Journal of Science and Technology
ISSN: 2456-5660 Volume 7, Issue 03 (MAY 2022)

www.jst.org.in *DOI:https://doi.org/10.46243/jst.2022.v7.i03.pp53-67*

An Overview of Potential Threats to Freshwater Ecosystem

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To Cite this Article
Dipty Kumari[#1], Dilip Kumar Paul*[2] *"***An Overview of Potential Threats to Freshwater Ecosystem** *", Journal of Science and Technology, Vol. 07, Issue 03, May 2022.*

Article Info
Received: 27-04-2022 *Revised: 12-05-2022* *Accepted: 22-05-2022* *Published: 31-05-2022*

Abstract
Globally, only 3% constitutes freshwater. Major sources of inland freshwater are ponds, lakes, wetland and streams which also support a major portion of biodiversity. Studies have indicated it supports 10% of all known species. Urbanization, industrialization and agricultural activities primarily disturbing the aquatic ecosystem. Insecticides, herbicides and fungicides from agricultural fields, heavy metals from industries are major problems aquatic life facing with. Microplastic and nanoparticles has emerged as a new threat in water bodies. Encroachment of water body are responsible for declining ponds and lakes. Fragmentation acting as a barrier to movement of organism. 8o% of municipal wastewater is discharged into water bodies untreated carrying loads of chemicals. Recent papers have concluded that over exploitation, water pollution, flow modification, degradation of habitat and invasion of exotic species has reduced the number of freshwater species. Eutrophication of smaller water bodies has degraded water quality. Excessive sedimentation due to algal mat deposition, organic debris or allochthonous clastic sediment makes water bodies shallower followed by rooted macrophytes and other nearby plants leads to formation of swamps or the terrestrial vegetation. Anthropogenic Climate change has led to change in temperature and hydrological cycle which directly affect aquatic ecosystem. The qualitative and quantitative change in water bodies has resulted in decreased species richness and diversity. This review is summarizing some potential threats of freshwater which are responsible for its degradation and biodiversity loss.

Keywords: Freshwater, threats, anthropogenic activities, encroachment, biodiversity loss.

Introduction

1.1 Freshwater As A Natural Resource

Water is a vital nutrient of life which is component of every living cell and up to 60% of the human adult body is composed of water. Only 3% of global water is fresh and only a small proportion of this water is available for human use. Surface freshwater habitats contain only around 0.01% of global water (0.29% or 0.3% of all fresh water) and cover about 0.8% of the surface (Gleick 1996; Dudgeon et al. 2006). This restricted part of global freshwater makes it a finite resource which must be used judiciously. The freshwater supports 10% of all known species (Strayer and Dudgeon 2010). Globally aquatic habitats mainly gets threatened by change in the hydrology system by climate change, pollution, and invasive species; and even by succession, agricultural intensification, forestry, mining, urbanization, transport, and overexploitation of biological resources (Ortmann-Ajkai et al. 2018; Janssen et al. 2016). Water as a natural resource is being exploited for our own needs and thus making it vulnerable. Common use of fresh water are seen in house, agricultural practices, industries, recreational activities, supports biodiversity and tourism, power generation and industrial purpose. Apart from this, inland water bodies like ponds, lakes, wetlands also provide certain services to us like flood protection, underground water restoration, carbon sequestering and food. Extraction, diversion and contamination of water create stress in the natural water ecosystem (IUCN.ORG), leading to loss of biodiversity (Bassem, 2020). These threats are resulting in decrease in number of water bodies and loss of aquatic organisms due to which there will be loss of ecological goods and services provided by them. So it will also hit national economy.

1.2 USE OF FRESHWATER IN DIFFERENT SECTORS

Water is a global asset which has cultural, aesthetic, economic, scientific values. Fresh water is present in glaciers, lakes, reservoirs, ponds, rivers, streams, wetlands and even groundwater. Freshwater is essential part of human daily needs either for domestic, agricultural or commercial use. Various areas are dependent on freshwater consumption like thermoelectric power plant requires freshwater for cooling, irrigational activities, public supply, industrial use, aquaculture, livestock, mining and domestic supply. It is also used as a solvent in a wide range of chemical preparations, in cooling towers, transportation (khatri et al., 2014). According to Otto (WRI's Aqueduct platform, 2020) data, domestic water withdrawals increased more than 600% since 1960.

