



Surface and Ground Water Pollution: Causes and Effects of Urbanization and Industrialization in South Asia

Bijoyee SarkerInstitute of Radiation and Polymer Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh
National Institute of Textile Engineering and Research, Nayarhat, Savar, Dhaka- 1350, Bangladesh**Kamrun N. Keya**

Institute of Radiation and Polymer Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh

Fatin I. MahirInstitute of Radiation and Polymer Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh
National Institute of Textile Engineering and Research, Nayarhat, Savar, Dhaka- 1350, Bangladesh**Khandakar M. Nahiun**Institute of Radiation and Polymer Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh
National Institute of Textile Engineering and Research, Nayarhat, Savar, Dhaka- 1350, Bangladesh**Shahirin Shahida**

Department of Mechatronics Engineering, Kyungsoong University, 309 Suyeong-ro, Nam-gu, Busan-48434, Republic of Korea

Ruhul A. Khan (Corresponding Author)Institute of Radiation and Polymer Technology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh
Email: dr.ruhul_khan@yahoo.com**Article History****Received:** 24 April, 2021**Revised:** 15 June, 2021**Accepted:** 28 June, 2021**Published:** 4 July, 2021Copyright © 2021 ARPG
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Abstract

Water pollution in South Asia is an alarming issue that has immersed recently. Developing countries, particularly those in South Asia, are fast adopting industrial pollution control standards similar to those in developed countries. So both surface and ground water are already scarce however, individuals and industries continue to pollute the already limited supply of water. On the other hand, the pollution of rivers is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities. Unplanned urbanization and industrialization occurring in these countries like Bangladesh, India, Nepal and Sri Lanka, etc. may be largely responsible for this grave situation. Therefore these human activities including industrialization and urbanization contributed immensely in no small measure to the degradation and pollution of the environment which adversely has an effect on the water resources such as surface and groundwater that is a necessity for life. This paper tries to discuss basically the causes and effects of urbanization and industrialization in surface and groundwater pollution and equally to address the controlling issues and challenges in South Asia.

Keywords: Surface water; Ground water; Water pollution; South Asia; Urbanization industrialization; Pollution controlling issues and challenges.

1. Introduction

In recent years there has been an increasing awareness of the unfavorable effect of many anthropocentric activities on both resource quality and availability. Water is one of the most critical resources required for survival [1]. For the existence of humankind fresh water is indispensable. It has contributed significantly to the acquirement of developing aims in various sectors of the purpose of many different countries. Over the years, water demands for domestic and municipal use. But nowadays the requirement of water owing to agricultural purposes and industrial processes has been steadily increasing. However, unfortunately, the quantities of water continue to remain limited which can economically develop on a long term basis [2]. Therefore, the quality of the available water resources is increasingly degraded in many areas due to the expanded volume of industrial and other wastes from human activities which are being disposed of to the environment. The environment, economic growth, and development are all highly influenced by regional and seasonal availability as well as the quality of surface and groundwater. The quality of water is affected by human activities and is collapsing due to the rise of population growth, urbanization, agricultural development and other factors [3].

The water resources on the earth are depleting fast. Out of several components of the environment, water, being traditionally the most convenient receptacle for the society in India which has been polluted to the threshold. The water resources are limited but the assault in the form of pollutants is an ongoing process. About 70 percent of all available water in India is feared polluted. This state of affairs is really alarming [4]. Without pollution controls, water would become grossly polluted and unusable for a wide range of human and non-human needs [5]. The

problem of water resources is not less urgent than that of other types of pollutions. In South Asia, human and physical geography are tightly bound to the rivers that radiate out and down from the great Himalayan massif and the extensive Indo-Gangetic basin aquifers. Driving some of the largest irrigation systems in human history and nourishing populations and ecosystems straddling rich alluvial floodplains, the annual flood pulses of these rivers — the Ganga, Indus, Brahmaputra, and Meghna amongst them has determined the development of human civilizations and provided livelihood security for several millennia. More recently, groundwater from alluvial and hard-rock aquifers has augmented less reliable surface supplies for irrigation and become the primary source of rural, urban and industrial water supplies [6].

