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# Sustainable Water Supply

Warwick University Summer School

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# Introduction

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## GOAL 6. ENSURE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL

No	SDG 6 global indicators (short title)	Custodian
6.1.1	Safely managed drinking water services	WHO UNICEF
6.2.1	Safely managed sanitation services	WHO UNICEF
6.3.1	Wastewater safely treated*	WHO UN Habitat UN DESA
6.3.2	Good ambient water quality*	UNEP
6.4.1	Water use efficiency*	FAO
6.4.2	Level of water stress	FAO
6.5.1	Integrated water resources management	UNEP
6.5.2	Transboundary basin area with an operational arrangement for water cooperation*	UNECE UNESCO
6.6.1	Water-related ecosystems*	UNEP
6.a.1	Water- and sanitation-related official development assistance that is part of a government coordinated spending plan	WHO UNEP
6.b.1	Participation of local communities in water and sanitation management	WHO UNEP OECD

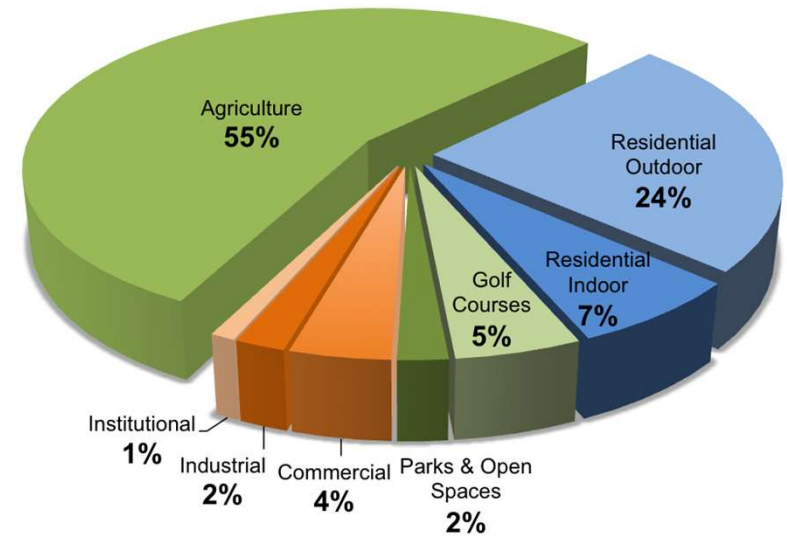
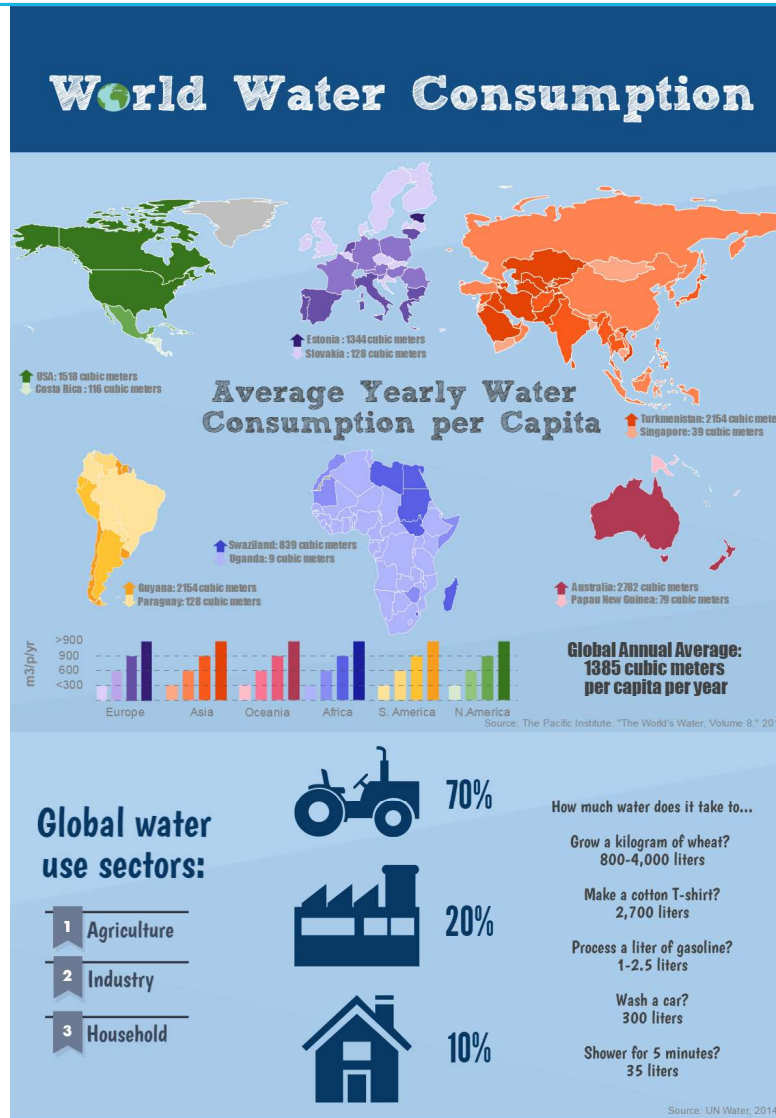


