

Water and pollution agents in the 21st century

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Abstract: Water is a vital element in socio-economic development; therefore the relationship between water and health cannot be overemphasized. Through ages, man has always strived to define a better living condition for himself. As a result of man's quest for comfort many anthropogenic activities lead to the pollution of our water, which limits the use to which it can be put to or its availability for use. This paper discussed pollution of water as the effect of dissolved solute, fluid or gas, which enters natural water body as a result of anthropogenic activities. Point or non-point describes the degree of localization of the sources. Pollutant can enter a water body through many sources, which sometimes make it difficult to attribute contamination to specific activity. Apart from the various activities that lead to the pollution of our fresh water bodies, the paper also discussed the need for an urgent action on a global, regional and national level in order to monitor and protect our fresh water bodies. Likewise, increased awareness, education and implementation of legislation are recommended. [The Journal of American Science. 2009;5(1):59-67]. (ISSN: 1545-1003).

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1 Introduction

Water is a fundamental element in sustainable development. Better access to safe drinking water, adequate sanitation and increased water for food production and industry contribute to health, livelihood and broader economic development outcomes. It is also essential for the environment services provided by wetlands and other aquatic ecosystems. Water resources occupy a special place among other natural resources. It is the most widely distributed substance on our planet: albeit in different amounts, it is available everywhere and plays a vital role in both the environment and human life^[1]. Comprising over 70% of the Earth's surface, water is undoubtedly the most precious natural resources that exist on our planet. Without the seemingly invaluable compound comprising of Hydrogen and Oxygen, life on Earth would be non-existent: it is essential for everything on our planet to grow and prosper.

Although we as humans recognize this fact, we disregard it by polluting our rivers, lakes, and oceans^[2]. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate. In addition to innocent organisms dying off, our drinking water has become greatly affected, as is our ability to use water for recreational purpose. In order to combat water pollution, we must understand the problems and become part of the solution.

Concern over massive anthropogenic change in the hydrological cycle of rivers, lakes and groundwater storage affecting their quality, their potential as water resources has been on the increase since the last century. In Mar del plata, Argentina (1977) the United Nations held the first World Conference on water resources. The 1977 conference contributed greatly to the strengthening and co-ordination of international co-operation in studying and assessing water resources. Since then technological advancement and development and other human activities has continue to put pressure on the sustainable exploitation, development and management of water resources as a human imperative This has called for world attention in recent times and most recent among the international forum that discussed water as a key to sustainable development include:

3rd World Water Forum, Kyoto 2003.

World Summit on Sustainable Development, Johannesburg 2002.

International Conference on Fresh Water, Bonn 2001.

United Nations Millennium Summit, New York 2000.

The 2nd World Water Forum, Hague, 2000.

Other events where issues' relating to development and future global water crisis has been put on the international agenda are:

The 1994 Ministerial Conference in Noordwijk and the 1994 OECD/DAC meeting in Paris.

The 1992 Dublin meeting, the 1992 UNCED meeting in Rio de Janeiro, the 1991 Nordic Freshwater Initiative in Copenhagen and the 1990 New Delhi meeting.

Africa has not been left out in the discussion on water resources issues. Forty-five African Ministers responsible for water resources in their respective countries met in Abuja, Nigeria on April 29 and 30 2002 to deliberate on the challenges facing the continent in its water resources sector. That gathering clearly underscores both the magnitude and realization by the highest water officials in the continent that urgent action is needed to address such problems. The ministers issued; “The Abuja Ministerial Declaration on Water-A key to Sustainable Development in Africa”, and pursuant to the declaration, launched “the African Ministerial Conference on Water” (AMCOW). In furtherance to the actualization of the millennium development goal on sustainable environmental development in Nigeria the first National Water and Sanitation forum was held in Abuja between August 29 and September 1 2006.

