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Case Study

To Suggest Purification of Yamuna River in Agra with Green Technologies: A Case Study

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A B S T R A C T

Yamuna River originates from glacier Yamunotri, it traces its path passing through parts of Uttarakhand, Uttar Pradesh, Agra, Mathura, Himachal Pradesh, Haryana, Madhya Pradesh and Delhi NCR. The river has traces of heavy metals and pollutants which are harmful for marine inhabitants and green belt around the Agra region. Agra people have to bank upon million-dollar project of Ganga water for the requirement. But still people are not getting enough water. So, need to visualize the situation and provide some green technology solution is required for its purification. Moreover, it is good for agricultural and irrigation process also. Data shows that nano technology can be efficient solution to it. In this series of nanomaterial, halloysite nanomaterial proved to the be the best, out of them for the purification of river suggested in literature. Along with-it incorporation of sewage plant is also required suggested by Government of India to preserve the green belt around and safeguard the river.

***Key words*:** Nano technology, Carbon nano tubes, Graphite, Nano-metal oxides, Halloysite nano material, Adsorption

Yamuna is one of the tributaries of Ganga originates from the Yamunotri glacier. Approximately, the major classification of Yamuna as per area can be divided into Himalayan segment, Upper segment, Delhi NCR segment, Eutriphicated segment and diluted segment. The purest form of water is when it is in the Himalayan segment thereafter it starts getting contaminated and polluted. Yamuna river Has not only the aesthetic value to it but also very useful for the contribution of water, electricity, hydro power projects, large scope of fisheries and habitat on the riverbank used for agriculture, irrigation, transportation and domestic water supply etc. But it has become the ground for industrial waste these days. So turned pale and losing its breath day by day. Only 172 km patch of Himalayan belt is mostly pure. Total catchment area roughly in Uttar Pradesh is basically 74208 km^2 [1]. Parameter range of Yamuna can be evaluated on the basis of dissolved oxygen, chemical oxygen demand, biochemical oxygen demand etc. Sources of pollution in river Yamuna and many more are highlighted in the paper. In paper, discussions about the basic sources of pollution have been done with respect to river Yamuna to eradicate and to purify the river. Most importantly it is required to consider the sources and after evaluating and suggesting measures to stop the point and the diffused sources of pollution. Paper has briefly outlined the measures taken by the government till 2021. After discussing the brief outline of the present status and technologies employed paper brings light on the nanotechnologies as a green technology requirement to fulfil the criteria of purification of river Yamuna. In the series of its all-different generations of nano materials to be considered giving best of green technology as a solution has been referred in paper. As far as the problem pyramid of Agra keeping river Yamuna in mind at Centre has been classified into three categories. Present state of river Yamuna as per different pollution parameters, Government initiatives taken till yet and sources of Pollution and in last green technology which can be suggested to purify Yamuna. Thus, to reduce the manpower, technology loss and load to bring up Ganga project to Agra and nearby region could be checked.

Water quality status has to be foremost analyzed and can be subdivided into following types according to that we can divide the water to be used for which of the purposes as per the pollutant level.

Class A: For drinking just after addition of chlorine and bleaching powder.
Class B: Fit for bathing.
Class C: For drinking only after filtration and other treatment.
Class D: Fit only for fish and marine life.
Class E: River water only could be used to irrigation industry cooling etc.

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At the entry point from Delhi the Yamuna River was good to use but at present it is class E category due to industrial pollutants because of industrial waste eliminated into it. Moreover, with due planning of sewage dispersal along with some green technology is required. We can propose the idea for the remediation of the river Yamuna. Pollution parameters can be chemical, physical and biological which can be understand in detail to reduce the pollution level. Physical parameter includes its Colour, Temperature, Turbidity. Chemical Parameters includes pH, Total Dissolved solids, Total Solids, Total Suspended Solids, Total hardness, Heavy metals and Free radicals. Biological parameters include the qualitative analysis of plankton. Here few of the basic para metres to be discussed out of them.

pH: Is a measurement of water acidity level as water dissociate into hydrogen and hydroxyl compounds entering the water may react with them leaving an imbalance in ion concentration. Thus, it depends whether it will be acidic or alkaline. Alkaline water is more safe than acidic water.

