



Pollution

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Water pollution: a challenging issue

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ABSTRACT

Water quality issues are a major challenge that humanity is facing in the twenty-first century. Here, we review the main groups of aquatic contaminants, their effects on human health, and approaches to mitigate pollution of freshwater resources. Emphasis is placed on chemical pollution, particularly on inorganic and organic micro pollutants including toxic metals and metalloids as well as a large variety of synthetic organic chemicals. Some aspects of waterborne diseases and the urgent need for improved sanitation in developing countries are also discussed. The review addresses current scientific advances to cope with the great diversity of pollutants. It is organized along the different temporal and spatial scales of global water pollution. Persistent organic pollutants (POPs) have affected water systems on a global scale for more than five decades, during that time geogenic pollutants, mining operations, and hazardous waste sites have been the most relevant sources of long-term regional and local water pollution. Agricultural chemicals and wastewater sources exert shorter-term effects on regional to local levels. Pollution control is a term used in environmental management. It means the control of emissions and effluents into air, water or soil. Without pollution control, the waste products from consumption, heating, agriculture, mining, manufacturing, transportation and other human activities, whether they accumulate or disperse, will degrade the environment. In the hierarchy of controls, pollution prevention and waste minimization are more desirable than pollution control.

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Introduction

Water is essential for life!" This categorical and timeless statement is how Secretary General Kofi Annan announced the Water for Life decade (2005–2015). We only perceive the profoundness of these words in today's alarming context of looming water scarcity at the global level. Indeed, communities and nations have grappled in isolation with the issue of drought, water pollution and water scarcity for centuries. The earliest precursor of pollution generated by life forms would have been a natural function of their existence. The attendant consequences on viability and population levels fell within the sphere of natural selection (Reilly, 1992; Wooten, 1997). These would have included the demise of a population locally or ultimately, species extinction. Processes that were untenable would have resulted in a new balance brought about by changes and adaptations. At the extremes, for any form of life, consideration of pollution is superseded by that of survival.

The war ranging between mankind and microbes is continuous and unending, so says a foremost professor of medical microbiology (Agbonlahor, 1998). He wrote: "God created Mankind and Microbes and left them to live happily in the beautiful earthly garden. They all sinned and their Maker was angry. He ordered them to, thereafter struggle for their continuous existence and survival here on earth. In the process, mankind exploited and microbes revolted, thereby ensuring a continuous conflict or war between them."

For humankind, the factor of technology is a distinguishing and critical consideration, both as an enabler and an additional source of by-products. Short of survival, human concerns include the range from quality of life to health hazards. Since science holds experimental demonstration to be definitive,

modern treatment of toxicity or environmental harm involves defining a level at which an effect is observable. Common examples of fields where practical measurement is crucial include automobile emissions control, industrial exposure (e.g. Occupational Safety and Health Administration (OSHA) PELs), toxicology (e.g. LD₅₀), and medicine (e.g. medication and radiation doses)

What is pollution?

Pollution can be defined in several ways. Water pollution occurs when energy and other materials are released, degrading the quality of the water for other users. Water pollution includes all of the waste materials that cannot be naturally broken down by water. In other words, anything that is added to the water, above and beyond its capacity to break it down, is pollution. Pollution, in certain circumstances, can be caused by nature itself, such as when water flows through soils with high acidities (Mitchell and Chel, 1978). But more often that not, human actions are responsible for the pollutants that enter the water.

Mankind's reckless exploitation of the biosphere has "In the past three decades, people and their inventions have drilled, polluted, engineered, paved, planted and deforested at soaring rates, changing the biosphere faster than ever before. The combined effects can, without hyperbole be called a global revolution. After all, many of them have world-wide repercussions: the widespread chemical contamination of waterways, the thinning of the ozone layer, and the loss of species diversity". The human body is two-thirds water. Water is essential nutrient that is involved in every function of the body. It helps transport nutrients and waste products in and out of cells. Water dissolves the carbon dioxide, oxygen and salts

