The name of the concept:
Water resources and water pollution

Sustainable development goals (SDGs)

Goal 6: Clean water and sanitation

Goal 12: Responsible consumption and production

Goal 14: Life below water

Definition

Water resource refers to any of the entire range of natural waters that occur on the Earth, regardless of their state (i.e., vapor, liquid, or solid) and that are of potential use to humans. Of these, the resources most available for use are the waters of the *oceans, rivers, and lakes*; other available water resources include *groundwater and deep subsurface waters and glaciers and permanent snowfields* (*Encyclopaedia Britannica*, 2018).

As diagram 1 shows, the distribution of water on Earth is very uneven. Only 3% of water on the surface is fresh; the remaining 97% is in the ocean. Of freshwater, 69% is found in glaciers, 30% underground, and less than 1% is located in lakes, rivers, and swamps. Looked at another way, only one percent of the water on the Earth's surface is usable by humans, and 99% of that usable quantity is underground (Bralower, n.d.).

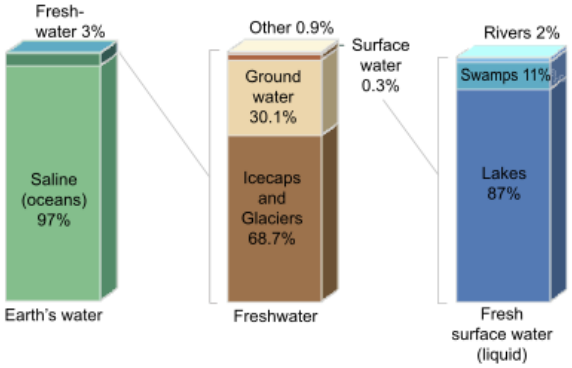

Fig. 1. Distribution of Earth's Water (Bralower, n.d.)

Although 2/3s of the Earth is covered by water bodies, such as oceans, lakes and rivers, known as "surface waters", a great deal of water resources are in underground rock structures, known as "aquifers". This underground water is called "groundwater". Surface waters and groundwater are the two resources affected by water pollution.

Water pollution occurs when harmful substances—*often chemicals or microorganisms*—contaminate a stream, river, lake, ocean, aquifer, or other body of water, *degrading water quality and rendering it toxic to humans or the environment* (Denchak, 2018).

Pollution can occur in different ways. If the pollutant is from a single location, such as wastewater discharged from an oil factory, it is called ***point-source pollution***. If the source is multiple and different, it is called ***non-point source pollution***. Examples are: agricultural, stormwater runoff or debris blown into waterways from the land. Sometimes pollution can affect areas far away from its origins, such as radioactive waste carried from England and France to nearby countries. This is called ***transboundary pollution***.

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According to the World Bank, there are currently

- 2.1 billion people who do not have access to safely managed water
- 844 million do not have even basic drinking water services
- 4.5 billion people do not have safely managed sanitation
- 2.3 billion people do not have basic sanitation services

As a result:

Every year 361,000 children under five years of age die due to diarrhea related to poor sanitation and contaminated water. These two factors are also linked to the transmission of diseases, such as cholera, dysentery, hepatitis A, and typhoid (The World Bank, 2018).

Despite the fact that fresh water resources are limited, and will be in more demand in the future, this crucial-for-life source continues to be contaminated and wasted. Some 80% of the world's wastewater is dumped—largely untreated—back into the environment, so it significantly pollutes rivers, lakes, and oceans. According to a UNESCAP estimation, 80–90% of all wastewater produced in Asia and the Pacific region is released untreated, which pollutes ground, surface water resources and coastal ecosystems (Koncagul, Tran, Connor, Uhlenbrook, & Cordeiro Ortigara, 2017).

Fig. 2. Clean Water and Sanitation (United Nations, 2018)

The urban population in the Asia Pacific region doubled between 1950 and 2000, and this led to an increase in the demand for new and improved wastewater treatment systems. However, 25% of the region's urban population lacked access to improved sanitation, whereas the rate was fifty-fifty for the rural population in 2009 (UNESCAP, 2010 in Koncagul, Tran, Connor, Uhlenbrook, & Cordeiro Ortogara, 2017).

The region is prone to water-related disasters, which have become more frequent and intensive over the past years due to climate change. During floods, for instance, the outflow of sewage mixes with already-contaminated stormwater. This leads to an increase in waterborne diseases. Therefore, action towards counteracting water pollution on local, regional and individual bases is required.