Turbidity: Is a measure of suspended particles which affects its clarity. It is an important indicator of suspended sand sediment and erosion levels. Highly transparent water is desirable.

Conductivity: Is capability of water to pass an electric current. It is a major of dissolved electrolyte ion in the water. It is a significant parameter as conductivity maybe an indicator of polluting discharges in water. Dissolved oxygen is the oxygen gas molecules present in the water. Plant and animal directly use the oxygen that is part of the water molecules but rather depend on the dissolved oxygen for the respiration process. High levels of sewage in water reduces the level of dissolved oxygen in it. Water temperature gets changed by air temperature, storm water, run-off, ground water in it flows, exposure to sunlight as per area and climate. The need of maximum an optimum temperature rises to understand the lifespan of water living organism.

Hardness: Is predominantly caused by di-Valent cation such as calcium, magnesium, alkaline earth metals such as iron magnesium etc. The total hardness is the sum of some of the magnesium and calcium concentration both expressed as calcium carbonate. Carbonate and bicarbonate of calcium and magnesium causes temporary hardness. Sulphate and chloride cause permanent hardness. Another important characteristic parameter of water is total solids.

Total solids: Includes total suspended solids and total dissolved solids.

a). Total suspended solids are solids that are retained on a filter of standard specific size under specific conditions. Water with high suspended solid is not advisable for bathing, industrial and other purposes.

b). Total dissolved solids are solids that are present in the dissolved state in water. Water with high dissolved solids is generally of inferior probability and may induce unfavourable physiological reaction.

In natural water Colour, is due to the presence of humid acids, fulvic acid, metallic ion, suspended matter, plankton, weeds and industrial effluents. Colour is removed to make water suitable for general and industrial applications and is determined by visual comparison of the sample with the distilled water. Transparency is a characteristic of water that varies with the common effect of colour and with this ability it measures the light penetration through the water body.

Solar radiation: Is the major source of light energy in the equity system, governing the primary productivity. The quality of seawater is also defined by biotic index of a stream, pond and lake which says it is more than 15 then it is clean and low that is considered to be polluted. Sequential comparison index does not require much of the background biological knowledge rather done by simple technique even by person of ordinary skill its value decreases with increasing intensity of pollution. Value less than five indication of severe pollution while value greater than 15 indicated of clean water zone [2].

Chemical waste water quality parameters include following:

1. *Dissolved oxygen*: Whenever dissolved oxygen is less there is presence of organic matter. So, more the deficiency of dissolved oxygen more will be the organic matter in water.

2. *Chemical oxygen demand*: the amount of oxygen required to carry out the decomposition of biodegradable and nonbiodegradable organic matter present in water is called chemical oxygen demand.

3. *Bio-chemical oxygen demand*: Amount of oxygen required for decomposition of only Biodegradable organic matter gives the bio chemical oxygen demand. These parameters were as per national and international drinking parameters.

Different parameters were considered in the table which are as follows sources of pollution can be:

1.) *Point source of pollution*

When the pollution is specific and generate considerable number of pollutants known known as point sources. They are of two types first domestic pollution; it basically contributes 85% of pollution in urban centres. Mostly, pollution due to unavailability of sewage system dispersal. Some more amount for the compound generated by domestic sources is organic matter, total salts, chloride nutrients, detergents, oil and grease etc. are also the key compounds generated by the domestic sources.

Industrial pollution: Rapid industries in Kota, Gwalior, Indore, Nagda, khatri, Yamuna Nagar, Panipat etc. are contributing in polluting the Yamuna River. Thermal power plants and foot industry etc. gets discharge the waste water into the Yamuna water. So mostly, it is required to treat effluents before discharging them into Yamuna.

2). *Diffused source of pollution*

Sources of pollution are not specific and large in numbers accounts for its less significance. This is due to the leaching, drainage and surface water off during monsoon. The pollutants are topsoil, organic matter, plant residue nutrients, organic chemicals talk against microorganism etc. The important diffused pollution sources are:

1. Agriculture pollution: These sources are of three types like wise agriculture residues, fertilizer and pesticides and animal husbandry. The dumping of garbage as a large portion of solid waste generated by unauthorized inhabitants along the banks of the river and its tributaries are dumped into it, like dead bodies of the animal dairies, unauthorized slaughtering flowers and materials used during worship of deity contributes pollution to rise.