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present in the body and distribute to the different parts through the process of blood circulation. Water helps in the utilization of the water-soluble vitamins as well as in removing the waste materials from body. It is also needed for the maintenance of proper body temperature. Although we can live without food for a month or longer but we can go less than a week without water. Water is absolutely essential to life. A loss of just ten to fifteen percent can kill us



Source: <http://www.react.ie/Health/Nutrition/Water.htm>

Source: Nestlé Water Institute (<http://www.water-institute.com>)

Water is so important for all living beings that it should always remain pure but unfortunately it gets polluted through various sources. The recommended standard for potable water or drinking water is that it must be free from pathogenic microorganisms and chemicals that are harmful to human health. All over the world water pollution is posing a threat to human life both in rural and urban areas. According to Rosebury (1961) water pollution is the cause of many diseases and consequently of atmospheric pollution. Most inhabitants are served by surface waters i.e., rivers, streams and lakes. The raw water from these sources is frequently polluted with human waste or sewage and industrial waste. Nearly 80 % of the world's diseases, particularly in developing world, can be linked with contaminated water. About 90 % pollution load in river system is due to human waste (Reilly *et al.*, 1997; Surendra, 2002). The degradation of both surface and ground water resources has had adverse impact on the quality of drinking water for human use, as well as harmful effects on aquatic life.

Outbreak reports have noted cases of diverse health outcomes (e.g., gastrointestinal symptoms, typhoid fever, meningo-encephalitis) with exposure to recreational water and in some instances have identified the specific etiological agents responsible (Prüss, 1998). The causative agents of outbreaks may not be representative of the "background" disease associated with bathing in faecally-polluted water as detected by epidemiological studies. Table 1. list of pathogens that have been linked to swimming-associated disease outbreaks in the USA between 1985 and 1998.

Table 1: Outbreaks associated with recreational waters in the USA, 1985–1998a

Etiological agent	Number of cases	Number of outbreaks
<i>Shigella</i> spp.	1780	20
<i>Escherichia coli</i> O157:H7	234	9
<i>Leptospira</i> sp.	389	3
<i>Giardia lamblia</i>	65	4
<i>Cryptosporidium parvum</i>	429	3
Norwalk-like viruses	89	3
Adenovirus 3	595	1
Acute gastrointestinal infections	1984	21

From Kramer *et al.*, (1998); Craun *et al.*, (1997); Levy *et al.*, (1998).

Two pathogenic bacteria, enterohaemorrhagic *Escherichia coli* and *Shigella sonnei*, and two pathogenic protozoa, *Giardia lamblia* and *Cryptosporidium parvum*, are of special interest because of the circumstances under which the associated outbreaks occurred i.e., usually in very small, shallow bodies of water that were frequented by children. Epidemiological investigations of these, and similar, outbreaks suggest that the source of the etiological agent was usually the bathers themselves, most likely children (Cransberg *et al.*, 1996; Voelker, 1996; Ackman *et al.*, 1997; Kramer *et al.*, 1998; Barwick *et al.*, 2000). Each outbreak affected a large number of bathers, which might be expected in unmixed small bodies of water containing large numbers of pathogens. Management of these small bodies of water is similar to management of swimming pools.

Consequences on health

Poor sanitation and contaminated drinking water are two of the most common environmental hazards in many countries of the world. Inadequate water, sanitation and hygiene account for a large part of the burden of illness and death in developing countries. Lack of clean water and sanitation is the second most important risk factor in terms of the global burden of disease, after malnutrition. According to Akolisa and Okonji (2005) about 1.1 billion people do not have access to safe water; almost 2.5 billion lack basic sanitation. A large segment of these people live in 49 developing countries. These countries are experiencing increasing cases of water-related diseases such as cholera, diarrhoea and dysentery, says the latest UN report presented at the ongoing 3rd World Water Forum in Japan. Growing water crisis in the countries has adverse effects on their long-term development, the report further adds. A series of conferences on water and international communities' efforts to improve the overall situation of water in these countries are going on, but water scarcity and lack of access to water and sanitation still continue, the report states.