Goals/ principles/ models related to the concept

There are two types of indicators of whether a water body is polluted or not:

- **Chemical indicators:** These indicators help us define the quality of water. One can measure the quality of water by taking a sample from and looking at the concentration of the chemicals it contains. If the concentration is significant and the substances are dangerous, then this is considered to be polluted water.
- **Biological indicators:** This type of measure involves examining life in the water. By looking at the number of fishes, insects and other invertebrates the water supports, one can decide if it is polluted or not. If there are many different types of creatures living in the water, then the quality of water is usually regarded as good.

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Water does not become polluted by itself. Pollution usually occurs as a result of human activity. For instance, when farmers use weed killers and/or fertilizers on their land, the chemicals are usually washed away by rain and then mix with water resources nearby. Similarly, chemicals released by a chimney can enter the atmosphere and fall back on to earth as rain and contaminate seas, lakes and rivers. This is called ***atmospheric deposition***. This is only one of the reasons why water becomes polluted. The other reasons for water pollution include, but not limited to, the following (Woodford, 2017):

- **Agriculture and nutrients**

Not only is the agricultural sector the biggest consumer of global freshwater resources, as farming and livestock production use about 70 percent of the earth's surface water supplies, the sector is also a serious water polluter. Throughout the world, agriculture is the leading cause of water degradation. It's also a major contributor of contamination to estuaries and groundwater (Denchak, 2018).

Chemical fertilizers used by farmers add ***nutrients*** to the soil, but these drain into rivers and seas and increase the fertilizing effect of sewage. Together, sewage and fertilizers can cause a massive increase in the growth of algae, or plankton, that eventually overwhelm huge areas of oceans, lakes, or rivers. This is known as a harmful algal bloom (also known as an HAB or red tide, because it can turn the water red). It is harmful because it removes oxygen from the water that kills other forms of life, and leads to what is known as a "dead zone" (Woodford, 2017).

- **Sewage and wastewater**

In theory, sewage is a completely natural substance that should be broken down harmlessly in the environment. In practice, sewage contains all kinds of other chemicals, from the pharmaceutical drugs people take to the paper, plastic, and other waste they flush down their toilets. When people are sick with viruses, the sewage they produce carries those viruses into the environment. As a result, it is possible to catch illnesses, such as hepatitis, typhoid, and cholera from river and sea water (Woodford, 2017).

Fig. 3: Sewage and wastewater (Miller, 2017)

Used water is wastewater. It comes from our sinks, showers, and toilets and from commercial, industrial, and agricultural activities. The term also includes stormwater runoff, which occurs when rainfall carries road salts, oil, grease, chemicals, and debris from impermeable surfaces into our waterways. More than 80% of the world's wastewater flows back into the environment without being treated or reused (Denchak, 2018).

- **Chemical waste**

Detergents are relatively mild substances. At the opposite end of the spectrum are highly toxic chemicals, such as polychlorinated biphenyls (PCBs). They were once widely used to manufacture electronic circuit boards, but their harmful effects have now been recognized and their use is very restricted in many countries. Although PCBs are widely

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banned today, their effects from the extensive use during the 20th century will be felt for many decades, because they last a long time in the environment without breaking down (Woodford, 2017).

- **Radioactive waste**

At high enough concentrations radioactive waste can kill; in lower concentrations it can cause cancers and other illnesses.

This form of waste is generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine. Radioactive waste can persist in the environment for thousands of years, making disposal a major challenge (Woodford, 2017; Denchak, 2018).

- **Oil pollution**

When one thinks of ocean pollution, huge black oil slicks often spring to mind, yet these accidents represent only a tiny fraction of all the pollution entering our oceans. Even considering oil by itself, tanker spills are not as significant as they might seem: only 12% of the oil that enters the oceans comes from tanker accidents; over 70% of oil pollution at sea comes from routine shipping and from the oil people pour down drains on the land. However, what makes tanker spills so destructive is the sheer quantity of oil they release at once (Woodford, 2017).

Fig. 4. Oil Pollution
(The Rational Walk, 2010)

- **Plastics**

Plastic is by far the most common substance that washes up with the waves. There are three reasons for this: plastic is one of the most common materials, and is used for making virtually every kind of manufactured object from clothing to automobile parts. Plastic is light and floats easily, so it can travel enormous distances across the oceans; most plastics are not biodegradable (meaning they do not break down naturally in the environment), so things like plastic bottle tops can survive in the marine environment for a long time. (A plastic bottle can survive an estimated 450 years in the ocean and plastic fishing lines can last up to 600 years).

Fig. 5. Plastics in the Ocean
(Wasmi, 2017)

While plastics are not toxic in quite the same way as poisonous chemicals, they nevertheless present a major hazard to sea birds, fish, and other marine creatures. For example, plastic fishing lines and other debris can strangle or choke fish (this is sometimes called "ghost fishing") About half of all the world's sea bird species are known to have eaten plastic residues. In one study of 450 shearwaters in the North Pacific, over 80% of the birds were found to have plastic residues in their stomachs (Woodford, 2017).