In South Asia, one of the indispensable water sources is surface and groundwater. Surface-water resources known as the water in the nation's rivers, streams, creeks, lakes, and reservoirs are vitally important to our everyday life. The main uses of surface water include drinking-water and other public uses, irrigation uses, and for use by the thermoelectric-power industry to cool electricity-generating equipment and on the other hand groundwater is the part of precipitation that seeps down through the soil until it reaches rock material that is saturated with water. Groundwater is stored in the spaces between rock particles and slowly moves underground, generally at a downward angle (because of gravity). It also may eventually seep into streams, lakes, and oceans. Water resources these water resources are now rapidly changing, and this change brings heightened risk and uncertainty. With rapid economic growth in South Asian developing countries, demand for water in urban and industrial uses is also growing rapidly. Thus, results not only increased withdrawal of water from rivers and aquifers, but also pollution of rivers and lakes from indiscriminate disposal of untreated and partially treated effluents. This seriously intimidates the ecosystem health and water security of millions of rural and urban households that have no access to formal water supply systems to meet their basic survival needs [7]. Therefore, In the last few decades, there has been an extraordinary increase in the demand for freshwater because of the rapid growth of population and the accelerated pace of industrialization [8]. Therefore, during current years there has been increasing awareness of, and concern about, water pollution all over the world and new approaches towards achieving sustainable exploitation of water resources have been developed internationally. The South Asian countries like Bangladesh, India, Sri-lanka, Nepal, etc. are the most water-rich regions in the world but they also show spatial variability and there has also been great variation in the strictness of monitoring and enforcement of regulations [9].

2. Bangladesh

The environmental absorptive capacity of this densely populated, the riverine country is very low; current environmental concerns focus on the impact of water pollution. Industrial facilities in pollution-intensive sectors such as food, wood pulping, chemicals, and fertilizer nearly always discharge their wastes into rivers which serve large downstream populations. Bangladesh has a tropical monsoon climate characterized by high seasonal rainfall, temperature, and humidity. Although surface water is used to be the primary source of water supply in Bangladesh, it is extensively polluted by sources such as industrial and urban wastes, agrochemicals and sewerage wastes and seawater intrusion. Surface water bodies are extensively conducted for disposal of untreated industrial wastes and this is one of the main sources of pollution. Buriganga is a typical example of serious surface water contamination. Apart from industrial sources, surface water in the country is also extensively contaminated by human faces as sanitation, in general, is poor. Industrial chemicals are extensively used in the country which is one of the reasons for polluting surface water. Due to the withdrawal of water from the Ganges, seawater trespasses a long way inside the coastline which causes river water pollution by salinity. There are also other minor sources that contaminate surface water extensively. Groundwater in Bangladesh is also polluted by a number of anthropogenic and natural sources. The infiltration of industrial and urban wastes disposed on the water bodies, intrusion or infiltration of saline water is one of the sources of contaminating groundwater. Also, extensive use of agrochemicals, leakage of sewers/septic tanks/pit latrines can lead to groundwater pollution [10].

3. India

Right now water pollution is one of the biggest issues in India. As may be evident, untreated sewage is the biggest source of such form of pollution. In fact, it is said that almost 80% of the water bodies in India are highly polluted. This is especially applicable for human habitation in their immediate approaches towards water bodies. Ganga and Yamuna are the most polluted rivers in India. This polluted water also seeps through the surface and poisons groundwater. It is estimated that cities with populations of more than one lakh people generate around 16,662 million liters of wastewater in a day. Strangely enough, near about 70% of the people in these cities have access to sewerage facilities and added with that cities and towns located on the banks of Ganga generate around 33% of the wastewater generated in the country [11].

4. Pakistan

In Pakistan, poor water quality is one of the major environmental and health-related concerns. Both surface and groundwater in the country are polluted with microorganisms and various toxic compounds [12]. Bad living conditions and natural disasters mixed with mismanagement frequently contaminate both surface and groundwater in the country. In Pakistan, water at the source, in the distribution network, and at the consumer tap is heavily polluted with coliforms and fecal coliforms all over the country. An overview of more than 7,000 water samples reviewed here reveals that an average of over 71% and 58 % samples in the country were extremely contaminated with total coliforms and fecal coliforms respectively [13].