Globally 70% of freshwater is used for agriculture (khokhar, 2017). India being an agrarian country, here a maximum percentage of total fresh water reserve is used for irrigation. In developing countries like India, the commercial sector depending on freshwater are: Agriculture, Automobile, Cements, Chemicals, Engineering and Construction, Food Processing, Health Care, Hospitality, Infrastructure, IT Services, Manufacturing, Mining, Power, Pharmaceuticals, Real Estate, Petroleum and Natural Gas, Steel and Textiles. Surface water is the major source of water for the industries (41%) followed by groundwater (35%) and municipal water (24%). Demand for Water for irrigation, industry and domestic needs in India will go up to 1,072, 130, and 102 billion m^3 (BCM) by the year 2050 (Suresh, 2021).

Over population has led to change in the land use trends which have resulted in stress in water body detoriating aquatic life and aesthetic value as well as creating a gap between demand and availability. Industrialization, urbanization and agricultural activity has increased in last century very rapidly and helped out transforming and developing the society.

1.3 Asset utilization and problem: Indian scenario

Total population of India is 1.38 billion which holds 16% of global population in which 76 million is without access to safe drinking water (IDEI 2020). For any country water availability per person depend on its population and when we talk about India it is reducing due to increase in population. Water availability in between year 2001 and 2011 was assessed as 1816 cubic meters and 1545 cubic meters respectively annually (PIB, 2020).

Industrialization is growing fast. Industries are causing Heavy metal contamination of surface water, which is becoming more serious issue as it may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis. According to central water commission study which was performed at different sites of 67 Indian rivers across 3 seasons, 2/3 of sample sites revealed presence of heavy metal above permissible limit prescribed by bureau of Indian standards but the iron exceeded at most sampling stations.(The wire, 2019).This result clearly indicating a heavy load of heavy metals in freshwater.

1.4 Role and importance of frewshwater biodiversity

Biological diversity is variety of plants, animals, microorganisms but not only at species but also at genetic level. But the diversity at organism level helps nature to be balanced and also helps in maintanance of different types of ecosystem. Certain importance of biodiversity to us are: direct and indirect like food supply, spiritual, aesthetic and recreation value, maintenance of structural diversity of ecosystem, and many other unquantifiable value(Basseem, 2020). Any change in number of organism at any trophic structure will show its impact on its ecosystem.

1. THREATS TO FRESHWATER: MAJOR ROLE OF ANTHROPOGENIC ACTIVITIES

Population is expected to reach approximately 9.7 billion by the year 2050 (United Nations DESA, 2018). Search for social development led to exploitation of the nature and ecosystem, as ecosystem is interrelation between living being and their environment. Palaeolimnological investigations of lakes have shown a much earlier anthropogenic impact (Bradshaw, 2005). Water quality depends on various physico-chemical parameters like pH, temp, DO, COD, transparency, alkalinity etc, and they vary from water to water depending upon catchment area, age of water body and its ambient environment. But human activities are solely responsible for these variations in water body. After a vast review of literature this paper will describe some major threats responsible for altering the chemical structure of water quality and also making them on the verge of extinction. Primary threats are urbanization, habitat destruction, over exploitation, eutrophication, climate change, dam construction, sedimentation and all these are results of modern civilization which are primarily linked to human activity The detoriated water quality ultimately results in loss of biodiversity (Dudgeon et al., 2006; Khatri et al., 2014)

Dudgeon et al., (2006), very well reviewed on ecological stressor responsible for global decline of freshwater biodiversity. They have listed 5 major cause of declining freshwater species worldwide: Over exploitation, water pollution and flow modification, degradation of habitat and invasion of exotic species. In recent studies, some emerging threats for freshwater are: changing climates, e-commerce and invasions, infectious diseases, harmful algal blooms, expanding hydropower, engineered nanomaterials, microplastic pollution, freshwater salinisation, and declining calcium. It shows some new form of human induced pollutants like microplastic and nanoparticles which is now emerging as a new threat for water body in which size less than 1micrometer is hard to detect. Almost 400 million tons of plastics are produced each year predicted to increase more than double by 2050 (Nature, 2021). Its major sources are plastic pellets, personal care products containing microbeads, paint, sewage sludge and many more. Its secondary sources include municipal debris such as plastic bags and bottles, fishing wastes, farming firm waste and other large size plastic wastes (Li-hui An., 2020). These microplastic particles degrade very slowly. When plastics combine with leachable additives and adsorbed contaminants then such particles also shows potential toxicity (Chang et al., 2019). The particle toxicity depends on certain factors like its concentration, size and exposure time (Kogel et al., 2020). The major problem is with the Nanoparticles with size 1 to 100 nanometers. Nanoparticles could be anything from metals to clay which can be ingested by aquatic organism and bioaccumulate further up in food chain (Wilson 2018).

