausea, muscular weakness or even paralysis to the villagers, residing nearby areas. The high content of cadmium caused vomiting, diarrhea, abdominal pain, giddiness, bone deformation, hypertension, choking, coughing and bronchitis to resident of the people residing in that areas particularly in Jajmau. The high content of chromium also caused mortality and low longevity of the aquatic organisms particularly fishes. The high MPN values and BOD values also indicated the organic pollution in the Bithoor, Permat and Jajmau region. The turbidity indicated very dirty Gangajal near Jajmau region where tannery effluents join. The researchers advised Gangajal for bathing and agricultural purposes only but after a slight treatment it could also be used for drinking pupose.

Rai, A.K., et. al. (2011) observed Gangajal slightly alkaline with higher total solids as well as saturated dissolved oxygen at Patna and chlorides within the permissible limits of drinking water quality standards. Some parameters found slightly higher limits of WHO, 1984 and not tolerable for household and commercial uses. Higher Hardness, DO, BOD and MPN values of Gangajal made it unfit for drinking purpose and requiring treatment before domestic consumption. The researchers also warned for strict legal action against culprits dumping and discharging local effluents.

Katiyar S., et.al. (2011) studied physico-chemical parameters with chromium at Jajmau (Kanpur) and found high chromium, BOD & COD with low DO due to a number of tanneries located in this area at the Ganga bank.

Rai, P. K. et.al. (2012) collected samples from three sewage treatment plants regularly discharging in to Ganga at Varanasi. Dinapur sewage treatment plant was found with maximum Biological oxygen demand and various heavy metals Zn, Cu, Cd, Pb, and Cr above permissible limits were being disposed with effluent of sewage treatment plant. Irrigated water & vegetables also found with coli form counts causing various health problems due to intense pollution of microbial & fecal contamination.

Khan M.M.A., (2012) studied the physic-chemical analysis of groundwater collecting sample in post monsoon 2005 & pre monsoon 2006 from 37 locations in parts of central Ganga Basin. Finding TDS, $HCO3^-$, Cl^-, $SO4^{2-}$, Na^+, K^+, Ca^{2+}, Mg^{2+} and summing up the concentrations of all major cations & anions they also calculated total dissolved solids. The value of TDS, Na^+ ,K^+ and Cl^- was higher in pre monsoon 2006 as compared to post monsoon data in 2005 clearly showing quality of groundwater is affected by land use on groundwater. They also found strong positive relationship between TDS vs $HCO3^-$, TDS vs Na ,TDS vs K^+ and moderate positive correlation with Cl^- ions and low positive correlation with $SO4^{2-}$,Ca^{2+} and Mg^{2+}.

Singh, J., (2012) investigated that water quality of river Ram Ganga at Bareilly was not up to the mark being highly alkaline for agricultural purposes. COD found very much higher than BOD indicated direct industrial discharge. The non-point sources like agricultural runoff, cattle-dropping etc were found the main sources of organic pollution.

Singh et. Al. (2012) measured Cu, Cr, Zn, Ni, and Cd concentration of Gangajal Grab samples and sediments for a period of January 2007 to December 2008 from 3 different sites following the Standard Methods using AAS and found the Ganga river sediments from Champanala to Barari as unpolluted with respect to Cd, Cu, and Ni where as Cr and Zn show pollutional status up to detrimental stage to the rich biodiversity of the river segment.

Das, S. et al. (2011) assessed Ganga River cleaning to highlight the tenuous relationship between the need for efficient management of environmental problems and public participation with three simple and straight questions: 1. Can public participation fit in to the technocratic model that is often adopted for environmental problems? 2. What approaches to participation kindle authorship and empowerment among those who share deep relationship with the river and the ghats? 3. Can religious practices be accommodated within scientific framework of adaptive management and resilience?in their published work. The answers argued for rethinking the relationship between pollution control programs and participation which is crucial for any effort to clean the Ganges, restore its waterfront, and catalyze broader regeneration in the Ganges basin.

Arya, S. & Richa (2013) found Gangajal throughout the city Kanpur right from Bithoor to Dhori Ghat is fast losing its individuality and dying both physically and biologically. At Siddhnath Ghat Ganga found highly polluted because of solid waste generated in tanning process and tannery effluents discharged in to the river making it unfit for drinking & bathing purpose.

Bhatnagar, M.K., et al, (2013) studied tannery effluents effect on Ganga river sediments at Jajamau (Kanpur) and reported that the amount of heavy metals Cr, As, Co, Fe, Cu, Mn, Zn, Pb, Cd and Ni were more down stream than the upstream. The alkalinity, BOD, COD, TS, TSS, magnesium, phosphate, nitrate, fluoride, phenol, oil and grease were also found above the permissible limit.

Kumari M et. al. (2013) collected samples from six stations and analyzed biochemical oxygen demand, electrical conductivity, chemical oxygen demand, pH, total acidity, temperature , Total alkalinity, nitrate nitrogen, dissolved oxygen ,phosphate, lead , Zinc, iron ,nickel, chromium, cadmium & copper. Cr & EC had smallest value confirmed by Pearson's correlation and based on proximity distances, EC, Cr, Ni, Fe, N, COD, temperature, BOD, and total acidity comprised one group; Zn, Pb, Cd, Total alkalinity, Cu, and phosphate in another group and DO and pH in a separate group. Box-whisker plots showed that as they moved downstream, the pollutant increase and maximum at the downstream station Raj Ghat and minimum at the upstream station Samane Ghat. Seasonal variations in Ganga Jal parameters revealed that total alkalinity, total acidity, DO, BOD, COD, N, phosphate , Cu, Cd, Cr, Ni, Fe, Pb, and Zn were the highest in summer and the lowest in monsoon season likewise temperature the highest in summer and the lowest in winter. DO was the highest in winter and the lowest in summer season. pH was observed to be the highest in monsoon and the lowest in summer season.