5. Sri Lanka

Water pollution is an increasing issue in Sri Lanka. Water pollution has increased ever since the country has started developing because of the accumulating number of industries that emit a significant amount of environmental contaminants, which all contribute to polluting the water bodies in Sri Lanka. Water pollution is an important issue that needs to be solved because of the insufficient amount of pure water is available to only 25% of all households in Sri Lanka. Consequently, this pollution of water causes many water-borne diseases and health impairments to all residents of Sri Lanka, specifically children. The two most polluted lakes in Sri Lanka are the Beira Lake and the Kandy Lake. These lakes are heavily polluted with regular outbreaks of algal blooms arising from eutrophication the increased organic content in water bodies depletes oxygen and affects fish populations. Furthermore, the increasing amount of garbage disposal is also deleteriously affecting the environment because of the lack of infrastructure for garbage collection. All this toxic garbage is then led to the sewers, which then lead to polluting the water bodies that it runs into. This contributes to much of the health problems and the pollution of the atmosphere [14].

6. Nepal

Pollution of water is the most serious public health issue in Nepal as many people drink water from spring, streams, canals, ponds, wells, rivers, etc. Many studies indicate that the public water supply is far from satisfactory in almost all localities in term of bacterial and chemical contamination. It came to the government of Nepal's notice through newspaper reports that Nepal was contemplating building a barrage on Nepal's river, ostensibly to supply water to Terai. Nepal's concerns were conveyed to the government of Nepal but did not receive much sympathy from Kathmandu. Water environment issue could be differentiated in two broad types. First is caused by diffuse sources such as River sedimentation, soil erosion, fertilizers, pesticides from agricultural fields, and from improper wastewater management. Diffuse source pollution is common in rural areas, where the majority of people are dependent on agricultural activities and lack access to basic sanitation facilities. Similarly, there is excessive use of chemical fertilizers and pesticides in agricultural fields near to agro-market areas such as Kathmandu, Chitwan. Second types of problem originate from both point- and diffuse sources that are specific to urban areas like Kathmandu and Pokhara. The sources include direct discharges of domestic and industrial wastewater and illegal dumping of solid wastes into natural water bodies (rivers, lakes, ponds). Primarily unplanned urban development and deficiency of waste management facilities are major barriers for alleviating water pollution problems. As a result, urban rivers like the Bagmati in Kathmandu valley is highly polluted whereas BOD level is extremely high. Similarly, discharges of human wastes have caused eutrophication and emergence of macrophysics in certain portions of Phewa Lake in Pokhara. Therefore, deficient water resources such as surface and groundwater in South Asian countries have increasingly restrained water pollution control and water quality improvement. So, protecting these water resources is extremely urgent because of serious water pollution and global scarcity of humankind [15].

7. Sources of Surface and Ground Water Pollution Due To Urbanization and Industrialization

Water pollution can occur from two sources. 1. Point source and 2. Non-point source (Table 1). Point sources of pollution are those which have a direct identifiable source. An example includes pipe attached to a factory, oil spill from a tanker, effluents coming out from industries. Point sources of pollution include wastewater effluent (both municipal and industrial) and storm sewer discharge and affect mostly the area near it. Whereas non-point sources of pollution are those which arrive from different sources of origin and number of ways by which contaminants enter into groundwater or surface water and arrive in the environment from different non-identifiable sources. Examples are runoff from agricultural fields, urban waste, etc. Sometimes pollution that enters the environment in one place has an effect hundred or even thousands of miles away [16].