Effluent from wastewater treatment plants can represent up to 70 percent of the flow of urban rivers, leading to increased nutrient loading and eutrophication (Brooks et al., 2006; Gücker et al., 2006). Industrial activities are known for dumping millions of tons of pollutants every year including solvents, heavy metals, toxic sludge (Bassem, 2020; WWAP, 2017).

Some of the major stress generator of freshwater is given below:

2.1 DAM CONSTRUCTION

Apart from the positive impacts like flood protection, generation of renewable energy and provision of water security, there are some negative impacts of dam constructed on river. It is one of the threats for rivers which served as one of the stressor (Gehrke et al., 2002; Schilt, 2007). Dam construction divert the regular flow of water which disrupts natural flooding cycle, brought drought in flood plains, may increase flood risk and also interrupt the migration of aquatic organisms (Environment Victoria). It causes reduction in biodiversity as well as obstruct migration of fish stock (Doll, 2010., Sondergaard, 2007), blocks access to spawning due to habitat fragmentation (Wu et al., 2019) and result in decline in number of fishes (Schick & Lindley, 2007). This led to socio-economic downfall in population of concerned area. Overall a number of problems arises like habitat degradation, altered migratory ways of organisms, and even as dams slow down the movement of water, it also prevent the natural downstream flow of sediment to deltas, estuaries, wetlands, and inland seas, affecting species composition as well as productivity. Today around 60% of Worlds major river flow are being interrupted by dams, canals and diversions which mainly affects vulnerable species of River like Dolphins, migratory birds as well as migratory fishes. The wetland which serves as biodiversity hotspots area suffers a bit more since water is intercepted by dams. Although impact of larger dam is commonly seen but few studies have also suggested that smaller dams can have serious impact on fresh water as seen in the case of study of steam in Massachusetts where elevated temperature and low dissolved oxygen is found downstream of dam impoundment. And this change has resulted in increased stress and death to fishes, mussels, stream insects, and other aquatic organisms (Mass.gov). It needs a more serious study to be conducted to know the impact of smaller dams on biota and water quality. However if smaller dams regulated properly can least harm the species and fresh water quality.

2.2 AGRICULTURAL PRACTICE

Agriculture and its allied sector are the major source of livelihood in India that significantly contributes to GDP (gross domestic product). In 2018 it contributed global 4% GDP (The World Bank, 2020). Agricultural practices cause 70% water extraction and are responsible for discharge of agrochemicals, organic matter, sediments in water bodies (Mateo-Sagasta, 2017). Even livestock sector is expanding globally they are producing its associated waste on larger scale.

In the rural areas, farming or agriculture is the main practice that results in increase in pollutant like nutrients, sediments, pathogens, pesticides, metals and salt. Antibiotics, fungicides and anti-fouling agents in agricultural practices may contribute to downstream pollution in water ecosystem.

This agricultural runoff water contains sediments, fertilizers, chemicals that stick to soil particles. The nutrients and ions are drivers for massive algal bloom formation and eutrophication of water body. Rain water caries soil particles

which settle as sediments in the after runoff. Sediment load also increases the turbidity that affects the fish directly or slows down its growth rate or clog its gills, prevent larval growth, alters migration route, reduces food availability, affects phytoplankton productivity (Grobbelaar, 2009) as well as zooplankton densities (Gophen, 2015). Algal blooms produced frequently in the lake due to high concentrations of phosphorus (P) and nitrogen (N) which is the result of anthropogenic activity (Callisto et al., 2014, Chislock et al., 2013). NO_3^- is a naturally occurring ion in the nitrogen cycle that is the stable form of N for oxygenated systems. High NO_3^- concentrations causes production of heavy blue-green algal growth (such as *Cyanobacteria*), which produce toxins that cause threat to fish and mammals (Breida, 2019). The use of insecticides, herbicides and fungicides in agricultural field are degrading the water quality. The fate of herbicides in the environment depends on certain properties like retention (adsorption, absorption, and precipitation), transformation (decomposition or degradation) and transport (drift, volatilization, leaching, and runoff), and by the interactions of these processes (Mendes 2019). On the other side inefficient use of water for irrigational purpose causes most of the problems for water ecosystem like excessive irrigation of field may cause soil erosion that carries all used products like insecticide, pesticides, chemical fertilizer, sediments to the river and local water bodies and all of these contaminate water and aquatic food source. Leaching is also responsible for groundwater contamination by herbicides (Flury, 1996). Different classes of pesticides contaminate ground water by leaching, diffusion, volatilization, erosion and run-off, assimilation by microorganisms, and plant uptake (Peres Lucas, 2018).

