Dirty Water

Module 12 • i2P • H2O Tour

"Filthy water cannot be washed"

- West African proverb

Clean Water

Water is essential to life on this planet. However, the very water required to sustain life can also lead to illness and death if it is not clean. Clean water can be defined as water that can be consumed by individuals without risk of illness or long term harm. In most Developed countries, the water delivered through the tap is safe to drink. It is safe because it has been treated to remove pathogens (bacteria, viruses and protozoa) and toxic chemicals. Unfortunately a significant proportion of people who live in Developing countries do not have ready access to clean water.

In its pure form, the water molecule consists of one oxygen atom and two hydrogen atoms (H20). As we learned in Module 2 the structure of water affords it unique properties that enable it to dissolve more substances than any other liquid. Water is thereby called the universal solvent.

Super Solvent

The water that we drink contains many dissolved substances such as sodium, potassium, magnesium, chloride and others that are essential to human health. These substances are introduced to water during the phases of the water (hydrologic) cycle. Minerals can be dissolved in water as it is moving through cracks in the rocks, or when it's running in streams and lakes on the Earth's surface. Gases are absorbed by water when it is in the air as clouds or falling as precipitation. As long as the substances dissolved in the water during the hydrologic cycle are not at high concentrations to harm humans (in the short term or longer term) the water is considered safe to drink (potable).

Figure 1: Salt is one of many substances that easily dissolve in water (source: Wikimedia Commons).

Water can also dissolve substances or harbour organisms that are harmful to humans. These harmful substances can be

introduced by both natural and man-made (anthropogenic) sources. Natural substances include uranium and arsenic, and pathogens such as bacteria, viruses and protozoa. Human sources of contamination can be from man-made items such as gasoline, organic chemicals and human (septic) waste.

Bad Water

The ability of water to dissolve many substances puts it at risk of harbouring dangerous or toxic organisms and chemicals. There are three principle categories of water contamination:

- Macroscopic
- Biological
- Chemical

Macroscopic Contamination

Figure 2: Macroscopic water contamination (source: Wikimedia Commons).

The cover photo of this module provides a fine illustration of macroscopic water contamination, which is comprised of all of the large pieces of waste that you can easily see in water. This garbage is referred to as macroscopic contamination (because you can see it). The contaminants can vary from plastic bottles or bags floating in a stream to tires in a lake or even sediments washing into a river from a nearby construction project. Some of the floating materials will join existing patches of garbage that are floating in the world's oceans. Macroscopic water contamination often is a sign that the water also has microscopic (or unseen) contamination with dissolved substances.

Biological Contamination

The World Health Organization (WHO) estimates that diarrheal disease across the world accounts for 1.8 million deaths every year (see: diarrheal disease). The WHO estimates that 88% of these deaths are attributable to unsafe water supply, sanitation and hygiene. These deaths occur almost exclusively among children in developing countries. One of the leading causes of these types of diseases is when harmful

microorganisms (bacteria, viruses or protozoa) are ingested from contaminated drinking water, or food washed in contaminated water.

Did you know?

Half of all people in developing countries have no access to proper sanitation.

In the developing world, roughly half the population (2.5 billion people) do not have access to appropriate sanitation facilities, and unsafe drinking water sources are used by over 884 million people (see: unsafe water). Approximately 4,500 children die each day from disease ridden water. Other children miss opportunities for education and have lower productivity because they have to spend an enormous amount of time collecting and transporting safe drinking water by hand for themselves and their families (see: education).

In developed countries water-born illness is comparatively rare, but people still die from contaminated water sources. For example, in May 2000, 2,500 residents of Walkerton, Ontario, Canada, became sick from drinking contaminated water. After an investigation, it was found that one of the wells used by the town water supply was contaminated with *E. Coli.* bacteria. The treatment system had failed and the bacteria made it into the water distribution system. By the time the situation was resolved, seven people had died. Following the incident, the Ontario Government made clean drinking water a priority and developed strict new laws regulating municipal water supply.

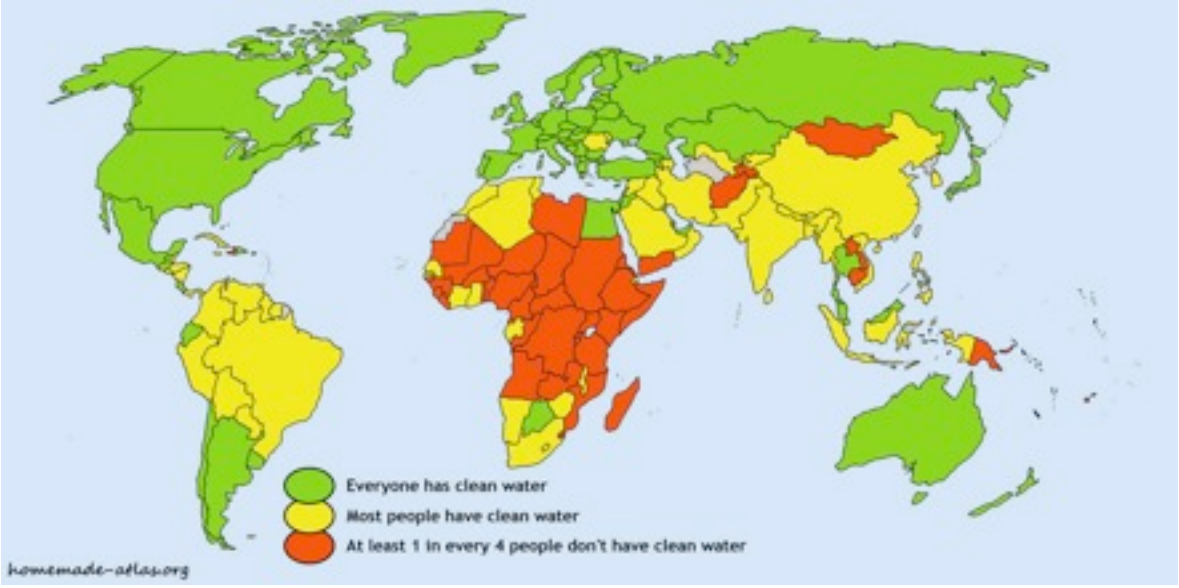

Figure 3: World clean water access by nation. Note the tiny area of red on the western half of the island in the Caribbean is Haiti, is the most water poor nation in the Western Hemisphere (source: United Nations Data).