Table-1. Characteristics of point and nonpoint sources of chemical inputs to receiving surface and ground waters due to urbanization and industrialization [17]

Point Sources	Nonpoint Sources
Wastewater effluent (municipal and industrial)	Urban runoff from agricultural areas.
Runoff and leachate from waste disposal sites	Activities on land that generate contaminants, such as logging, wetland conversion
Runoff from mines, oil fields, industrial sites	construction, and development of land or waterways
Overflows of combined storm and sanitary sewers	Atmospheric deposition over a water surface
Runoff from construction sites	Septic tank leachate and runoff from failed septic systems
Runoff and infiltration from animal feedlots	Runoff from pasture and range

8. Components of Polluted Water

Water pollution is the contamination of water bodies, usually as a result of human activities. Water bodies include for example lakes, rivers, oceans, aquifers, and groundwater. Water pollution results when contaminants are introduced into the natural environment. There are several classes of water pollutants. They are oil and derivatives, carbonic compounds, thermal pollution, pH, heavy metals, biodiversity in water, suspended impurities, algae and bacteria, silts and sediments, oxygen-demanding wastes and others [17].

Surface water pollution includes mainly pollution of rivers, lakes, and oceans so discharging sewage and industrial waste are the common paths of entrance for those contaminants into the sources. The most frequently discharged component is carbonic compounds and it includes detergents and other cleaning materials, surfactants, pesticides, and other organic industrial wastes. Many of these materials are poisonous for living organisms and cause serious water pollution problems. Detergents and other cleaning materials form an important source of water pollution. They change the pH of the water and thereby the distribution and activities of aquatic life. Then some industries discharge hot water directly in the water bodies which causes a rise in temperature and results which are known as thermal pollution. The important industries which cause thermal pollution are nuclear powers, power generators, etc. where water is used as the coolant, but nearly all the industries contribute for the above, though they vary in their extent. Bacterial population reduction in response to thermal pollution has also been reported in some studies. Temperature also affects electrical conductance of water in addition to the oxygen content in water, which is also affected by temperature. Heavy metals are important components of colors and dyes and are also used in various pharmaceuticals and other industries. The excess or surplus or unused heavy metals ultimately find its way into the water bodies which shows biological magnification [18].

Groundwater contamination occurs when pollutants are discharged to the ground and make their way down to groundwater. Pollution can take place from on-site sanitation systems, landfills, effluent from wastewater treatment plants, leaking sewers, petrol filling stations or from over application of fertilizers in agriculture. It can also occur from naturally occurring contaminants, such as arsenic or fluoride. One of the main components of groundwater pollution is arsenic or fluorides which have been recognized as the most serious inorganic contaminants. On the other hand, natural fluoride in groundwater is also of growing concern and can especially be released from acidic volcanic rocks and dispersed with water when the hardness of water is low. Pathogens are also one of the components of polluted water which is introduced by the lack of proper sanitation measures. Furthermore, Volatile Organic compounds are also one of the dangerous contaminants of groundwater which mainly come from industrial solvents and operations. Then metal can be easily traced by the formation of certain rocks which can be naturally entered into the groundwater. However, some industrial activities can also confound metals among groundwater and contaminate it. Some pharmaceuticals like antibiotics, anti-inflammatories, antidepressants, decongestants, tranquilizers, etc. are also the reason for contaminating groundwater as they are frequently used for the treatment of wastewater [19].

9. Urbanization

Urbanization generally leads to higher phosphorus concentrations in urban catchments [18]. Increasing imperviousness increased runoff from urbanized surfaces, and increased municipal and industrial discharges all result in increased loadings of nutrients to urban streams. This makes urbanization second only to agriculture as the major cause of stream impairment [16]. In the urban territories, precipitation run-off as stormwater is one of the major non-point sources of pollution affecting the nature of our waterways and water inlets. Stormwater from road surfaces is frequently degraded with auto oil and the faces of creatures and soil and residue run-off from development destinations and in mechanical ranges regularly contains more toxicants and chemicals. In some outer-urban and urban shore areas, a reticulated sewerage system is not available. So sewage is discharged to onsite wastewater systems and septic tanks. Seepage and surface run-off of septic tank effluents may also be considered as the non-point source of pollution of rivers in these areas [19]. The pursuit of economic advancement had conjured a disregard for environmental conservation, which in turn has resulted in water problems of considerable magnitude. Despite the proclamation of laws and setting up of governmental agencies, the control of environmental degeneration and enforcement of regulation have been slow due to budget and skilled manpower constraints [20].