Africa faces a multitude of problems in the water resources sector. Those problems include the temporal and spatial rainfall variability, the periodic cycle of droughts and floods, and the significant growth in population, urbanization and environmental degradation^[3]. The population of the continent is approaching 700 Million, and is expected to exceed a billion by 2025. This rapid increase in population accompanied by urbanization poor land use and unregulated waste disposal is taken a toll on water resources, at both the quantitative and qualitative levels. About 65 percent of the rural population and 25 percent of urban population are without adequate water^[4]. The fact that Africans rely on natural resources for a part or all of their incomes call for improved natural resources management so that income levels can increase and to reduce the risk associated with the use of these degraded natural resources.

2 Concept of pollution

Pollution is the contamination of the earth’s environment with materials that interfere with human health, the quality of life, or the natural functioning of the ecosystem (living organisms and their physical surroundings)^[5]. Less technically, it is the act of making the state and/or conditions of an environment unhealthy and unbearable^[6]. Pollution can be of three types-air, water and land. But for the purpose of this discussion, the focus shall be water pollution.

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. When it is unfit for its intended use, water is considered polluted. There are two main categories of pollutants.

Biodegradable pollutants are materials such as sewage that rapidly decompose by natural process. These pollutants become a problem when added to the environment faster than they can decompose.

Non-degradable pollutants are materials that either do not decompose or decompose slowly in the natural environment. Once contamination occurs it is difficult to remove the pollutants from the environment.

Two types of water pollutants exist; point source and non-point source. Point sources of pollution occur when harmful substances are emitted directly into a water body. Point source pollution comes from specific, localized and identified sources.

A nonpoint source delivers pollutants indirectly through environmental changes. Nonpoint source pollution comes from dispersed or uncontained sources. An example of this type of water pollution is when fertilizer from a field is carried into a stream by rain, in the form of run-off, which in turn affects aquatic life. Whatever the nature of pollution, the effect may be immediate or delayed. Nonpoint sources are much difficult to control. Pollution arising from nonpoint sources accounts for a majority of the contaminants in streams and lakes.

In Africa fresh water is rapidly being depleted through inefficient use and pollution by industrial effluents, domestic effluents, and by degradation of watersheds in major river basins. Because of lack of resources, knowledge and organizational skills, to undertake measures for mitigating environmental degradation, poor societies often use poor quality water contaminated by sewage, industrial and agricultural pollutants or siltation from soil erosion and suffer from debilitating diseases. Thus evidently showing the close correlation between environmental degradation of water resources and poverty.

3 Contributing agents of water pollution

Agents of water pollution include;

3.1 Fertilizers and Agrochemicals.

Fertilizers, contain nutrients such as nitrates and phosphates. In excess levels, nutrients over stimulate the growth of aquatic plants and algae^[2]. Excessive growth of these types of organisms consequently clogs our waterways, use up dissolved oxygen as they decompose, and block light to deeper waters. This in turn, proves very harmful to aquatic organisms as it affects the respiration ability of fish and other invertebrates that reside in water.

Agriculture is an important part of the Nigerian economy which engages about two-thirds of the country's labour force and generates on the average about 40 percent of the Gross Domestic Product. In the face of declining productivity in agricultural sector, the need to ensure food sufficiency and security has led to the application of fertilizers and agrochemicals to enhance the potentials of agriculture in Nigeria. Despite the roles of this inputs in the enhancement of agricultural potentials, they constitute a source of risk to the environment most especially water systems. For instance the main liquid effluent released from NICON Fertilizer Complex are benfield reflue urea disorder bottom, contaminated water run-off, and utility wastewater^[7]. The waste water consists of boiler blow down, cooling tower blow-down, demineralized regenerant waste and sanitary plant treated effluent. These streams contain primarily and basically ammonia, urea and dissolved solids. The effluent discharged to the environment are as shown in table 1 and 2.

