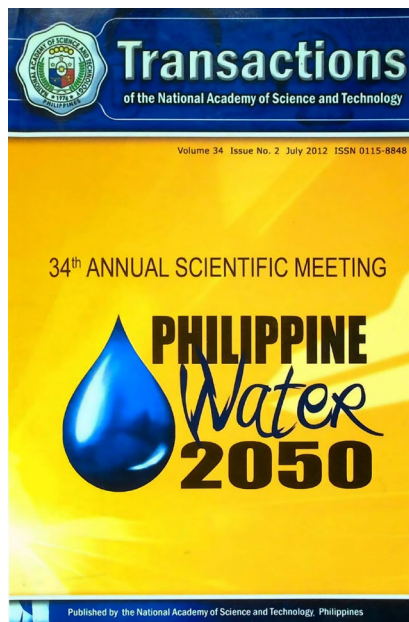


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Water Resources: Health and Safety Issues

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WATER RESOURCES: HEALTH AND SAFETY ISSUES

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Abstract

Water is an important basic commodity that is essential for human existence. As such, water should be safe and of the highest quality. Countries, like the Philippines, have set up considerably resources to ensure that safe and clean water is readily accessible and available to the majority of Filipinos. Many water borne and related diseases may result with poor water management, inadequate sanitation and inappropriate hygiene practices. These water-related diseases include diarrheal diseases, arsenic and fluoride poisoning, intestinal nematode infections, malnutrition, trachoma, schistosomiasis, malaria, Japanese encephalitis, lymphatic filariasis and dengue. However, efforts to implement successful public health interventions to combat these diseases are complicated by the fact that these diseases are associated with a variety of economic, societal and environmental factors.

Biological agents that may affect water quality and safety include bacteria like *Vibrio cholera*, *Echerichia coli*, *Salmonella*; parasites like *Plasmodium* and helminths such as *Dracunculus medinensis*. Chemical agents that may affect water quality and safety include heavy metals and pesticides that result from industrial and other man-made activities. Government agencies such as the Local Water Utilities Administration (LWUA) are tasked to ensure that water resources meet the Philippine National Standards for Drinking Water (PNSDW). Efforts should be sustained to promote quality water resources for everyone. Research and development efforts should also be intensified to achieve this objective.

Keywords: biological agents, chemical agents, water borne diseases,

Water is the very essence of human life. Humans can survive without food for months but cannot survive without water for more than a week. As such, water is considered a basic human need. The state should therefore ensure the availability and accessibility of safe and clean water for all its citizens to sustain human needs and activities. However, with rapid industrialization and urbanization, together with rapid expansion of human

populations, water has become an all important critical, and in some areas, a scarce and threatened human commodity.

Improving water quality, accessibility and availability have the potential of improving the quality of life of billions of individuals. No less than the United Nations has underscored the importance of water resources in its Millennium Development Goals or MDGs: To halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water. Except for sub-Saharan Africa and Oceania, all regions are on track to meet the Millennium Development Goal drinking water target – but if current trends continue, 2.4 billion people will still be without access to basic sanitation by 2015. It is also important to note that water is also critical in achieving the targets of the other MDGs, specifically MDGs 4, 5 and 6. To stop the unsustainable exploitation of water resources, it has become imperative that countries develop water management strategies at the regional, national and local levels that will promote both equitable access and adequate water supplies.

The urban population of the world is forecast to grow to 6.3 billion people in 2050, from 3.4 billion in 2009. Urban growth will be equal to all of the world population growth over this period plus some net moves from the current rural population. Problems of adequate water supply, sanitation and drainage will increase in the urban slum areas already faced with a backlog of unserved populations.

In 2006, 54% of the world's population had a piped connection to their dwelling, plot or yard, and 33% used other improved drinking water sources. The remaining 13% (884 million people) relied on unimproved sources.

Our water resources are continuously being threatened by pollution and contamination mostly resulting from senseless and irresponsible human activities. The effects of climate change have further aggravated this problem. There is therefore the need to continuously address these issues that pose a threat to human health and survival.

Water management, drinking water supply and sanitation, and hygiene can form the basis for the prevention of a significant number of water-related

diseases. These water-related diseases include diarrheal diseases, arsenic and fluoride poisoning, intestinal nematode infections, malnutrition, trachoma, schistosomiasis, malaria, Japanese encephalitis, lymphatic filariasis and dengue. However, efforts to implement successful public health interventions to combat these diseases are complicated by the fact that these diseases are associated with a variety of economic, societal and environmental factors. Efforts within governments are likewise fragmented at different levels and coordination among these and across sectors continue to be a challenge. Moreover, there is still the need to identify effective and feasible policies as well as plans, programs and projects that will address the current problems that beset water resources.

This paper will focus on these water issues that may lead to important health problems. The paper will also discuss and highlight the biological and chemical agents that significantly affect water quality and safety that may potentially lead to public health problems. However, it is important to remember that water quantity is just as important as water quality for satisfying basic human and environmental needs. A brief description of local water utilities' mandate and activities in the Philippines will also be done.