The animal feeding operations produces millions of tons of manure each year but the problem is with improperly managed farms that may pass runoff carrying pathogens such as bacteria and viruses, nutrients and oxygen demanding organics and solids that can contaminate the fishing spot nearby. Overgrazing of livestock exposes soil for erosion as compared to sustainable grazing (Kairis, 2015; EPA, 2015) which goes in local water bodies like ponds and lakes making it unsuitable for use.
The last two decade has seen the growth in the production of agricultural products in the form of veterinary medicine including antibiotics, vaccines, growth promoters that ultimately go to water ecosystem making the water unpleasant. In India scenario, 40% urban India is dependent on underground water due to which ground water table is declining at alarming rate of 2-3 meters/year. India contributes 18% of world population and has 4% of worlds freshwater but 80% of this water gets utilized for agricultural practice which is poorly practiced in India since long time (Dhawan, 2017). So India needs a strong management of irrigation practice mingled with law. There is a need to enforce law in pest management and fungicides and herbicides use to prevent use of fatal or deadly combination of these chemicals. It will help from contamination of water bodies from non point source to large extend.

2.3 INDUSTRIAL ACTIVITY

The industrial activity produces effluent that includes dyes, heavy metals, detergents, hot water, plastic and fibers that degrades the water quality (Mateo-Sagasta etal. 2017).Water ecosystems gets polluted by heavy metals released through mining, weathering of rocks, industrial wastewater and surface runoff (Sun et al, 2019). Common heavy metal pollutants found in aquatic ecosystems are As, Cd, Cr, Cu, Ni, Pb, Hg, and Zn (Masindi et al., 2018) industries being the major source. Heavy metals can be very toxic to organisms in the early developmental stages of organisms. Metallic element with relatively high density as compared to water can be toxic even at low concentrations is termed as “heavy metal” (Lenntech, 2004).
Although its little amount carry out physiological process but its increased level i.e. beyond level of homeostatic regulation can be toxic to humans (Breida, 2019). Accumulation of heavy metals due to consumption of contaminated water in humans can cause damage to heart, liver, kidney, brain and bone (Hong, Y. J et al., 2020). Among all tested heavy metals, Cu, Zn and Pb is shown to have highly accumulative property whereas As and Cu is least. Strong carcinogenic property is shown by As and Pb. Cd and Hg are grouped in highly toxic elements (Breida, 2019). People consuming fish and shellfish get exposed to methyl mercury which is an organic compound and is toxic to central and peripheral nervous system. Inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested (WHO, 2017).
Study conducted by Chen and et al., 2015, indicated that increase in arsenic resulted in decreased population of zooplanktons. However some benthic organism serves as a useful indicator of heavy metal contamination like relative abundance of some benthic species such as *Achnanthidium minutissimum* showing its high resistant to metal contamination and others like *Fragilaria construens* and *F. crotonensis* declined due to its sensitivity to arsenic. The

www.jst.org.in *DOI:https://doi.org/10.46243/jst.2022.v7.i03.pp53-67*

author had the opinion that arsenic contamination can also impact the structure of lakes food webs through trophic transfer.

Sectors like refineries, mining, tanneries, pharmaceuticals, pulp mills, and sugar production/distillery generates hazardous waste water directly to water bodies (Ranade, 2014).

Persistent organic pollutants are toxic chemicals produced from agricultural and industrial sector. They have an adverse effect on human as well as on wildlife. As these are carried by wind and water they go far off from the place of origin. POPs persist for long periods of time in the environment and can accumulate and pass from one species to the next through the food chain. Aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, polychlorinated biphenyls (PCBs), dioxins, furans are considered as dirty dozen POPs. Over 90 countries under the treaty, known as the Stockholm Convention (May, 2011) agreed to reduce or eliminate the production, use, and/or release of these 12 key POPs (IAEA).

The major effects on exposure to POPs in humans via bioaccumulation are: death, cancer, allergy, sensitivity reactions, damage to central and peripheral nervous system, disturbance in endocrine and reproductive system and affects immune system too. Lee et al, 2006, suggested that an increased level of POPs in human blood serum can be linked to Diabetes (UNEP).

2.4 URBANIZATION

According to United Nations report, (UN DESA 2018), 55% of worlds present population living in urban areas which may reach up to 68% by 2050. The world's urban population has increased from 751 million in 1950 to 4.2 billion in 2018. Authors like Wiederkehr, 2020., mentioned about the impact of urbanization on streams, rivers as well as on smaller water bodies.