Table 1. Condensate Analysis

Components	Stripper Inlet (ppm)	Stripper Outlet	
		Design	Actual
CO ₂	2000	25	5
NH ₃	1000	25	10
Methanol	2000	50	5
Hydrocarbons	50	0	0

Table 2. Final Plant Liquid Effluent

Parameter	Designed Criteria	Lab Results	% Compliance
pH	6-9	7	100
Temp (°C)	35	35	100
NH ₃ (ppm)	10	10.8	83
PO ₄ (ppm max)	150	128.1	100
BOD ₅ (ppm max)	20	15	100
HM (ppm total)	3	1.02	100
Oil (ppm max)	10	0	100
TSS (ppm max)	30	11.5	100
TDS (ppm max)	1000	900	100
Colour	Clear	Clear	100

Pollution is also caused when the silt and other suspended solids such as soil; plowed fields, construction and logging sites, urban areas, and eroded riverbanks wash off when it rains. The flux of inorganic and organic particles of rivers is generally dictated by both natural and artificial factors^[8]. Predominant among the natural factors are climate, geomorphology, vegetation and the mineralogical constitution of rocks within the basin. Urbanization, as manifested by population stress on the soil surface, and overgrazing and bush-burning or deforestation have been identified as the major causes of increased particulate loads of rivers in semi-arid environments^[9].

Under natural conditions, lakes, rivers, and other water bodies undergo Eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter

various bodies of water, fish respiration becomes impaired, plant productivity and water depth become reduced therefore, aquatic organisms and their environment become suffocated.

Pollution in the form of organic materials enters waterways in many different forms as sewage, as leaves and grass clippings, or as runoff from livestock feedlots and pastures. When natural bacterial and protozoan in the water break down this organic material, they begin to use up the oxygen dissolved in the water. Many types of fish and bottom dwelling animals cannot survive when levels of dissolved oxygen drop below two to five parts per million. When this occurs, it kills aquatic organisms in large numbers, which leads to disruptions in the food chain. This can lead to serious nutrition problems in regions where such event takes place. Many marine, coastal and freshwater fisheries that provide protein for a large part of the population are threatened by poor water quality emanating from pollution. Pollution of rivers and streams with chemical contaminants remains one of the most critical environmental problems of the 21st century.

3.2 Sewage

Water has a very significant effect on human health. The relationship between water and health has been recognized from the time of Hypocrites, if not earlier, in the association of marshy places with fevers^[10]. Yet until the second half of the 19th century, mankind had no true appreciation of the significance of water as a vehicle of disease.

Pathogens are another type of pollution agents that prove harmful. They can cause many illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. Pathogens are organisms such as bacteria, viruses and protozoan. These pollutants enter waterways through untreated sewage, storm drains, septic tanks, runoff from farms and particularly boats that dump sewage. In 2004, it was reported that Baghdad's three wastewater treatment plants which were yet to function discharges raw sewage from the city's 3.8 million residents into the Tigris River^[11] More so, in many major cities of developing countries, the huge volume of water used in homes ends up as sewage or in open drains as wastewater polluted with chemicals and irritating odors not even suitable for irrigation which finds its way to either surface water body or underground aquifers. This fact is evident of the Lagos lagoon, Nigeria. The increasing population experienced in major cities of the world especially developing countries has led to crowded and unhygienic settlements. This has resulted in the littering of every available space with refuse, illegal structures and abandoned vehicles. Many public drains have been converted to receptacles for domestic, industrial and human wastes.

In Nablus and Tulkarm, Palestinians have been wrestling with a growing environmental nightmare for years. Untreated human sewage flows into the Nablus River, the Alexander's main tributary for much of the year. In addition, Tulkarm residents contribute raw sewage to the Alexander. Indeed, waste generated by 240,000 Palestinians, Olive oil press in late fall and stone cutting plants contaminate the Alexander at scores of different sites, reportedly causing human health problems. Though microscopic, these pollutants have a tremendous effects evidenced by their ability to cause sickness. Cholera and typhoid are caused by the bacteria *Vibrio cholerae* and *salmonella typhi* respectively. Other diseases traceable to water pollution by pathogens from human faeces, human urine and animal excreta include gastroenteritis, infectis hepatitis, leptospirosis, schistomiasis, salmonellosis^[12, 13, 14].

