Water Pollution and Sustainable Development Goals Nexus: An Ample Review

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***Abstract*—Pure water is one of the most essential components of the environment for supporting living things, including humans. Rapid population growth, urbanization, industrialization, and subsequent development works are causing more contaminants to enter the environment, including water. The sustainable development goals (SDGs) were adopted by United Nations (UN) since the year 2015. To achieving agendum of 2030 for future environmental sustainability and sustainable development, the pure water is one of the focusing areas of the sustainable development goals (SDGs). Water also interlinked issue of other SDGs such as no hunger, sustainable production and consumption, reduction of poverty, health and life on land etc. Apart from these direct connections there are many more ancillary linkages between the water quality and sustainable development. Some previous studies have been reported to accounting and realize the connections between water quality and all the SDGs. This review aimed to finds, how water quality is important for achieving sustainable development goals (SDGs) for the future environment sustainability. The questions of this study were aimed to find out the nexus between water pollution and SDGs.**

***Index Terms*—Water pollution, sustainable development, sustainable development goals, environmental sustainability;**

I. INTRODUCTION

Increasing trend of global population growth and subsequent high rate of urbanization and industrialization as well as associated development works is lead to excessive natural resources consumption [1]. The rapid deformation of socioeconomic activities is course to environmental degradation including water pollution [2]. Since the early stages of industrial revolution, the global population size was less than a billion, it was about 700 million [3]. Now, the population is more than 7 billion and it has expected will be 9 billion by 2050, subsequent projection has been made, the global population will be reached at least 10 billion at the beginning of 22nd century [3]. Most of this population growth will be seen in Asia and Africa, in which hastily growing demand of standard water for drinking, agricultural, industrial activities as well as other usages for development works in all sectors proportionately [4].

Pure water is one of the basic uppermost essential components in the environment for sustenance of biotic components including human being [5-8]. Rapid increasing rate of population growth and subsequent amassed demands of urbanization and industrialization as well as associated development works are triggers to rising contaminates into the environmental components including water [5-9]. Globally water has been contaminated by different contaminates including organic and inorganic pollutants beyond the level of permissible concentration [10]. Different human induced activities such as excessive uses of solvents, drugs, radioactive materials, chemical wastes and industrial wastes are directly or indirectly responsible to increase of many pollutants in water [11]. The chronic health hazards including cancer, coronary disease, liver damage, neurological and cardiovascular disease, damage of central nervous system, and sensory disturbances are occurring due to toxic and hazardous organic/inorganic pollutants [12].

The sustainable development goals (SDGs) were adopted by United Nations (UN) since the year 2015[13]. To achieving agendum of 2030 for future environmental sustainability and sustainable development, the pure water is one of the focusing

areas of the sustainable development goals (SDGs) [14]. Water also interlinked issue of other SDGs such as no hunger, sustainable production and consumption, reduction of poverty, health and life on land etc. Apart from these direct connections there are many more ancillary linkages between the water quality and sustainable development. Some previous studies have been reported to accounting and realize the connections between water quality and all the SDGs [14].

This review aimed to finds, how water quality is important for achieving sustainable development goals (SDGs) for the future environment sustainability. The questions of this study were aimed to find out the nexus between water pollution and SDGs. Another important question of this study was discourses links between pure water and other SDGs. So that, this review mainly discusses broadly the role of water quality for achieving sustainable development goals by considering the following aspects.

i) Present state of water pollution along with sources and types of common water pollutants;
ii) Water pollution and sustainable development goals(SDGs) nexus;

Sate of global water pollution: causes, sources, types and consequences

A few examples of human-induced activities that are causing problems with water quality include the concurrent trend of growing human needs and the ensuing technological advancements, the expansion of urban and transportation facilities, the rapid growth of agricultural and manufacturing activities, and the overexploitation of environmental components [1,11]. The rapid population growth is led to the rise in demand of drugs (antibiotic and analgesics) to cure diseases. Higher rate of production demand of personal care products (cosmetics, fragrances hygiene products) is desire due to modernization of life style of human being; moreover, the excessive uses of biocides and pesticides for better agriculture productions are common phenomenon are seen in the environment [15].