10. Causes of Surface and Ground Water Pollution Due to Urbanization

Urbanization is again a process of becoming urbane. It is the process of being developed. Urbanization always gives people more choices and also gives insights to think in a positive manner. Development is multidisciplinary in nature and urbanization is a component of development. It is a process of reorganization and reorientation of the entire social system and social environment. With the increasing growth of urbanization, it causes pollution in Million different ways [21].

- Sewage from households goes into the rivers if there is not proper drainage system.
- Increased use of plastic and other non-bio degradable materials which are in turn left into the water bodies.
- The physical disturbance of groundwater due to the construction of houses, industries, roads, etc.
- The land is losing its natural characteristics because of using chemical pesticides and fertilizers. Besides, the over usage of these chemicals causes them to flow into the water bodies when there is rain. This causes the growth of weeds in the water and affects the aquatic life also.

11. Industrialization

Several Asian economies have gone from being largely agriculture-based to relying heavily on income from industry. The fastest-growing sectors include food and beverages; electrical equipment; cement; metals; chemicals; plastic and rubber products; and textiles, for which production has expanded in the range of 20-45%. In at least 30 Asian and Pacific countries, more than 20% of the total GDP is earned through industrial activity. Although environmental awareness in the industrial sector has increased, enforcement of regulations is difficult and pollution continues to rise as the region is dominated by small- and medium-scale industry [21]. Many of the industries are

situated along the banks of the river such as steel and paper industries for their requirement of huge amounts of water in manufacturing processes and finally, their wastes containing acids, alkalis, dyes, and other chemicals are dumped and poured down into rivers as effluents. Chemical industries concerning with manufacture of Aluminum release a large amount of fluoride through their emissions to air and effluents to water bodies. Fertilizer industries generate a huge amount of ammonia whereas steel plants generate cyanide. Chromium salts are used in the industrial process for the production of sodium dichromate and other compounds containing chromium. All such discharges finally arrive at water bodies in the form of effluents affecting human health and the organism living there [16].

12. Causes of Surface and Ground Water Pollution Due to Industrialization

Industrialization is not only related to the growth of industries but it is a process of value addition. The process of change from an agrarian and handicraft economy to one dominated by new technological manufacturing. It makes people's work easier. Industrial water pollution is caused by the discharge of harmful chemicals and compounds into water, which makes it unsuitable for drinking and other purposes. Although 70% of the Earth is covered by water, only water bodies like lakes, ponds, rivers, reservoirs, and streams provide us with fresh water, and so, keeping them clean is an issue of survival not only for humans but for all other forms of life. Some causes are [22].

1. There is a lack of strict pollution control policies in many countries of the world, especially in South Asia.
2. Use of Outdated Technologies. Some industries still rely on old and outdated technologies that produce a greater amount of pollutants compared to modern technologies
3. Industrial water is not treated adequately before discharging it into rivers or lakes. This is particularly true for small scale industries that do not have enough capital to invest in pollution control equipment.
4. Unplanned industrial growth contributes to water pollution. Though industrial growth boosts the economy of a country, it degrades the environment, especially when it is unplanned. The growth can also contribute to the lack of proper waste disposal sites, and a total disregard for pollution control laws are some negative consequences of unplanned industrial growth.

13. Effects of Urbanization and Industrialization

Justice V.R. Krishna Iyer once remarked that the unconscionable industrialization, the unpardonable deforestation and the inhuman extermination of living species betray exploitative brutality and anti-social appetite for profit and pleasure which is incompatible with humanism and conservationism. Today a bath in Yamuna and Ganga is a sin against bodily health, not a salvation for the soul, so polluted and noxious are these holy waters now [22]. When our population was limited, water supplies seemed endlessly renewable. We could then afford to foul one water source, abandon it, and move on to another. This, however, is no longer possible since the exponential growth rates of the human population have already reduced the availability of water to below its per capita availability. So, there is a huge impact on water resources due to both urbanization and industrialization [23].