3.3 Petroleum and Petrochemicals

Other agents of water pollution exist in the forms of petroleum, radioactive substances, and heat. Petroleum often pollutes water bodies in the form of oil, resulting from oil spills. These large-scale accidental discharges of petroleum are an important cause of pollution along shorelines. Besides the supertankers, offshore drilling operations contribute a large share of pollution. One estimate is that one ton of oil is spilled for every million tons of oil transported. This is equal to about 0.0001 percent^[2]. Oil pollution is a growing problem, particularly devastating to coastal wildlife. Small quantities of oil spread rapidly across long distances to form deadly oil slicks. Whether or not accidental oil spill occur during exploration or transportation, its impact on the delicate marine ecosystem of coral reefs, and land could be devastating. Tankers spills are an increasing environmental problem because once oil has spilled, it is virtually impossible to completely remove or contain it. Even small amounts spread rapidly across large areas of water. Because oil and water do not mix, the oil floats on the water and then washes upon broad expanses of shoreline. Attempts to chemically treat or sink the oil may further disrupt marine and beach ecosystems.

The major effluent of petroleum and petrochemical industries are wastewaters, oil spills and leaks. The petroleum and petrochemical industries have been identified as major producers of effluents into the environments. The Kaduna Refinery in Nigeria was one of the seven largest contributors to the poor quality of Kaduna River. It is estimated that 3,160 tons per year of grease and oil is been released into Nigerian environment^[15]. Several other endemic pollution activities of this sector have also been reported in the Niger Delta. The different types of effluent from oil refineries includes;

Waste water from the handling of raw materials and product stores, and oil and its components pollute rainwater run off from the refinery area;

Acidic waste water containing hydrogen Sulphide originating from the distillation of oil under reduced pressure;

Alkaline waste water from washing petroleum products with caustic soda. This waste water contains Sodium Sulphate, Sodium Hydrogen Sulphide at concentration as high as 100g/litre;

Acidic waste water from washing oil products with Sulphuric acid and from the processing of acid pitch;

Waste water containing arsenic (III) oxide up to a concentration of 10g/l from removal of hydrogen Sulphide from the produced gas;

Waste water containing mercaptans arising from acid pitch cooking processes; and Waste water containing lead as Sodium Plumbite (Na_2PbO_2) is formed by removal of mercaptans from oils. The median effluent characteristics of different operations are as listed in Table 3.

Table 3: Median Waste Flows and Loading for Petroleum Refinery Operations Following Oil/Water Separation. (Net Kg per 1,000m³ of feed stock^a)

Parameter					
	Topping	Cracking	Petrochemical	Lube	Integrated
BOD ₅	3.4	73	172	217	197
COD	37	217	463	543	329
TOC	8.0	41	149	109	139
TSS	12	18	49	72	58
O/G	8.3	31	53	120	75
Phenols	0.03	4.0	7.7	8.3	3.8
NH ₃ -N	1.2	28	34	24	20
Sulphides	0.05	0.94	0.86	0.01	2.0
Total Cr	0.01	0.25	0.23	0.05	0.49
Cr ⁺⁶	0.007	0.15	0.13	0.02	0.30
Flow ^b	67	93	109	117	235

Source: Nigerian Strategic Options for Redressing Industrial Pollution (World Bank Publication)

a: Feedstock= Crude Oil and/or natural gas liquid throughput

b: Except flow, which is m³ per 1,000m₃ of feed stock.