Studies have shown that urban streams go through the change in ecosystem structure and function. Impact of urbanization on urban streams have been seen on characters like higher dissolved solid and nutrient concentrations, altered hydrology, and increased water temperature, conductivity, and pH. Poor water quality of stream causes abundance of pollution tolerant taxa like hirudinea and gastropods (Wiederkehr, 2020; Yule et al., 2015).

With the industrialization, more urbanization took place. Positive impact of urbanization is socio economic growth but it is going on at the cost of polluting the environment. According to a study conducted by Rashid 2018, in Muzaffarabad city located on the bank of Jhelum and Neelum, observed that population of the city is growing rapidly and it has created many issues especially related to water scarcity and pollution. Grimm et al 2008; Elmqvist et al 2013., have listed some major issues related to urbanization of a river basin which can be more than one of the following:

1) Deforestation
2) Catchment degradation
3) Silting and sedimentation
4) Degraded water quality
5) Alteration of the hydrology
6) Water scarcity
7) River fragmentation
8) Overexploitation
9) Habitat loss
10) Extinction of native species of water bodies
11) Change in species assemblage
12) Threat to biodiversity
13) Frequent floods and drought

After 1950 urbanization peaked up globally, that caused global environmental degradation, increased dependency on natural resources, habitat loss and ecosystem change (McNeill 2000, McDonald 2013). According McDonald(2013) urbanization lead to fragmentation of natural habitat, isolation of population and reduction of gene flow and loss of sensitive species. An urbanized area is full of concreted structures as well as industries. More concrete area allows less groundwater recharge. With the rapid urbanization some serious problems also arises like cutting of more tree, more construction work will lead to more sedimentation in water, faulty sewers and septic tanks may also contaminate water body through runoff, idol emersion adds chemicals along with dyes, medical waste discharge, etc will increase. Even industries further add up the various harmful substances along with heavy metals and other

www.jst.org.in *DOI:https://doi.org/10.46243/jst.2022.v7.i03.pp53-67*

persistent organic pollutants (POPs) through industrial effluent. These all will make water unfit for consumption even for animals.

2.5 MICROPARTICLES: COMBINED EFFECT OF INDUSTIALISATION AND URBANISATION

Industrial production and its effluent as well as rapid urbanization are more responsible for massive production of MPs in different forms. Sources may be from urban dust, tyres, road wear particulates, household factories, skin care products, synthetic cloth, plastic pellets, pharmaceutical carriers, microcapsule fertilizers in agricultural practices, etc. In this time of pandemic, surgical masks are also emerging as source of plastic pollution by increasing landfills and creating medical waste (Selvaranjan, 2021). Apart from its use on larger scale, it is also becoming a threat for natural environment and living creature globally. Its effect can be seen from sometimes clogging the sewerage lines to digestive tracts of grazing as well as aquatic animals. Plastics are non biodegradable, instead of degradation it gets broken down to small tiny pieces as microplastics. Today microplastics come in different types like pellet, fragment, film, fiber, foamed plastic and Styrofoam. These tiny particle of microplastic and nanoplastic which resembles as food particle swept from land and finally goes to water bodies where it is consumed by the wildlife resulting malnutrion, death of the organism, reproductive problems or it might hinders growth (Susanti, 2020). All these problems have arisen due to poor management of plastic wastes. MPs are also detected in drinking water (Campanale, 2019), emerging as threat for public health via water as well as air we breathe (Haughney, 2021), Can also pass through skin (Yee, 2021), serving as vector for transport of hazardous chemicals (Campanale, 2020). Inhalation may lead to immediate bronchial reactions (asthma-like), diffuse interstitial fibrosis and granulomas with fiber inclusions (extrinsic allergic alveolitis, chronic pneumonia, chronic bronchitis, and interalveolar septa lesions (Prata, 2018 ; Campanale, 2020). A clear indication of abnormal functioning of the cell has been observed but even after this a large number of researches need to be done for bioaccumulation impact on human cells and organ.
And since plastics are indispensable part of our life, there must be a comprehensive study of the additives of plastic materials and their fate in the environment so that a less toxic or harm free plastics can come into existence.