Lands with higher levels of the impervious area have higher curve numbers which correspond to a greater surface runoff because impervious surfaces reduce the permeability of land surface and infiltration at the site. The total volume of runoff increases as the urbanization density increases. The results may indicate that the increase in impervious cover increases surface-water runoff while the increase in urban irrigation and underground Karst results in greater recharge to the groundwater [24]. Moreland erosion and more sediment are washed into streams. This increases the chance of flooding and harms the water quality of the streams. Some small streams are paved over (using culverts). Natural land that used to soak up runoff is replaced by roads and large areas of pavement. Surface water run-off from the urban area. Runoff is defined as the portion of the precipitation that makes its way towards rivers or oceans as surface flow or groundwater flow. The most common effects of urbanization are reduced infiltration and decreased travel time, which significantly increases peak discharges and runoff [25].

The wastes generated in various industrial processes can basically bring about some changes when they are poured into the water bodies. Industrial water pollution can have distant reaching effects on the ecosystem. The water used in various industrial processes comes in contact with toxic chemicals, heavy metals, organic sludge, and even radioactive sludge. So, when such polluted water is thrown into the ocean or other water bodies without any treatment, they become unfit for any human and agricultural use [26]. Manufacturing and other chemical industries require water for processing and cleaning purposes. This used water is recycled back to water sources without proper treatment, which causes results in groundwater pollution. It is also to be noted that solid industrial wastes that are dumped in certain areas also contribute to groundwater pollution. When rainwater seeps downwards, it dissolves some of these harmful substances and contaminates groundwater [27]. Industrial wastewater can increase the murkiness of the water. This, in turn, can prevent sunlight from reaching the bottom of the water bodies. As a result, bottom-dwelling plants can fail to photosynthesize. Excessive murkiness of water can also block the gills of fish, and thus, make it difficult for them to take up dissolved oxygen from the surrounding water [28]. Fluoride contamination of groundwater from industries has been a cause of concern for a long time. Excessive intake of groundwater with a large amount of fluoride leads to dental fluorosis, fluorosis of bones, and metabolic alterations in the body tissues. So, in South Asia, low-income communities are disproportionately at risk because their homes are often closest to the most polluting industries. Waterborne pathogens are a major cause of illness from contaminated water resources such as surface and ground water, in the form of disease-causing bacteria and viruses from human and animal waste, these toxins can cause a host of health issues, from cancer to hormone disruption to altered brain function [29].

14. Managing Water Quality

14.1. Monitoring

Demographic changes, industrialization, and urbanization have serious implications for water quality across Asia [21]. With rapid industrialization and urbanization, the water requirement for energy and industrial use is estimated to rise to about 18% of the total requirements in 2025 [10].

Poor environmental management systems, especially in industries such as thermal power stations, chemicals, metals and minerals, leather processing and sugar mills, have led to the discharge of highly toxic and organic wastewater. This has resulted in pollution of the surface and groundwater sources from which water is also drawn for irrigation and domestic purpose [16]. However, a major issue in preparing the Asian Water Development Outlook has been the paucity of data on all aspects of water-related issues. Even when data were available, their reliability was often unknown. The problem was further compounded by the presence of either inconsistent national datasets or different data from various national sources on the same parameters, and significant differences in many cases between national and international datasets [30]. The traditional concept of water resources development with an emphasis on exploiting water resources systems should be oriented towards the concept of water resources management with more emphasis on allocation issues [31]. The enforcement of regulations regarding the discharge of industrial wastewater and limits to the extraction of groundwater needs to be considerably strengthened, while more incentives are required for promoting wastewater reuse and recycling. However, the multitude of national and international guidelines for the evaluation of water quality makes it unsurprising that basin-wide agreements are only slowly crystallizing, although the concept of indexing water quality with a numerical value across physical, chemical and biological parameters could standardize Tran's boundary assessments [32].

14.2. Resource of Organization and Centralization

Fragmented water resources management has led to overinvestment and uncoordinated management, especially for surface water and groundwater; and for allocation of water to various sectors [31].

In most countries in South Asia, wastewater from domestic sources is hardly treated, due to inadequate sanitation facilities. This wastewater, containing highly organic pollutant load, finds its way into surface and groundwater courses near the vicinity of human habitation from where further water is drawn for use. Considerable investments should be done to install treatment systems [16].