3.4 Radioactive Substances

Radioactive substances are produced in the form of waste from nuclear power plants, and from the industrial, medical, and scientific use of radioactive materials. Special forms of waste are Uranium and Thorium mining and refining. About 200 tones of Uranium (Depleted Uranium-half life of 4.7 billion years) lying around Baghdad, the containers which carried the ammunition were discarded. For months afterwards, many used them to carry water while other used them to sell milk publicly. During the Gulf war, over 300 tones of depleted Uranium weapons was used by American forces in 1991. This penetrates tanks and caused health problem affecting over 3000,000 people. In Basra, two years study shows that DU has caused Leukaemia in all age groups (under 15 most), breast cancer, sterility in man, anophthalmia, microphthalmia, corneal opacities and coloboma of the iris. Miscarriages and premature births, congenital malformations, additional abnormal organs, hydrocephaly, anencephaly and delayed growth have also been reported^[16].

3.5 Heat

and personal contact may also spread infection. Cholera is not likely to spread in communities with controlled water supplies and effective sewerage.

5.1.2 Typhoid fever

The cause is bacterium *Salmonella typhi*. Infection is usually contracted by ingestion of material contaminated by human faeces or urine, including water and food. *Salmonella typhi* occasionally continues to proliferate in the gall bladder of a few patients who have recovered from primary infection, and these carriers continue to excrete the organisms in their faeces or, occasionally, in their urine for long period, even for life. The largest water borne outbreak of typhoid fever in Britain, investigated by Suckling, killed 43 people in Croydon in 1937^[21]. It was caused by a combination of circumstances, which included a person who was a carrier of *Salmonella typhi* working down a well that was pumping into supply when the filtration and chlorinating plants were bypassed. Other outbreak of typhoid include: Aberdeen in 1964 involving 400 people (HMSO, 1964), Dade county, Florida USA 1973, involving 210 cases, Poitiers in France 1974 involving 60 cases^[22]. Both are believed to have been due to water contamination coinciding with inefficient disinfection.

5.1.3 Paratyphi fevers

These are caused by *Salmonella paratyphi* A, B, or C. Infection may exceptionally be via contaminated water, but is more commonly due to ingestion of contaminated food.

5.1.4 Bacillary dysentery

This is caused by bacteria of the genus *Shigella-sh. Dysenteriae I, Sh. Flexneri, Sh. Boydii and Sh. Sonnei* – there are several subspecies. Infections can occasionally be contracted via water contaminated by human faeces, but is more commonly due to ingestion of food contaminated by flies or by unhygienic food handlers who are carriers. The most virulent is *Sh. dysenteriae I* (formerly known as *Sh. shigae*) which produces an exotoxin and has often proved fatal.

5.1.5 Traveller's diarrhea (Turista)

The cause is not definitely known, but may be some forms of pathogenic *Escherichia coli* or rarely *shigella*. It is probably transmitted in the same way as bacillary dysentery and water may sometimes be the vehicle. Infants' diarrhea is probably related to this.

5.1.6 Virus diseases

Virus differ from bacteria-they are very much smaller and they multiply only within suitable cells in which they produce changes which gives rise to a range of diseases. More than one hundred different types of virus have been identified in faeces.

5.1.7 Poliomyelitis

This virus persist in the intestines of infected, not necessarily paralyzed, persons for a short while after infection, and is shed in the faeces: it can often be found in untreated sewage and even in the effluent from sewage disposal units. Like other viruses, it does not multiply in the absence of living cells. Infection probably takes place from contaminated fingers directly, or on food, there have been a few reports of water-borne infection, but little confirmation. It is common where sanitation and food hygiene are poor, and in such communities children are widely infected.

Presently, Nigeria is ranked highest in polio infections and effort is ongoing with the assistance of WHO to eradicate it.

5.1.8 Infectious hepatitis

The virus inhabits the intestine and is discharged in the faeces. Carriers may be infected for long periods. Transmission is probably as for poliomyelitis. Several water-borne epidemics have been reported, especially where water treatment has broken down, where the distribution system has been disturbed, or where badly constructed wells have been contaminated from cesspits, or as a result of heavy rainfall.