2.6 ENCROACHMENT

One of the negative impacts of urbanization is encroachment of small water bodies like ponds. Most of the ponds and wetlands are facing severe encroachment by the local citizens. Ponds and wetland are very important for us as they provide drinking water as well as recharge underground water. They also support diverse biota. Even they provide source of livelihood. Nowadays, smaller water bodies in urban area are becoming a real estate. Private builders find these water bodies as a piece of real estate for construction of multistory building.
In India states like Bihar, Haryana, Punjab and Tamil Nadu are facing the same problem rapidly (Chaba, 2020; The Hindu, 2021 and Khan 2021).
This can be understood through two case studies:
Case 1 - 15 to 20 % of the village ponds in Punjab also facing illegal encroachment. This encroachment is either temporary or permanent. Under temporary encroachment, poor landless people from low-caste communities using it for keeping their cattle, to store fodder, growing vegetables and making cow dung cakes while under permanent encroachment pucca houses have been made.
Case 2- Pallikaranai marshland in Bangalore. The dumping of solid waste, sewage discharge, and construction of new buildings such as a railway stations and a new road have shrunk this wetland to a great extend (Cseindia, June 2013).
Decreasing these freshwater bodies through encroachment will directly cause scarcity of drinking water.

2.7 OVER EXTRACTION

Although 70% of earth surface is water, we are leading to water scarcity problem because we are having a small fraction of freshwater. The later is being draining more rapidly than getting replenished. From India and china to United States, major aquifers are facing problem of over extraction. There are certain sectors which uses are great part of available freshwater globally like industry, agriculture and municipality.
Global freshwater use has increased from 1950s onwards. India uses some 230 km^3 of groundwater per year, making it the world's largest user of groundwater (World Bank, 2012). Gorton (2017), very well studied on underground

water situation in India and according to him around 85% of drinking water in rural areas provided by ground water. Rate of water extraction is too high where as groundwater replenishment has been unable to sustain water levels in many of the country's aquifers. He also stated that groundwater depletion is at critical level and the problem must be solved for long run water security. Similar trend has been seen in lakes by Alemayehu et al., 2007, who worked on highland lakes of Ethiopia and put the view that overexploitation of the lake resulted in loss of lakes in the area.

The river has its own importance and play role in socio-economic development to ecosystem management, supply drinking water and agriculture. But with growth of population, these resources are overexploited for irrigation, electricity generation, etc. The Indian Ganges basin is depleting because of increasing population and growing irrigational demands by an estimated rate of 6.31cm / year.

UC Santa Barbara assistant professors Debra Perrone and Scott Jasechko have studied and analyzed tens of millions of groundwater wells around the world spanning 40 countries that collectively account for half of all global groundwater pumping. They concluded that many wells are at risk of running dry, up to one in five wells in their survey. (University of California, 2021).

According to USGS data, over 50 billion gallons per day for agricultural need of United States is full filled by underground water and half of the total population relies on it for drinking water. Rapid ground water pumping can create a major issue of declining underground water. This decline of underground water will show some other key issue like drying well, increased pumping cost, reduction of water in streams and lakes, land subsidence and increased cost of pumping (USGS, 2018).

With the increasing population, demand for global water use will also increase by industrialization, agricultural practice and domestic use. So the concern must be for replenishment of underground water system to sustain increasing population. We need to focus on the different ways of replenishment.

2.8 INVASION OF EXOTIC SPECIES

Invasive species are considered as non native species produced in new habitat which can be accidental or intentional but it results in loss of native species. They alter the habitat there.

Exotic species invasions often results in native biodiversity loss (Milardi, M. et al., 2019), decrease in the income of fisherman (Xia Y and et al., 2019), can competitively exclude or reduce the population of native fauna (Vanni et al., 2009), can cause alteration to the habitat, may arise competition for food and living space, introduction of pathogen, hybridization, along with environmental and socio-economic effects (Sankar et al., 2018).

Case 1- study conducted by Biju Kumar and et al, from the Department of Aquatic Biology and Fisheries, University of Kerala, revealed the role of the 2018 floods in introducing the most dangerous exotic fishes such as arapaima and alligator gar into Kerala's wetlands. These are illegally imported fishes are reared by ornamental and commercial fish traders across India. They slowly begin to wipe out local diversity as well as changes economic growth by altering the functions of the ecosystem (Sandilyan, 2018).