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- **Thermal pollution**

  Heat or thermal pollution from factories and power plants also causes problems in rivers. By raising the temperature, it reduces the amount of oxygen dissolved in the water, thus also reducing the level of aquatic life that the river can support (Woodford, 2017).

Sustainable Development Goal 6 states that safe drinking water, and adequate sanitation and hygiene, are fundamental to protecting health, and directly contribute to achieving good health and wellbeing. According to the UN *Synthesis Report on Water and Sanitation* (2018), water-related diseases are closely linked to poverty, and disproportionately affect vulnerable communities that do not have access even to basic WASH (water supply, sanitation and hygiene) services. Universal access to WASH is essential for ending preventable deaths from diarrhea and other water-related diseases, and for improving nutrition, health service delivery, social wellbeing and economic productivity (United Nations, 2018).

Improving access to WASH in schools can enhance pupil and teacher health, school attendance and welfare, which improve educational outcomes for all. This is particularly beneficial for girls and young women with respect to menstrual hygiene management (United Nations, 2018, p.18).

Water is an essential ingredient in agriculture and food production. It is intrinsic to ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture. Most water withdrawals are in the agriculture sector. Therefore, water shortages and scarcity can seriously affect agriculture and food production, particularly in vulnerable developing countries where the demand for food is increasing and undernutrition is endemic. World hunger is rising again today, following a prolonged period of decline, as more people suffer food insecurity (United Nations, 2018, p 18).

Daily Life

Application in daily life

Greywater is used water from your bathroom sinks, showers, tubs, and washing machines. It is not water that has come into contact with feces, either from the toilet or from washing diapers.

Greywater may contain traces of dirt, food, grease, hair, and certain household cleaning products. While greywater may look “dirty", it is a safe and even beneficial source of irrigation water in a yard. Keep in mind that if greywater is released into rivers, lakes, or estuaries, its nutrients become pollutants, but for plants it can be a valuable fertilizer. Aside from the obvious benefits of saving water (and money on your water bill), reusing greywater keeps it out of the sewer or septic system, thereby reducing the cost of sewage treatment in the country by decreasing the amount of treated waste. Reusing greywater for irrigation reconnects urban residents and their backyard gardens to the natural water cycle (Greywater Action, n.d.).

Fig. 6. Greywater Treatment (Water Wally, n.d.)

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Application in specific industries

Link to case studies in different sectors:

Waste management sector

- Wastewater Treatment in Hong Kong

Manufacturing sector

- Textile Wastewater

Description of the related issues

Wastewater treatment

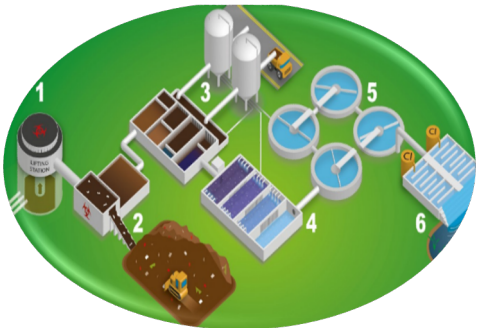

Fig. 7. Wastewater Treatment (Scutt, 2012)

The United Nation's *Synthesis Report on Water and Sanitation* (2018) states that collecting, treating and reusing wastewater from households and industry, reducing diffuse pollution and improving water quality are major challenges for the water sector. Ambient freshwater quality is at risk around the world. Freshwater pollution is prevalent and is increasing in many regions worldwide.

Preliminary estimates of household wastewater flows, from 79 mostly high- and high-middle-income countries, show that 59% is safely treated. For these countries, it is further estimated that safe treatment levels of household wastewater flow with sewer connections and on-site facilities are 76% and 18% respectively.

The same report also shows that water and energy are closely associated. Forty-two percent of electricity consumption in the water sector is used to treat wastewater in developed countries. However, 80% of wastewater (including urban and agricultural run-off) is still not treated globally (WWAP, 2017). Between 60% and 95% of municipal wastewater is not collected in least developed countries (IEA, 2016a in United Nations, 2018).

Wastewater, if treated or reclaimed, can be used in the following ways:

- Cleaning roads and vehicles
- Irrigating parks and sport fields
- Flushing toilets
- Fire fighting
- Industrial production
- Urban development and landscaping (GovHK, 2018)

Contamination of water in one country can have an impact on another country that shares the same water resources. Thus, water treatment requires collective solutions and cooperation among countries.

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