Biological Agents that affect water quality and safety

Almost all kinds of microbes can infect and colonize our water supply. This can range from bacteria to protozoan parasites and from viruses to fungi. All these organisms can infect humans through the water supply and lead to both short term and long term sequelae that may bring deleterious and even life threatening consequences.

The water-related diseases can be classified into four categories:

- a) Waterborne diseases – include infections that are spread through water supplies (e.g. cholera caused by *Vibrio cholerae*)
- b) Water-washed diseases – include infections spread through lack of water for personal hygiene (e.g. *Echerichia coli* and *Salmonella*)
- c) Water-vectored diseases – include infections spread by insects that depend on water (e.g. malaria caused by *Plasmodium falciparum*, *P. vivax*, *P. ovale* and *P. malariae*)

- d) Water-based diseases – include infections spread through an aquatic invertebrate host (e.g. Guinea worm disease caused by *Dracunculus medinensis*)

The table below describes the major diseases attributable to water, sanitation and hygiene as well as environmental factors. Most of these diseases remain as important public health problems in most developing countries where adequate and safe water supply is also a problem. Almost one-tenth of the global disease burden could be prevented by improving water supply, sanitation, hygiene and management of water resources.

All of these diseases can be caused by a variety of organisms thereby rendering prevention and control measures more difficult and complicated. Moreover, organisms have developed adaptive mechanisms that enable them to replicate and live in water, even under the most challenging conditions. For example, bacteria can form biofilms that can act as a shield against environmental and human host defenses (Huq *et al.*, 2008).

These biofilms that are composed of complex communities of microorganisms, when ingested, can readily cause disease due to the large infective dose delivered (Faruque *et al.* 2006). This phenomenon, for example, has been demonstrated with *Vibrio cholerae*, the causative agent for cholera. This ability to form biofilms is also responsible for their persistence in the environment. Other bacteria that may cause waterborne diseases are *Aeromonas* and *Plesiomonas*, *Salmonella typhi* and non-typhoidal *Salmonella*, *Shigella* and *Escherichia coli*. The viruses that may also cause waterborne diseases are Rotavirus which is the most common cause of diarrhea in children, Adenovirus, Calicivirus, Norwalk-like virus and Coronavirus.

Among the protozoan agents, the most important are *Entamoeba histolytica* and *Giardia lamblia*. The diseases they cause can have both acute and chronic effects. Studies have shown, for example, that early childhood diarrhea, especially if recurrent, correlates with impaired physical fitness and cognitive dysfunction as well as decreased semantic fluency and retarded growth or reduced height for age.

There is therefore the need to develop and evaluate novel methods of household water treatment as well as effective and reliable surveillance systems for determining and monitoring water pollution and contamination

Table. Major diseases attributable to environmental factors

Disease	Annual global burden attributable to water, sanitation and hygiene		Percent of total burden attributable to environmental factors	Environmental pathways
	Deaths (thousands)	DALY* (thousands)		
Diarrhea	1,523	52,460	94	Water supply, sanitation, hygiene
Malnutrition	863	33,579	50	Water supply, sanitation, hygiene, water resources management
Malaria	526	19,241	42	Water resources management
Lymphatic filariasis	0	3,784	66	Water supply, sanitation
Intestinal nematodes	12	2,948	100	Sanitation
Trachoma	0	2,320	100	Water supply, hygiene, flies
Schistosomiasis	15	1,698	100	Water supply, sanitation, water resources management
Japanese encephalitis	13	671	95	Water resources management
Dengue	18	586	95	Water supply, sanitation

* Disability adjusted life year, a summary measure of population health. One DALY represents one lost year of healthy life.

Source: World Water Assessment Programme, 2009, UN World Water Development Report 3: Water in a Changing World; Paris, UNESCO and London, Earth Scan, p 89

Chemical Agents that affect water quality and safety

Rapid increases in population, urbanization and industrialization have threatened the quality of our water supplies. The discharge of domestic and industrial wastewater and agricultural runoff has caused extensive pollution of the receiving water-bodies. This effluent is in the form of raw sewage, detergents, fertilizer, heavy metals, chemical products, oils, and even solid

waste. Each of these pollutants has a particular noxious effect that influences human livelihood and translates into economic costs.

Nearly 2.2 million metric tons of organic pollution are produced annually by domestic (48%), agricultural (37%), and industrial (15%) sectors. For example, the four main rivers of the NCR—Marikina, San Juan, Parañaque, and Pasig—have poor water quality and are considered “biologically dead” in some areas. There is also a significantly higher health risk for people living near dump sites such as the Payatas area.

One key indicator of water quality is the amount of dissolved oxygen (DO) present, where fish and other aquatic life need at least 5 milligrams per liter (mg/L) of oxygen to survive. In 2003, the annual average DO levels for these four rivers ranged from 2.2 mg/L to 3.7 mg/L. By 2005, the levels were worse for each river, ranging from 1.5 mg/L to 3.4 mg/L. The Parañaque and Pasig rivers experienced the greatest decreases of 34% and 31%, respectively.