2.9 SEDIMENTATION

Lakes and ponds are sources of inland freshwater. Diwate (2021) has listed some controlling factors of sedimentation in India. According to the author, Problem of sedimentation is controlled by certain factors like rainfall, lithology and slope of the area as well as anthropogenic activities. Rate of sedimentation of smaller water bodies like lakes also increases due to eutrophication caused by incomplete decomposed matter at bottom of water body (Hasler, 1947). Eutrophication is a natural process of water body that occurs over centuries but can also be human induced within decade (Addy and Green 1996). Eutrophication is condition seen in aquatic ecosystem in which algal growth increased rapidly due to nutrient enrichment followed by lack of oxygen in profundal zone of water, death of organism and settlement of organic debris as sediment. As the ponds and lakes are formed, they undergo through various ecological changes. They commonly see runoff, especially from urban and agricultural areas, carries fertilizers, pesticides, eroded sediment from rocks or industrial effluent that accelerate eutrophication when discharged into a water body (Smith et al. 1999). Industrialization and urbanization has led to rapid eutrophication. Such activities speed up their aging. Excessive addition of plant nutrients, organic matter and silt deposition are the factors that leads to increased algal growth and rooted plant biomass with reduced water clarity. Also, deforestation and clearing of land for farming, has increased the rate of siltation in the lakes that dramatically decreases the lakes' volume which increased the rate of evaporation (Xu, 2017). The sediment deposition takes place due to either algal mat deposition, organic debris or allocthonous sediment deposition. After a point of sediment and

silt deposition, ponds and lakes become so shallow that the rooted macrophytes and other nearby plants makes their way to formation of swamps or the terrestrial vegetation as seen in the diagram.

2.10 Sources of anthropogenic sources creating eutrophication

Sources could be of two types;

1) Point source 2) non- point source

1) Point source- it includes those pollutants which are releasing from fixed locations. For example, industrial waste or sewage treatment plant waste
2) Non point source- it include those pollutants that enters into main water body without any identifiable point of entry. For ex, runoff water with agricultural waste. Urban ponds and lakes are suffering from the same.

On a global scale, researchers have demonstrated a strong correlation between total phosphorus inputs and algal biomass in lakes (Anderson et al. 2002). According to khatri (2014), major causes of eutrophication common to both rural and urban area are as follows:

i) Fertilizers
ii) Animal husbandry
iii) Poultry farming
iv) Deforestation
v) Industrial effluent
vi) Municipal Sewage discharge
vii) Domestic effluent
viii) Aquaculture practice

Even increases in minute amounts of the nutrient can stimulate tremendous growth and productivity. Sequential steps given below responsible for extinction of small water bodies-