14.3. Discretion and Deftness of Government

Proactive policies for water quality improvement are emerging across South Asia, although many are in their infancy and a unified framework has yet to evolve. Several countries are implementing large-scale and ambitious programs aimed at rehabilitating degraded water resources [21]. Given the transboundary nature of many river basins and the need for their collaborative management, improved and effective water quality management strategies in South Asia require the collection, analysis, and sharing of accurate data. Currently, this task is, with some exceptions, generally poorly implemented. In most countries, sporadic or patchy data collection prevails, and it is often accompanied by inadequate analysis [33].

An adequate legal framework of rules and regulations should be in place to address various issues like a water resources inventory, planning, use, quality and protection by the Government. In addition, there are several acts covering water resources. They fall under the jurisdiction of different agencies and are not directly related to the general concept of water resources management. In order to address the various issues and problems related to water resources development, a new law on water resources management is essential [2].

14.4. Environmental Discretions

Climate change has resulted in devastating impacts on people. It contributed to the proliferation of climate refugees and high incidence of poverty in South Asia. The region faces both political and technical obstacles in developing a sustainable approach to combat climate change. This is exacerbated by non-availability of information as well as reluctance to acknowledge the problem by key actors. The best strategy will be to integrate policies and regulations in the various countries of the region to develop strategic plans. The approach of prevention and protection should replace the existing emphasis on relief and rehabilitation [34]. Environmental issues have become an important component of water resources development project planning. At the current stage, there are many issues that need to be reconciled between the conservation and development groups. These issues include environmental values and costs, the acceptance of trade-offs between environmental losses and project benefits, a clear definition of sustainable development, and so forth. The participatory approach, which requires involving all stakeholders, poses the most difficult procedure in practice. In many cases, the process becomes a forum for the confrontation between the pro- and anti-project groups, with the involvement of nongovernmental organizations [2]. The ultimate goal in the control of water pollution would be zero discharge of pollutants to water bodies; however, the complete achievement of this objective is usually not cost-effective [35].

14.5. Emerging Challenges

85% of drinking water in South Asia meets the target of the Millennium Development Goal of coming from an improved source; this water is, in fact, frequently contaminated with human organisms. So, the more childhood death, less cognitive development, less educational achievement, and less economic growth is the failure to deliver clean water to the population of South Asia means. Improving water quality throughout South Asia is one of the

most difficult projects. It is necessary to improve the water quality by water engineers so the health impact of these interventions is less commonly assessed. Factoring in the water quality, depleting ground water, pollution of surface water, and source sustainability and security are the major future challenges in fulfilling the right to water in South Asia [36].

Another important concern is the urban-rural disparity in the use of improved sanitation facilities. The majority of the un-served around 895 million populations are located in rural areas. Pakistan, Bhutan, India, Afghanistan, and Nepal are confronting enormous urban-rural disparities in the use of improved sanitation facilities. This gap affects a significant number of people in Pakistan and India due to the size of their population. The urban-rural disparity in South Asia indicates a larger issue of severe social exclusion and injustice prevailing in this part of the world. The practice of open defecation due to lack of public amenities such as toilets is one of the foremost and immediate sanitation challenges in South Asia [37].

There is definitely a need for systematic access to accomplished water resources management. However, under the present institutional framework, several departments/agencies deal with the water resources development according to their own requirements, without much-integrated effort towards basin-wide planning and management. In the long run, this practice leads to inefficiency in water use and undesirable consequences of development. Furthermore, management of wastewater, its treatment and re-use are important factors to be considered in association with the concept of water resources management, as these practices will impact on the availability of freshwater and on water quality [2].

14.6. Water as an Economic Good

Water has been recognized as an economic good in many international declarations, such as those reviewed previously, including in the policies of major lenders and donors. However, there is a risk in observing the notion of water as a commodity because of the shifting of the public perception away from a sense of water as a common good which includes duty and responsibility. A simple and straightforward solution, designed on the basis of pure economic efficiency, has the potential of ending up unsustainable [38]. For the improvement of water infrastructure in the developing world, subsidies are vital. The principle of full cost recovery sometimes handicaps developing nations that are striving to provide basic needs by subsidizing their basic water infrastructure [39]. The application of economic principles to the allocation of water is acceptable and provides a simple tool for the development of water services in a more efficient direction. However, water should not be treated as a market-oriented commodity when it comes to domestic use for very basic needs particularly for people in extreme poverty. More discussion, analysis, study, and commitment are needed in deciding whether water is a common or an economic good [40].