1). Immersion of idols immersion of idols during Durga Puja, Ganesh Puja takes place at the bank of the river flowers, straw bamboo, clay, chemicals used for paints plastic bags find its way in to the river. Durga Puja is also getting popularity in northern India so is Idol immersion increased eventually.

2). Pollution due to in stream use of water due to be bathing and clothes washing, cattle wading and open defecations it increases the greater number of pathogens in river water. Foaming is caused due to detergent in water.

Policies incorporated to improve Yamuna water quality

Government has taken following policies till yet in to account: Various policies and plans have been introduced by the government for the improvisation of the water quality of river Yamuna and reduction of pollution level these includes.

1. NCR regional plan 2021 in order to improve the overall situation in the NCR region for the harmonized and balanced development of the region following strategies were proposed.

Blueprint for water resources in the region ,integrated regional schemes for augmented of drinking water phase supply in NCR as a single entity ,protection of land for groundwater recharge ,recharge of aquifer, relocation of water consuming industries ,recycling of waste water for non-drinking use, creation of mass awareness on saving water ,commercial approach for tariff, institutional capacity building, allocation of land for water treatment plans and water distribution system, funding of water supply schemes through five year plan.

2. *Yamuna action plan*

Launched in April 1993, by the Union government to tackle the pollution of Yamuna River. Schemes under this scheme are being implemented by the state government through identified nodal agencies with the emphasis on public participation and institutional development. All the works under this are being executed by DJB and MCD for Delhi, UP Jal Nigam UP and PHED for Haryana [3]. It basically emphasized on following points.

(a). Minimization of the cost of conveyance of sewage and the energy needs for pumping through the decentralization of several sewerage and sewage treatment facilities.

(b). Encouraging low-cost technology options for sewage treatment through Agra for forestry oxidation pond.

3. *Inland waterways authority of India*

Inland waterways Authority of India came into existence on 27 October 1986 for the development and regulation of inland waterways for shipping and navigation. The authority primarily undertakes projects for the development and the maintenance of infrastructure on national waterways through grant received from Ministry of shipping. The head office of the authority is that Noida authority has its regional office at Patna, Kolkata, Goa, Guwahati and Kochi and sub-offices at Allahabad, Varanasi, Bhagalpur, Farakka and Kollam.

4. *NEERI's EMP for rejuvenation of rivers*

The National environmental engineering research Institute has introduced environment management plan for the renovation of Yamuna River. In this project the mission is to provide innovative and effective solutions for the reduction of pollution along with the river restoration. It includes the proposal of constructing earthen dams and waste wires of water storage and efficient use. Monitoring of pesticides and toxic waste in rivers are also involved in this.

5. *Yamuna riverfront developed by landscape division of DDA 2010*

Development project and the structure plan

The flood plan has been studied and analyzed based on several ecological and physical para metres such as existing natural features like water bodies, proximity to habitation and movement corridors, intensity, conformity of abating activities and social cultural characteristics.

To understand the present level of Yamuna river Principal component analysis in Region like Hathi ghat, Agra Gokul bridge Mathura, Yamuna near Pipli village, Aligarh, Yamuna near Gurwari Valley Village, Palwal, Chhainsa village, Faridabad and Kalindi Kunj near flyover Gautam Buddh Nagar has been done by [4]. The data clarifies that four factor explains in which nutrient factor includes 41.79%, domestic sewage is 22.41%, physio chemical variant is11.92% and waste water pollution from industries [5].

New technology proposed by Professor Norio Taniguchi in 1974 for purification of Yamuna River, deals with the object in the order of nano-meter [6]. It is used for the purification of waste water ground water and waste water contaminated with toxic metals, organic salutes, inorganic solute and micro-organism. Many Nanos material and interactive research for developing and coating of green nano material in water treatment technologies [7].

Thus, concluded that nanotechnology will play a crucial role in water security and this will lead to agriculture and irrigation industry as well [8]. It is having great role in addressing issues such as health, energy and water in total. Thus, information will help us to understand the week area, risk involved and potential factors in detail.