6 Challenges of water pollution in the 21st century

It has been estimated that nearly 1.5 billion people lack safe drinking water and an estimated 5 million deaths per year has been linked to water borne diseases. It is a fact that oceans cover 70 percent of

our planet but most unfortunate, humans have long acted as if these bodies of water could be used as a limitless dumping site for wastes. Raw sewage, garbage, and oil spills have begun to overwhelm the diluting capabilities of the oceans, and most coastal waters are now polluted. Beaches around the world are closed regularly, often because of high amounts of bacteria from sewage disposal, and marine wildlife is beginning to suffer.

Our continued existence on planet earth is greatly tied to the availability of safe drinking water, and as a result of this, the world is perhaps faced with the challenge of a worldwide effort to monitor and restrict global pollution of water in any form. Because of the concern for increased unabated degradation of environment, the United Nations in 1972 (Stockholm, Sweden) created the United Nations Environmental Program (UNEP), the first UN agency to be headquartered in a developing country, with offices in Nairobi, Kenya. The UNEP was designed to be “the environmental conscience of the United Nations”, and in addition to encourage sustainable development, increasing Standard of living without destroying the environment. At the time of creation of UNEP in 1972, only 11 countries had environmental agencies. Ten years later that number had grown to 106, of which 70 were in developing countries^[2]. Although many countries have consented to various treaties on environmental protection, these are not been implemented to the letter most especially in developing countries because of the belief that developed world want to keep the developing world in an economically subservient position. Water pollution goes on unabated in many developing cities. Sewage and effluent are been discharged into water bodies without proper treatment; banned pesticides have continued to be employed in pest control. For instance in August 2004 in a monitored BBC report (Network Africa), DDT was being used to control mosquitoes in the snowy region of Tanzania. Again most chemical discharge, radioactive and nuclear discharge takes place in developing countries of Africa, Asia and South America where problem of war still persists and where oil exploration does not employ adequate modern technology that minimize pollution. There is now an urgent need for the protection of our fresh water resources than ever before. We should be aware that human health is linked to availability of good quality water. More so, global population has continued to soar which means an increase demand for potable water. Any water related outbreak could spread like wild fire, which may cause death and paralyze economic activities. As reported on BBC news headlines (14-9-2004, 04:00H GMT), in Darfur, western Sudan, an estimated 10,000 displaced people die monthly due to lack of access to food and potable water.

7 Conclusion

Water if polluted can be made unfit for use and made home to millions of pathogens. It is also evident that water pollution related problems have the potentials to disrupt life on our planet in a more devastating manner. At global, continental, regional and national levels, congress has passed laws to try to combat water pollution act. Thus acknowledging the fact that water pollution is, indeed, a serious issue and call for urgent attention. But the government alone cannot solve this enormous problem of water pollution. It is ultimately up to us, as individuals, as a people and as corporate body, to be informed, responsible and involved when it comes to the problems we face with our water. We must become familiar with our local water resources and learn about ways of disposing harmful household and industrial wastes so that they don't end up in sewage treatment plants that can't handle them or landfills not designed to receive hazardous materials. Application of fertilizers should be considered with the need for it and better alternative where there is possibility of fertilizers been washed into surface water.

Global environmental collapse is inevitable. The developed world must work with developing nations to ensure that process of industrialization does not add to the world's environmental problem. Conservation strategies have to become widely adopted and accepted. People must learn that energy use can be dramatically diminished without sacrificing comfort, politicians must think of sustainable development rather than economic expansion.

Water is a necessity of life, life begins in it, and it sustains life. Therefore if measures are not taken and water pollution continues, life on earth will suffer surely. Collective and concerted efforts in awareness and education certainly remain the two most important ways to prevent water pollution in the 21st century.

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