Chemical Contamination

Figure 4: Chemical in flasks (source: Wikimedia Commons)

There are two principle categories of chemical compounds that contaminate water: *organic* and *inorganic* compounds. An *organic* compound is any member of a large class of chemicals whose molecules contain carbon. Although not all organic compounds are contaminants, many are potentially harmful to humans. Organic contamination can come from a variety of sources. The list of organic compounds that can be found in water is very long and includes gasoline and other petrochemicals, pesticides, herbicides, food processing waste, industrial solvents (from factories and dry-cleaners) and medications (pharmaceuticals). Drinking water containing these compounds can in some instances increase cancer risk, produce reproductive difficulties, and cause a host of other health problems. One of the major problems with some of these compounds is their persistence in the environment, sometimes lasting for hundreds of years before breaking down.

Did You Know?

There have been almost 50 major incidents of groundwater arsenic contamination around the world. The worst hit country is Bangladesh which had some of the highest rates of infant mortality due to water born disease. To obtain a clean source of water UNESCO sponsored a program to dig groundwater wells in Bangladesh. Unfortunately arsenic was not tested for and now after millions of wells have been dug, one in five has been found to be contaminated with naturally occurring arsenic (see: Bangladesh).

Most *inorganic* compounds that contaminate water are naturally occurring, however, they appear in very high concentrations in water because humans have precipitated their release. Examples of inorganic pollutants are arsenic, lead, copper, cyanide, mercury, nitrates and nitrites. Some of these compounds, such as arsenic and cyanide are exceedingly toxic to humans, and can cause rapid death with exposure in significant amounts. Drinking water can be contaminated with these substances when toxic minerals like arsenic - found in the rocks brought to the surface during mining - dissolve into nearby rivers and lakes. Factories and lead pipes can also be sources of water contaminants, and nitrates and nitrites are produced by

septic systems or from animal waste. Other sources of inorganic water contamination include the leach-ate (highly contaminated water) from landfills or from industrial settling ponds.

Thermal Pollution

Figure 5: Duck swimming by a dead fish killed by Algal bloom in a Lake in France. Algal bloom can be produced by chemical and thermal water pollution (source: Wikimedia Commons)

Thermal pollution occurs when the natural temperature of water is either artificially warmed or cooled. Sources of thermal pollution include industrial cooling water (returned to the environment warmer than it was left), storm runoff from parking lots and sewers, and on a global scale the production of greenhouse gases. Thermal pollution of water can effect an entire ecosystem. For example, if the temperature of a lake is increased, the amount of oxygen dissolved in that water decreases, damaging fish and other inhabitants. As well, changes in water temperature can alter the nature of the flora and fauna supported in a body of water, causing changes in a regions biodiversity (see: biodiversity). An example would be the increase in algae growth in a lake (algal bloom) because of increased water temperature. The algae can consume all the oxygen in the water, resulting in the death of all the fish.

Washing the Water

The World Health Organization describes basic sanitation as “the least expensive technology that ensures the proper disposal of sewage and waste to provide a healthy living environment in the home and with other people”(see: WHO sanitation). What is the least expensive technology that will allow people to live healthy lives? In developed countries, the least expensive technology is very expensive indeed! Municipal governments spend millions of dollars every year to treat and distribute drinking water to urban populations, and treat sewage before it is released back into the environment.

Unfortunately developing countries do not have the finances necessary to treat drinking water and sewage in the same manner as developed nations. Consequently basic

means must be undertaken to preserve clean water resources in these nations. Educating populations and introducing simple, inexpensive, yet robust technology is the key to solving the sanitation problem.

Did you know?

Five times as many children die each year of diarrhea as of HIV/AIDS.

One of the first principles of sanitation is to keep sewage and garbage away from a drinking water source. This measure in combination with simple and inexpensive technologies such as chlorination, filtration and solar radiation have been instrumental in improving access to clean water in some developing nations. Non-governmental organizations, governments, companies and individuals are all contributing time and funds to develop and distribute these technologies (see: clean water solutions).

How you can help

Individuals can do a great deal to keep water pollution to a minimum. Here are some tips that can be used to lessen the risks of contaminating water:

- Always remember that what you put down the sink or toilet ends up in water, either surface water or in groundwater. Don't put toxic substances into your drains.
- If you can't help put things down the drain (like laundry or dishwasher detergent and other cleaning products), try to use more environmentally friendly products.
- Try not to use fertilizers, herbicides or pesticides in your garden and on the lawn. These substances will runoff with a rainstorm into a river or lake.
- Take your litter home with you when you are out and dispose of it properly or if you can, recycle it. You can also pick up trash that you see lying around.
- Clean up any spills (outside) of contaminating substances like oil or gasoline.

Another thing to keep in mind is that no matter where you are, someone is always downstream. They need a clean source of water as much as you do so the efforts that you make in keeping water clean helps people directly, and the entire planet as a whole.

Class Exercise

Each student should count the number of household substances they have that would be potentially dangerous if leached into their drinking water. This includes gasoline, fertilizers, human waste, pesticides, cleaning products, etc.

Where do these substances go if washed down the sink?