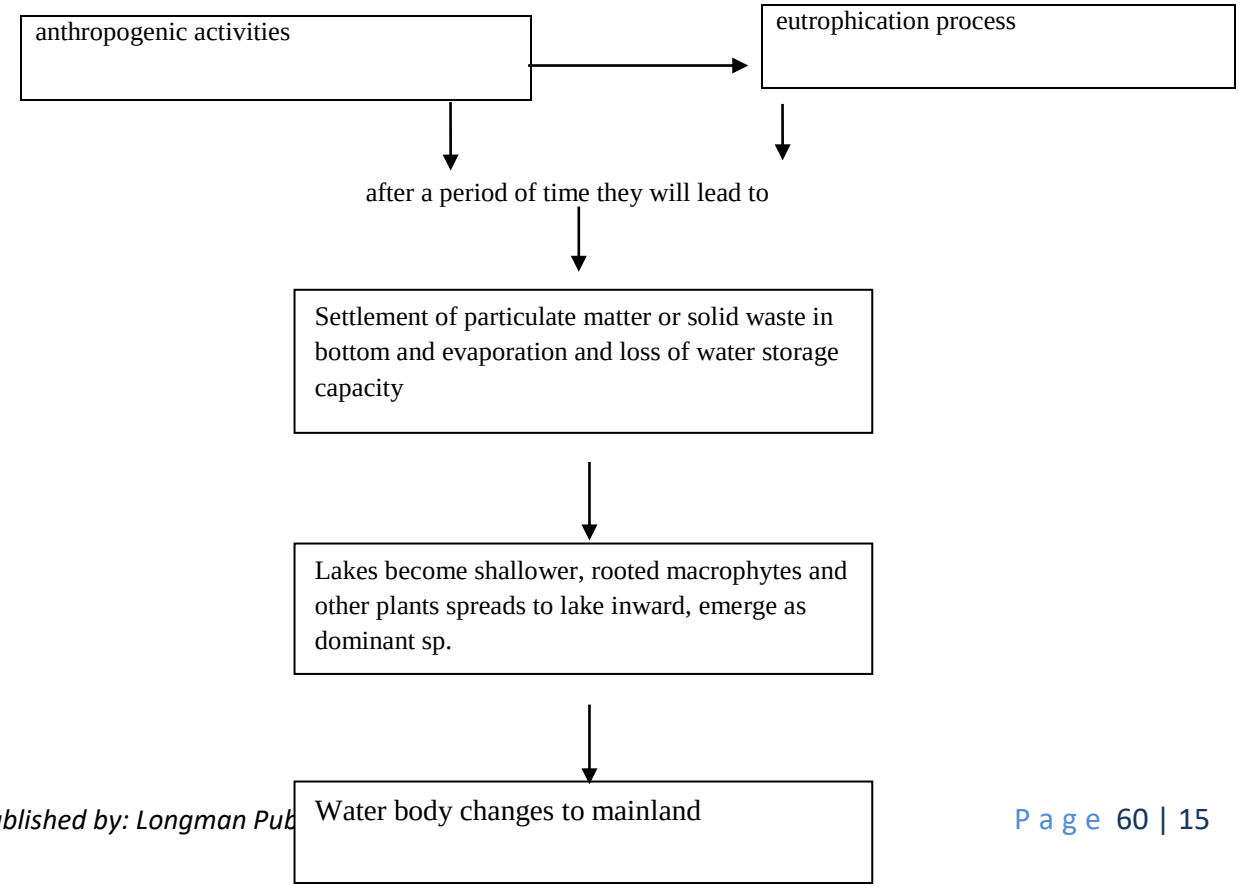

FIG: steps involved in extinction of lakes and ponds in urban areas due to nutrient enrichment and sedimentation.

2.11 CLIMATE CHANGE

Anthropogenic climate change is major threat which we are facing today globally. The recent decades have seen warmest temperature ever, extreme weather (WMO, 2021), extreme precipitation (Swain, 2020), flooding (LSE, 2021) which also increases with seasonal cycle of water availability (Tabari, 2020), drought, altered flow regime of river because of climate change.(Doll, 2010). Ganga basin in recent years has faced the precipitation extremes related with flooding of the region (Padma, 2018). Present scenario is being very helpful in predicting the future trend of increased flooding in monsoon while the dry season flow will be only slightly increased. Free-flowing rivers play a critical role in moderating the effects of climate change by transporting decay organic particles and eroded rock to the ocean thereby withdrawing about 200 million tons of carbon out of the air each year (Chelleney, 2020).

It might be possible that by 2050, climate change may alter the flow regime significantly (Doll, 2010), change in species interaction (Cahill, 2013). Increased global temperature is causing change in precipitation pattern and also shifted agricultural season. According to Rapp, 2014., there has been an increase in global temperatures in the 20th century due to anthropogenic activity might have contributed significantly to climate change. In Fifth Assessment Report, the Intergovernmental Panel on Climate Change, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded there's a more than 95 percent probability that human activities over the past 50 years have warmed our planet. Climate change is now regarded as a global problem which has an impact on natural and human system (Hensen and Cramer 2015), hydrological cycle and hence on the ecosystem (Huntington 2006; Oki and Kanae 2006; Hassan 2020). Climate change affects freshwater ecosystems not only by increased temperatures but also by altered freshwater regimes i.e., pattern of flow variability, disappearance of wetlands with drier ends (Doll, 2010). And if anthropogenic activities are not controlled then a more serious condition will arise globally in the coming years.

2. CONCLUSION AND DISCUSSION

Freshwater threat has emerged as a global problem. Recent trends have shown that development and urbanization creating a huge impact on aquatic life. Deforestation, mining, dam construction, agricultural practices are common practices running parallel to development. But industrialization and over population has led to more intense exploitation of natural resources globally. With more population, more urbanization happened and will continue as the trend indicating the same. There is a need of various ecological assessment and water restoration program or mission. There is a lack of global platform for implementation of laws and policies related to freshwater conservation. There is a lack of research towards generating water harvesting technique as well as wastewater treatment. Frequent biomonitoring program by government agencies is an essential requirement of water bodies to know the impact of increasing population and its impact on water bodies. Survey of water body after implementation of laws is a lagging step towards the goal of clean water to achieve which will further help out in redrafting the policies.

3. FUTURE CHALLENGE

Water pollution is becoming a global challenge now days due to anthropogenic activities which brings about problems for physical and environmental health of billions of people, biodiversity loss as well as economic loss. In the coming years, major issue the freshwater bodies will be facing are: heavy metal load and massive E-waste generation globally. Proper disposal of such product will be a future problem to deal with. Secondly, dealing with tons of generation of microplastics in larger water bodies will be tough. In upcoming years more research is required

for biodegradation of plastics. More research is required on effect of micro and nanoparticles on aquatic life. Focus on the study of the impacts of micro and nanoprticles and e-waste will be important step which must be taken immediately in decision making and drafting policies in regulating the use of plastics. Regulated sediment flow in smaller water body should also be focused at regional level otherwise future generation will soon lose our some of the important and heritage water site.

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