Generally, the pollutants in wastewater are mainly organic and inorganic compounds; the organics that including pharmaceuticals, dyes, phenols etc; and other pollutants termed as inorganic that are mainly phosphates, chlorides, fluorides, nitrites and toxic heavy metals including arsenic, chromium, mercury, lead and copper etc [16]. The organic pollutants and their derivatives are releasing/introducing from diverse industrial effluents that including textile and dying, timber and wood, food and beverage, juice and milk, oil and petrochemical, pesticide and biocides manufacturing, personal care products and pharmaceuticals industries etc. [17]. Heavy metal contamination in the aquatic environment is caused by a variety of human-caused activities, including landfilling, the use of pesticides in agriculture, mine drainage, the infiltration of untreated industrial effluents, the dumping of municipal waste, excessive solvent use, radioactive waste, volcanic eruption, physio-chemical weathering, and chemical waste. [5,18-24].

Water contamination worldwide is also a result of inadequate sanitation. Nearly 2.5 billion people on the planet do not have access to proper sanitation. [25]. Excessive industrial activities and unplanned effluents discharge to the aquatic environment were finds as most important and vital sources of water pollution. The United Nations (UN) recently estimated that industrial effluents generate 1500 km^3 of wastewater globally each year [25]. Approximately 70% of home sewage and over 33% of untreated industrial effluents directly discharge into the aquatic system. [25]. In this connection, thousands of previous studies have been reported that, industrial wastewater has been carrying numerous water pollutants including heavy metals, pharmaceuticals, dyes, phenols etc. with higher concertation beyond permissible limit [5].

The higher concentration of highly toxic heavy metals (THMs) including chromium, lead, mercury, nickel and arsenic having severe toxic effects have been find in the wastewater. The permissible of limit by USEPA of arsenic, chromium mercury, lead and copper are 0.01, 0.1, 0.002, 0.015and 1.3 mg/L respectively [5,12]. Although, for the maintaining of the cell functions of living organisms, it's needed some metals with low concentrations like; copper, iron, manganese and zinc, while high concentrations are poisonous [5,12]. The bioaccumulations of heavy metals (HMs) are responsible for adverse effect on living organisms [12]. The chronic health hazards including cancer, coronary disease, liver damage, neurological and cardiovascular disease, damage of central nervous system, and sensory disturbances due to some toxic heavy metals such as; mercury, arsenic, lead, antimony, silver, cadmium, and aluminium etc. [12]. The complex toxins mixture of ECs and HMs in the

water system is the vital challenge to achieving agenda 2030 for future environmental sustainability and sustainable development as a whole [22]. Although the interest of society and economists in environmental issues has varied over time but there is always a strong reason for developing environmental policies due to the increase in external factors associated with pollution and exploitation of natural resources, hence, these external factors may be widely exacerbated and the environment is easily exploited, spoiled or exhausted at very rapid rates, which directly affects to achievement of sustainable development goals. So that, it is prime concerned of governments and policy makers to ensuring availability of quality water /pure water for different uses including drinking purpose and that would be one of the pulsating challenges of achieving SDGs by 2030.

Water, sustainable development and sustainable development goals (SDGs) nexus

The meaning of sustainable development as reported accordingly that when resources access as dynamic harmony between the equitable availability and intensive goods and services to all people keeping protection of environment and enough preservation of the earth for future generations [26]. The sustainable development has 3 dimensions that are social, economic and environmental (Fig-1) [26].

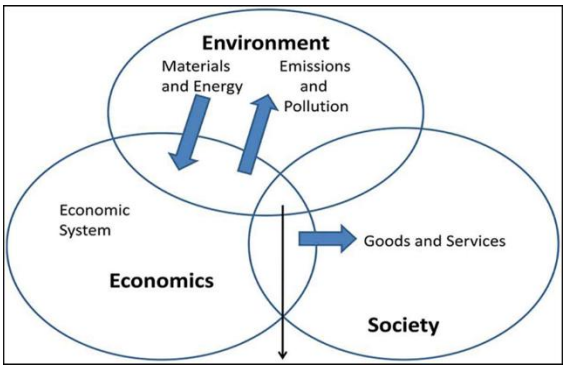

Fig-1: The concept of sustainable development [26].

For this purpose, it has emerged as important to cover the ever-increasing demand of natural resources that allows you to achieve sustainable development [26].

The demanding development works have been deteriorating and damaging the environmental parameters including air, water and land [1,5]. The term sustainable development has been focusing to protect the environment keeping continuing development works as much as needed. The inclusive and universal 17 SDGs (Fig-2) and their associated 169 targets and many more indicators were fixed and well-defined implementation policies have been stated to achieving sustainable development by 2030[10]. Water is one of the focusing areas of the SDGs has been implicitly considered as SDG 6 of SDGs. Water also interlinked issue of other SDGs such as no hunger, sustainable production and consumption, reduction of poverty, health and life on land etc [14]. Apart from these direct connections there are many more ancillary linkages between the water quality and sustainable development [14].