Pandey, R., et al. (2014) studied physicochemical parameters of Ganga Jal collecting samples from Phaphamau, daraganj and samgam at Allahabad (UP) between January 2014 and March 2014 with 15 days interval. The researchers investigated maximum values of BOD, pH, total hardness and total alkalinity at phaphamau, maximum DO at sangam, minimum BOD at sangam, minimum DO at phaphamau. Correlation coefficients were calculated between different pairs of parameters to identify the highly correlated and interrelated water quality parameters.

Pandey, R., et al. (2014) studied physicochemical parameters in Ganga Jal from shringverpur, phaphamau, daraganj and sangam at Allahabad during summer, monsoon and winter of 2013-2014 to check the pollution index and determined heavy metals using Atomic Absorption Spectroscopy (AAS) technique obtaining fluctuating levels with high concentration in summer and low in winter season. The heavy content order was Fe>Zn>Cr>Co. The statistical analysis through correlation coefficients proved phaphamau location to be highly polluted and the sangam to be least polluted.

Raghuvanshi D., et al, (2014) analyzed Ganga jal quality from Rasoolabad to Chatnag Ghat at Allahabad in 2012-2013 and reported average pH value 8.07±0.44 mg/L, electrical conductivity 188.49±63.00 µmho/cm, DO 6.47±0.82 mg/L, BOD 9.41±1.41 mg/L, COD 15.28±3.07 mg/L, Total Hardness 118.56±40.91 mg/L, Total Alkalinity 168.46±12.50 mg/L, Chloride 27.49±16.97 mg/L and TDS 216.83±13.84 mg/L which all are beyond the permissible limits of WHO and USPHS indicating high pollution resulting aquatic bio system and human beings under danger.

Hasan, S. (2015) monitored Ganga Jal pre and post Ganga Action plan and found the plan to be successful due to improvement in DO and BOD. Though pollution is increasing day by day due to population growth, rapid industrialization and urbanization.

S. Singh, et al (2015) monitored Ganga Jal quality during mass pilgrims bathing (Kumbh) at Sangam along with other bathing ghats collecting samples from eight selected sites of Ganga and Yamuna and analyzed for alkalinity, Biochemical Oxygen Demand, chloride, calcium hardness, electric conductivity, magnesium hardness, pH, temperature, turbidity, total hardness and DO. The observations were very poor specially at Daraganj and Ramghat.

Tiwari, A., et al (2016) collected water samples of Gangajal at kanpur , Allahabad and Varanasi during 2011-2012 recording its temperature 17^0 C in winter. They found pH, TDS, EC, sulphate, phosphate, nitrate, BOD & COD values minimum at Allahabad, chloride & DO minimum at Kanpur and alkalinity & total hardness minimum at Varanasi. They investigated Gangajal quality at Kanpur in poorest condition as compared to Allahabad and Varanasi. Their observation was that fish species like exotic Cyprinus carpio, Oreochromis niloticus and catfish have powerfully invaded in degraded Gangajal.

Bhutiani et al (2016) analyzed monthly variation in physic-chemical parameters temperature, pH, DO, BOD, COD, alkalinity, acidity, total hardness, calcium, magnesium, TDS,TS, free CO2 and chlorides at Haridwar during January 2014 to June 2014 and found all the parameters within the range except calcium near Devpura Jagjeetpur and near STP Jagjeetpur whereas near Misharpur it was found within the limit.

Srivastava, V. et al (2016) studied physic-chemical and biological status of Ganga from Gangotri to Allahabad and found all parameters exceeding permissible limits revealing Gangajal unfit for drinking purposes and also unhealthy for aquatic life. The major cause of pollution they found was dumping of domestic wastewater, solid wastes, industrial effluents and joining drains.

III. CONCLUSION

Establishment of a large number of hospitals, industries, textile mills, chemical plants, distilleries on the bank of river Ganga in Kanpur, Varanasi and Allahabad, has led to increase in the pollution level in the Ganga River. Most of the city waste, industrial waste is dumped into the river without thinking twice about the consequences it would have on aquatic life as well as human health. There is urgent need of taking some appropriate preventive measures to stop further deterioration of the Ganga river water quality. A comprehensive tracking and appraisal system should be made for all those who are involved in the Ganga Action Plan. Central and state boards should take the initiatives to spread awareness, not only among the poor people but also among those who are actually responsible for the poor condition of the river Ganga. Strong legislation is the need of the hour to curb down the flaws in the system. Theoretical and practical environmental education should be made compulsory for all right from the school level to make the future decision makers aware of the present scenario and to put them on the thinking path.

Despite of uncounted studies, analysis & research work carried out to monitor physico-chemical status of Ganga throughout its stretches by various researchers, the pity is that our holy river Ganga is still being highly polluted. Strong action is needed, otherwise a day is very near when Ganga river will only be in books like river Saraswati.

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