14.7. The River Basin Management

Water can have an overreaching value capable of coalescing conflicting interests and facilitating consensus building among society [38]. To incorporate all of the physical, political, and economic characteristics for a river basin, a process for cooperative watershed management is vital. Although groundwater and surface water systems are interconnected, these agencies work at cross purposes and their actions are not coordinated at the hydrological system level in South Asia. So, some additional desirable features for successful river basin organizations are [31].

- that the river basin should be of sufficient size with problems of competition and conflicts in water resources development and management to justify a separate organization;
- A clearly defined authority with responsibilities that would not override the prerogatives of national and local agencies;
- Adequately trained and motivated personnel;
- Adequate data, information and modeling studies leading to sound policies and sustainable solutions;
- Full consideration of all issues on water and related land resources; and
- Effective procedures for community participation in the planning and programming of water resources activities.

15. Spiritual and Cultural Aspects of Water Resources in South Asia

Water is a common symbol of humanity, social equity, and justice. It is one of our compelling links with the sacred, with nature, and with our cultural heritage [41]. A case in point is the Ganges River in South Asia, which has a very strong spiritual and cultural significance to all Indians, Bangladeshis, and Nepalese. Regrettably, the current IWRM mechanism does not acknowledge water's spiritual and cultural dimensions. Without recognizing these, it is possible that all efforts towards sustainable water resources management may be piecemeal and ephemeral [38].

15.1. Recycling of Effluents

Re-use and recycling of municipal wastewater and industrial effluent are very important on account of (a) the reduction of the pollution load in the receiving water, and (b) the reduction in the requirement of freshwater for various uses. Re-use of the municipal wastewater after the treatment necessary to meet industrial water requirements has been in practice, albeit in a limited way, for quite some time in India. In some areas, treated sewage is being used for horticulture, watering of lawns and even for flushing public sewers and toilets [2].

15.2. Community Involvement

Community management of water supply and sanitation is a viable option, particularly for poor urban settlements where adequate services are not provided. However, in general, urban communities show lower levels of participation than rural communities because community ties are weaker in the former, thus preventing a proper collective definition of priority needs and the expression of demands. Nevertheless, governments should support and encourage community management of services, in particular by setting up formal mechanisms for interaction between the community and the municipal authorities. It is necessary that decisions are taken at the lowest appropriate level, with public consultation and involvement of the users in the planning and implementation of water projects. Therefore, capacity building of local institutions is necessary to make community management effective [42].

16. Conclusion

A collaborative and coordinated effort is needed among all the countries in South Asia in order to address the causes and effects yet the controlling point & challenges of water resources like surface and groundwater. Improper disposal of industrial and municipal wastes, unplanned urbanization and lack of water filtration and disinfection practices are the major causes of contamination in surface and groundwater throughout South Asia. Wastes discharged by industry constitute over one half of the pollution is carried by our waters. To control and eventually to eliminate the degradation of waterways by industrial wastes will require a massive investment in industrial waste management measures. Traditionally, the industry has not been motivated to invest substantial sums in relatively unproductive processes like pollution control. Water responds to gravity, not to politics. Water quality management programs should be organized functionally on the basis of natural drainage basins, not on the arbitrary configurations of cities, counties, and states. Unless local interests, both government and industry, assert the necessary leadership to create rational organizations to plan and operate regional water quality management programs in South Asian region.

Acknowledgments

The research work was supported by the The Ministry of Science and Technology, Government of the People's Republic of Bangladesh under the Special Allocation for Science and Technology Programme, Financial Year 2020-2021. The project title was: Analysis and Treatment of River Water Using Bio-based Polymeric Materials and Gamma Radiation for Radiological Applications, Group Serial No.445 EAS.

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