The rivers are also contaminated with heavy metals and pesticides, most likely effluents from domestic sewage and garbage; municipal wastes from public markets and slaughterhouses; untreated or partially treated wastewater from industries along these rivers; and oil spills from gasoline stations, barges, and boats.

Let us cite as an example, the Pasig River. The Pasig River has become a sewage and industrial sewage and industrial effluent depot. Oil slicks, unpleasant odor, dark-colored water, hyacinth blooms and floating garbage and feces contaminate the river. High organic loads and contaminants with heavy metals, pesticides, nitrates and phosphates are also seen.

Industrial pollution accounts for 45% of the total pollution in the Pasig River. About 315 of the 2,000 or more factories situated in the river basin have been determined as principal polluters of the river, dumping an average of 145 t of biochemical oxygen demand (BOD) per day. According to records, the textile and food manufacturing industries are the greatest water polluters among those considered in the study. The pollution rate is expected to decrease by 2% a year due to the limited commercial land available along the river and the increased requirements for container transport.

In another river system, the Manila Bay, similar findings were also noted. Dissolved oxygen consumption was lower than 3 mg/L. Dissolved inorganic nitrogen was $0.90 + 0.53 \mu\text{M}$, nitrate was $0.10 + 0.16 \mu\text{M}$ and nitrite/ammonia was $8.0 + 1.35 \mu\text{M}$. For heavy metals, there was increased concentration of chromium, lead, cadmium, zinc and copper. Similar findings were also seen in Laguna Lake. But unlike the Pasig River where majority of the pollutants were industrial wastes, discharge of untreated domestic wastewater mostly from the western (Metro Manila) portion accounts to 77% of total BOD loading into the lake.

A recent SWS survey revealed that 50% of respondents believe that water pollution is already a very serious problem. Chemical hazards such as heavy metals like mercury and lead pose important health threats with acute and chronic effects. Chronic exposure to heavy metals can affect several organ systems in the human host. It may lead to anemia, spontaneous abortions and infertility, cancer and even developmental delays in children resulting to low intelligence quotients.

For example, natural arsenic pollution of drinking water is now considered a global threat with as many as 140 million people affected in 70 countries on all continents.

Summary of Non-carcinogenic Health Quotient (NHQ) values of five heavy metals in five fish species for dry season showed that mercury and lead are the two heavy metals of concern in terms of adverse health effects associated with heavy metals bioaccumulation. For the wet season, Non-carcinogenic Health Quotient (NHQ) values showed that among the five heavy metals investigated, lead is the most urgent pollutant of concern in terms of adverse health effects from risks associated with fish consumption from the lake.

For the wet season, Non-carcinogenic Health Quotient (NHQ) values showed that among the five heavy metals investigated, lead is the most urgent pollutant of concern in terms of adverse health effects from risks associated with fish consumption from the lake.

Chronic exposure to heavy metals involves several organ systems in the body. This may lead to neuropathies, nephropathies, anemia, spontaneous abortions and infertility. This may also lead to growth and developmental

effects such as low intelligence quotients and growth delays as well as cancers.

Provision of Safe and Potable Water for Human Consumption

Access to safe water and adequate sanitation services has proven to be one of the most efficient ways of improving human health. The World Health Organization has estimated the economic costs avoided, and returns gained, by various levels of investment in water supply and sanitation services: every US\$1 invested in improved water supply and sanitation yields gains of US\$4 to US\$12, depending on the type of intervention.

The Local Water Utilities Administration is the government agency tasked to support institutions for the promotion, development and financing of local water utilities. They help ensure that water resources meet the Philippine National Standards for Drinking Water (PNSDW). The PNSDW sets the limits for physical, chemical, biological and radiological parameters for drinking water.

Some of the water quality issues that are being monitored include:

- a) Iron content
- b) Manganese content
- c) Turbidity
- d) Color
- e) Chloride content- limit is 250 ppm
- f) pH
- g) Total dissolved solids- limit is 500 ppm
- h) Arsenic

Water service providers belong to any of three levels:

- a) Level 1 Spring Water
- b) Level 2 Ground water
- c) Level 3 Individual distribution through pipes

Major source of water is ground water at 88%, with combination of ground water and surface water at 7% and surface water at 5%. Ideally each municipality should have at least one water district. There are currently 849 water districts, 490 of which are active.

Most of the water districts have complied with and satisfied requirements for safety. Some issues still remain such as the need for more accessible and reliable laboratories and financial support for upgrading and improving equipment.

Actions that have to be taken to address water issues affecting health and safety

Environment and health issues should be mainstreamed into economic development. There should be continuous efforts to promote sustainable and equitable water resources for everyone. There is also a need to build national and local capacity for a more efficient and effective management and monitoring system of waste and water resources. Personal protection from pollution and infections should also be ensured for all. Finally, research and development efforts for a more reliable and safe water supply should be promoted and sustained by concerned agencies.

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