There are many reports on the impact of waterborne diseases in countries worldwide revealing thousands of outbreaks due to bacterial, viral, and parasitic micro-organisms associated with the consumption of untreated or improperly treated drinking water. The World Health Organization (WHO) estimated in 1995 that every eight seconds a child died from a water-related disease and that each year more than five million people died from illnesses linked to unsafe drinking water or inadequate sanitation. WHO also suggest that if sustainable safe drinking water and sanitation services were provided to all, each year there would be 200 million fewer diarrhoeal episodes, 2.1 million fewer deaths caused by diarrhoea, 76,000 fewer dracunculiasis cases, 150 million fewer schistosomiasis cases and 75 million fewer trachoma cases (Ademoroti, 1987).

An important fraction of the burden of water-related diseases, in particular: water-related vector-borne diseases, is attributable to the way water resources are developed and managed. In many parts of the world the adverse health impacts of dam construction, irrigation development and flood control may lead to an increased incidence of malaria, Japanese encephalitis, schistosomiasis, lymphatic filariasis etc. 1.3 million people die of malaria each year, 90% of whom are children under 5 (Ademoroti, 1987). There are 396 million episodes of malaria every year. About 200 million people are infected with schistosomiasis, 20 million of whom suffer severe consequences. Six million people are blind from trachoma and

the population at risk is about 500 million. Drinking water supplies that contain high amounts of certain chemicals (like arsenic and nitrates) can cause this type of serious disease. Drinking and bathing in polluted water supplies are among the most common routes for the spread of infectious disease, and nearly half the world's population suffers from water-related diseases. Children who live in unsanitary conditions, or who drink dirty water, are sick more often and more seriously; many die before the age of five from water- and sanitation-related diseases, including diarrhoea, cholera and malaria (Ambika, 1998; Cheesbrough, 2000). Such diseases are the single largest killers of infants in developing countries and even when they do survive, they lag behind others in growth and development. Faecal contaminated of drinking water and food is associated with hepatitis A, a common viral infection in all countries of the region. Bangladesh, India, Maldives and Nepal are countries with high hepatitis a endemicity. Studies from these countries indicate that 85- 95 % of children may be infected and already immune to the disease by ten years of age.

Most countries are also highly endemic for hepatitis E. Data gathered by WHO show that more than 60 water borne outbreaks of hepatitis E were reported from Bangladesh, India, Indonesia, Myanmar and Nepal during the last twenty years. Approximately four million cases of hepatitis E virus infection occur in the region every year. Besides this, unsanitary excreta disposal and contamination of drinking water by pathogens as well as the use of inadequately treated wastewater in irrigation and of faecal sludges in soil amendment and fertilisation is especially associated with elevated prevalence of intestinal helminth infection as well as similar other intestinal and parasitic infections including cholera, typhoid, paratyphoid, polio, cryptosporidiosis, hookworm disease, ascariasis, and schistosomiasis. Human excreta-transmitted diseases predominantly affect children and the poor. Most of the deaths due to diarrhoea occur in children and in developing countries. The World Health Organization (WHO) estimates that 1.8 million people die annually from diarrhoeal diseases including cholera; 90% an under 5, mostly in developing countries. 133 million people infected with high intensity intestinal helminthes infections. These diseases cause around 9400 deaths every year. Ten percent of the population of the developing world are severely infected with intestinal worm's related to improper waste and excreta management and can lead to malnutrition, anaemia and retarded growth.

About 40 million people throughout the world are infected with trematodes and that over 10% of the global population is at risk of trematode infection. According to Atiribom (2007) in less developed countries, poor nutritional status and poverty exacerbate morbidity and mortality associated with excreta-related diseases. Diarrhoeal disease alone amounts to an estimated 4.3 % (62.5 million) of the total disability adjusted life years global burden of disease. It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries (WHO, 1999). Other health issues indirectly associated with water resources development include nutritional status, exposure to agricultural pesticides and their residues and accidents/injuries. The different pollutants have different effects on the people. A high fluoride contents leads to dental and skeletal fluorosis, bone deformation and other disorders. Excess nitrate is known to cause holes in heart, discolours the skin and impairs the digestive system. Saline water can cause an imbalance in the salt content of the body.