Fig-2: Sustainable development goals [14]

The all SDGs have constituted by own exclusive agenda but among them has significant interlink and relation between the agendum. They are individual whole and integral targets has fixed to achieve by 2030 [27]. The SDG 6 'Clean water and sanitation' is one of the vital SDGs which is directly related to water, but water also interlinked issue of other SDGs such as no hunger, sustainable production and consumption, reduction of poverty, health and life on land etc [14]. Apart from these direct connections there are many more ancillary linkages between the water quality and sustainable development. Therefore, the prerequisite of clean water for SDGs can be categorized as follows;

- Direct SDGs: SDG 6
- Water dependent SDGs:
- Indirect linkage to water with other SDGs

SDG 6. 'Clean water and sanitation': Ensuring the available, accessible, affordable clean water and its sustainable control as well as sanitation facilities for all was termed as SDG 6 of SDGs. Hence, water has

specified as goal of 2030 agenda [28]. SDG 6 and its 6 targets (6.1- 6.6) include safe drinking water, sanitation facility, water quality improve and water pollution reduce, efficient uses of water for all sectors, integrated water management and protection of aquatic ecosystem has to be ensure for sustainable development by 2030 [27,28]. These all 6 targets are clearly illustrated that there are synergies among the quality water and its management. Sanitation and water pollution is related and without sanitation water become contaminated, so that sanitation facility can influence the water quality and costing of water facility as a whole. For example, in Cambodia as one of the Asian countries has spent 188M USD for quality water due to poor sanitation facilities [14]. On the other hand, water pollution and inadequate sources of safe drinking water impede the shifting of inhabitant and subsequent costs of social, economic and environmental burden, for instance about 35 million of Bangladeshi citizen was away from their existing habitat due to groundwater contamination by arsenic [14]. So that, they have extra burden for ensuring socio-economic facilities to inhabitant's due to arsenicosis.

Therefore, globally water has considered one of the challenging natural resources and environmental components. The clear understanding of water sources, water costing, water demand, water supply, potential contaminations of water and water scarcity is essential to identify for accessing clean water and sanitation facility for all. The integrated management and its future states should be counting by sustainable manner for succeeding agenda 2030.

Water dependent SDGs: Successes of all sustainable development goals are directly and indirectly depending on availability of water and also water is a vital interlinked issues for SDGs. Some of the SDGs will not be possible without water that including SDG 1, SDG 2, SDG 3, SDG 7, SDG 13, SDG 14, SDG 15. Elimination and marginalization of poverty is the main target of SDG 1. The poverty depends on availability of natural resources including surface and underground resources, biotic and abiotic resources. Moreover, the capacity of collection, deformation, manufacturing and value adding of natural resources are key factors of poverty alleviation [14]. So that, all kind of economic activities including primary, secondary and tertiary economic activities is needed to integral actions for eradication of poverty. SDG 1 and its targets especially 1.3 is to ensuring basic services including food, energy and water etc. Water related contaminations are hampering the agricultural productions, for instance, China and some South Asian countries including Nepal, Pakistan, Bangladesh and India are facing challenges of quality water sources for irrigation. The surface water contamination as well as arsenic contamination of groundwater is common phenomena of those countries. In addition, extra costs are enforced for water decontamination as well as extra burden also imposed for healthcare facilities due to water related diseases [14]. Hence, the water pollution may be encumbering the overall socioeconomic development of the countries which is main obstacle to eradication of poverty for sustainable development by prescribed timeline.

Making zero hunger is called as SDG 2 was focused for accessible, available and affordable food and nutrition for all. For this connection, the sustainable agriculture is essential, but water pollution is hampering the overall agricultural productions as well as threaten to environment while using agricultural inputs (pesticides, herbicides, insecticides, fertilizer etc.) for improved agriculture yield [27,29]. On the other hand, the contaminated water is directly influencing the nutrition. In the developing countries almost 50% under aged (5 years) children were facing dehydration due to unsafe drinking water [14]. Therefore, water pollution control can indorse zero hunger country and ultimate sustainable development.

SDG 3 was aimed to guarantee sustainable health and well-being by its 9 specified targets. The water is the interlinked issue of heath. The waterborne diseases are potential threat on human health due to unsafe water uses. Water pollution not only responsible for environmental threat but also water can be hampering the health gains. It is reported, in the developing countries about 90% of untreated wastewater have been released into water system which is direct impacting on health and well-being of human being. The success of SDG 3 is definitely connected to safe water [14].