This knowledge will eventually be beneficial in all types of treatment plants and give best results. With good, stable and best treatment plan model could be designed such that waste water can be used safely. Henceforth, it helps us to solve the water crisis. But we need to understand some basic types of nano materials and methodology suggested to briefly understand the green material best suited for it.

The nano membrane in the nanotechnology field employed can be accomplished by the process of absorption. Adsorption is the adhesion of atoms ions or molecules from a gas, liquid or dissolved solids onto the surface, where solid used to absorb gases or dissolved substances called adsorbents and the absorbed molecules are called as adsorbate [9]. It is a surface phenomenon. Nano materials shows great degree of rate of absorption for heavy and rare earth metals as well as micro pollutants altogether. This brings in the series of Nano material great deal of research

interest. Going through different merits and demerits of different nano materials from the starting are as follows:

After comparing and understanding the criteria of requirement, best and can be proposed as per research discussion will be eliminated in last. Carbon nanotubes (CNT) is a versatile absorbent that is heavily used in the removal of various pollutants from the aqua solutions, with high surface to volume ratio and controlled pore size distribution have an exceptional Sorption capacity and high sorption efficiency compared to conventional granular and powdered activity carbon. They are effective to purify water over wide range of pH and the sorption capacity of CNT's depend upon the functional group associated with them as Carboxylic, Phenolic and Lactonic group favours absorption of polar compounds [10]. Carbon nanotubes are highly promising to remove the ice due to the large surface area [11]. Research has also been focused on the allotropes of carbon which is Graphene. From past decade, there has been huge growth in the use of graphene and graphene-based materials for the environmental remediation due to their unique properties. Compared to CNT's is the utilization of graphene-based material as absorbent may offer several advantages. First single layer graphene material possesses two basic planes which is available for the pollutant absorption [12]. In contrast the inner walls of the CNT's are not easily by the adsorbates while graphene oxide (GO) the reduced graphene oxide (RGO) can easily be synthesised through chemical exfoliation of graphite, without using complex apparatus [13]. A variety of studies describes the application of graphene materials as adsorbent for the removal of in- organic species from aqua solution [14].

Among the available absorbent nano sized metal oxides (NMO's) including many types: Manganese oxide, Aluminium oxide, titanium oxide, magnesium oxide etc. classified as most promising and for the removal of pollutants from the aqueous system [15]. This is due to the large surface area and high activity caused by the quantization effect [16]. Out of which magnetic adsorbent have attracted intensive interest in water treatment due to the easy separation and collection due to the presence of strong magnetism. At the same time magnetic nano material can avoid or decrease the possibility of serious agglomeration and restacking of graphene sheets and thus provides a higher available surface area and enhancement of absorption capacity [17]. Due to its high degree of magnetism RGO-magnetite and GO ferric hydroxide composites were proved best for the removal of arsenic type impurities mainly in Ganga and Yamuna. Nano metal oxides due to the high-efficiency holds great promise in the field of water purification and leaves great scope for new adsorbents in near future to be discovered. Several graphene-based materials have been proved to be efficient for water purification. A new graphene-based nano composite materials from graphene oxide inserted in iron aluminium oxide composite with different concentration of graphene oxide and characterize them for the arsenic absorption from water as well-known as halloysite nanomaterial [18]. Thus, data presented here will assist to understand the potential of nano materials and their use in water treatment technologies for river Yamuna. Helloysite nano material membrane by the process of absorption can be proclaimed for the purification of Yamuna River in times to come. Nano absorption technology can be cited excited as an effective remedy for the polluted water of river Yamuna as per the reviewed literature.

CONCLUSION

From the literature reviewed we can point out the following key points which will be the strong points to progress in this field.

1. Yamuna water can aid into the scarcity of water in Agra region.
2. New technology will be producing and rare and heavy metal can be produced as by product.
3. Major Arsenic contamination could be covered through this which is threat to mankind.
4. Sewage plans are required to run this effectively along with this.
5. Marine and aquatic flora needs to be preserved
6. Check for pollution is urgently required and must be in cooperated.
7. Hard water in Agra will be administered as well.

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