Pathogenic Agent Disease	
Bacteria	
<i>Vibrio cholerae</i>	Cholera (extremely heavy diarrhea, dehydration)
<i>Vibrio vulnificus</i>	Skin and tissue infection, death in those with liver problems
<i>Yersinia spp.</i>	Acute gastroenteritis (including diarrhea, abdominal pain)
Viruses	
Adenovirus	Respiratory, eye, and gastrointestinal infections
Astroviruses	
Calicivirus	Gastroenteritis
Coxsackie viruses	Various, including severe respiratory disease, fever
rash, paralysis, aseptic meningitis, Myocarditis	
HAV Infectious	Hepatitis (liver malfunction); also may affect kidneys and spleen
Norovirus	Gastroenteritis
Poliovirus	Poliomyelitis
Polyomavirus	Cancer of the colon
Reovirus	Respiratory infections, gastroenteritis
Rotavirus	Gastroenteritis
Protozoa	
<i>Acanthamoeba</i>	Eye infections
<i>Balantidium coli</i>	Balantidiasis (dysentery, intestinal ulcers)
<i>Cayetanensis</i>	Abscess in liver or other organs
<i>Cryptosporidium</i>	Cryptosporidiosis (diarrhea)
<i>Cyclospora</i>	Gastroenteritis Amoebic dysentery
(prolonged diarrhea)	
<i>Entamoeba histolytica</i>	with bleeding abscesses of the liver and small intestine,
<i>Giardia lamblia</i>	Giardiasis (diarrhea, nausea, indigestion)
<i>Isospora belli</i> and infection	Intestinal parasites, gastrointestinal
<i>Isospora hominis</i>	
<i>Microsporidia</i>	Diarrhea
<i>Toxoplasma gondii</i>	Toxoplasmosis

How to solve this problem?

Water pollution is the most serious environmental quality issues in Nepal. It is caused by the disposal of solid and liquid wastes on land and surface water. The most significant waste is sewage, industrial effluent and agricultural residues and chemicals. Research findings on the relative public health importance of providing safe drinking water supplies, sanitation and hygiene education may seem counter intuitive. Improved hygiene and sanitation have more impact than drinking water quality on health outcomes, specifically reductions in diarrhoea, parasitic infections, morbidity and mortality, and increases in child growth. Combining the results of the many studies and reviews conducted, it becomes evident that improvements in excreta management, hygiene and water supply may reduce diarrhoeal morbidity, diarrhoea mortality and child mortality by significant amounts. According to Adams *et al.*, improvements in drinking water quality through household water treatment can lead to a reduction of diarrhoea episodes by 35%, improved sanitation reduces diarrhoea morbidity by 32% and hygiene interventions including hygiene education and promotion of hand washing can reduces diarrhoeal cases by up to 45%. Improving access to safe water sources and better hygiene practices can reduce trachoma morbidity by 27%, ascariasis by

29% and hookworm by 4%. There is no treatment plant in any industrial district and industrial effluent is directly discharged into the adjoining rivers or streams. Intensified irrigation, dams and other water related projects contribute importantly to disease burden. Better management of water resources reduces transmission of malaria and other vector borne diseases.

Conclusion and Recommendation

A historical perspective of the relationship between humans and microbes has been presented. Pathogens in water, sediment and fish and their infections were reviewed and discussed. Issues arising from fish disease infections in relation to fish health, productivity from wild and cultured fish, socio-economic and human health impacts were also discussed. To ameliorate these impacts and ensure good health, the following recommendations have been made:

- i. Man's onslaught through pollution and direct alteration of the aquatic ecosystem should be regulated to minimize impacts.
- ii. Environmental factors (physical, chemical and biological) that can adversely affect the health of fish and cause fish diseases and death should be avoided.
- iii. Measures to prevent the contamination of drinking water and food and adequate preparation of fish for human consumption should be encouraged.
- iv. Provision of adequate water supply, improvement in personal hygiene, destruction and control of disease vectors and their habitats should be routinely carried out to prevent the multiplication and spread of disease pathogens.
- v. Epidemiological investigations into pathogens of fish and humans, their virulence, treatment and above all their prevention should be intensified.

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