SDG 7 is being attaining to universal entrance of reasonable, reliable and sustainable energy. Water may relatively have connected issue for ensuring safe and sustainable energy. Generally, energy conversion, production and alteration etc. [17,10]. can adverse effect on water quality. Utilization of contaminated water for resource abstraction is potential threat to soil

pollution due to infiltration of pollutants and subsequent reduction of food production as well as environmental pollution. The large quantity of water required in the hydropower energy, so that poor quality of water can affect on the biotic components of aquatic ecosystem which related to SDG14.

SDG 13 is related to climate action, the relationship climate change and water pollution is less connection each other, but realization and impact of climate change can have accelerated the frequency of flood and other climatic hazards [14]. The contaminated water can spread out due to inundation and ultimate effect to the environment. So that, water pollution control can reduce the obvious flushing of contamination in the aquatic and terrestrial ecosystem.

The sustainable uses of marine, seas and oceans resources are main focus of SDG 14 which called 'life below water'. It is reported that about 80% of marine water pollution is occurring due to introduction of untreated wastewater from sewage, industrial discharge, nutrients releasing and other land-based activities including excessive use of solvents and agriculture inputs [14]. So that, water pollution can impact on the marine ecosystem and resources which is important aspect of SDGs.

The terrestrial ecosystem preservation, restoration, protection and sustainable use are main aims by achieving SDG 15. Water pollution control is needed for sustainable management of fixed targets of SDG 15 including mountain and inland ecosystems, forest, habitat, alien species etc. These all targets are connected with water quality [27,14].

Indirect linkage to water with other SDGs: Apart from these direct connections there are many more ancillary linkages between the water quality and sustainable development and its goals. The SDG 4, SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 16 and SDG 17. The goal 4 is for quality education, in its targets have to ensure education for all children. Global scenarios were reported that in the developing countries including India, Bangladesh, Nepal, and other African and Latin American countries have seen severe health problems among the school going students due to unsafe water and lack of sanitation [14]. SDG 5 is related to gender equality, most of least developed and developing countries across the world have been facing unequitable distribution of sanitation and safe water and most the female citizens were poorly facilitated due to custom and tradition of communities [27]. The decent work and economic development were aimed by SDG 5. Development works should be run without contamination of environmental parameters for economic growth. So that, water pollution is indirectly connected to SDG 8. Sustainable industrialization is depending on resistant infrastructure and fostering innovation these are main targets of SDG 9. Less contaminated water use is needed for industrial activities as well as cleaner technologies are recommended for sustainable industrial development. Hence, indirectly water quality is linked to water use in the industries.

Equal opportunity and inclusive social development is mentioned in the SDG 10. The poorest people of developing countries are less access to safe water and sanitation. So that, for sustainable social development should be ensure available safe water and sanitation facilities for all. Water quality can influence, hampering and delaying to reduce gap between unequal access of safe water among the citizens [14]. The safe water one of the basic services of sustainable cities and communities. So that water pollution in backward linkage with the SDG 11. The control of water pollution will be essential to decrease unjustifiable use of natural resources including water, land and air etc. The responsible production and consumption is connecting with sustainable resources management which main target of SDG 12. SDG 16 and water pollution is seeming to unclear but dishonest institutional water governance can have accelerated the safe water shortage and subsequent sustainable use of water [14]. The equal justice, peace and strong institutional management is recommended for sustainable natural resources management for future environmental sustainability. SDG 17 is an inclusive goal among SDGs, the comprehensive execution and stimulating the all goals by international cooperation is need for sustainable development. The water is only components that can link throughout the SDGs.

Conclusions

High rate of population growth and subsequent demanded associated development works are triggers to increasing pollutants into water. The water bodies have been polluted by different organic and inorganic pollutants. Anthropogenic activities including over exploitation, excessive uses of solvents, drugs, radioactive materials, chemical wastes and industrial wastes are directly or indirectly responsible to increase of many pollutants in water. The 17 SDGs and their

associated targets fixed by the UN for the sustainable development and ultimate environmental sustainability by 2030. Pure water is one of the significant goals of SDGs has been implicitly considered as SDG 6. To achieve the agendum 2030 as well as meeting these goals quality water has gained the prior and foremost global need. The safe water is requiring not only for resilience of environment and ecosystems but also essential for equal socio-economic development and ultimate sustainable development and subsequent environmental sustainability.

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