# Use, Source and System



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# Water Use





# What Factors Affect Water Availability?



**Size of city**



**Climate**



**Characteristics of population**



**Industry and commerce**



**Environmental Concern**

**Need for water conservation**

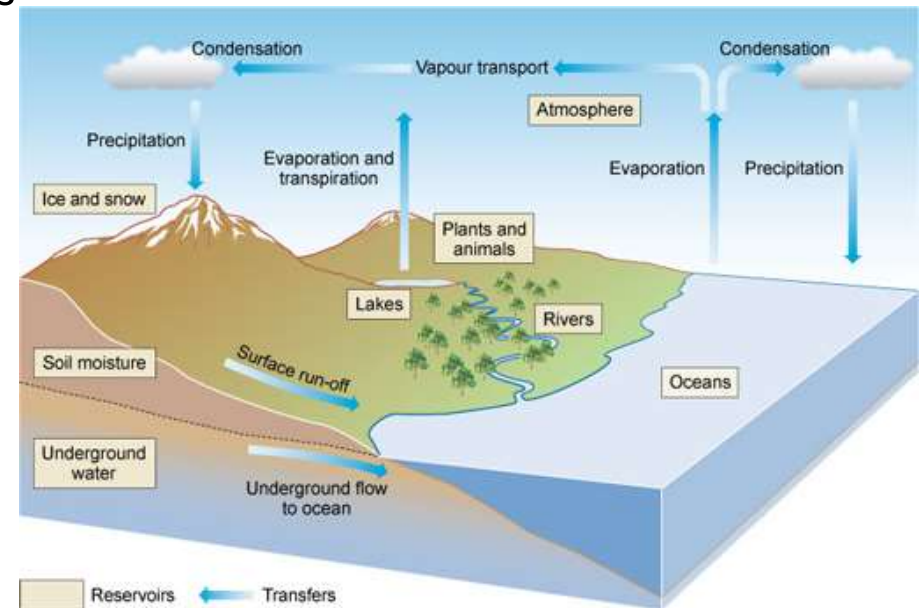
# Sources of Water

## Classification:

- Surface Water- lakes, ponds, rivers, etc.
- Ground Water- drilled wells, hand-dug wells, springs
- Precipitation – rainwater, fog, ice and snow

## Factors to be considered to select source:

- Quantity
- Quality
- Reliability
- Safety of source
- Water rights
- Environmental impacts



The Water Cycle

<https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=79936&printable=1>

# Comparison of Water Sources

Water Source	Advantages	Disadvantages
<b>Surface</b>	<ul style="list-style-type: none"><li>• Quick access</li><li>• Easily extractable in large quantity</li></ul>	<ul style="list-style-type: none"><li>• Exposed to potential microbiological and chemical contamination</li><li>• Multiple treatment steps may be required</li></ul>
<b>Hand-Dug Well</b>	<ul style="list-style-type: none"><li>• Groundwater may be higher quality than surface water</li><li>• Can be dug using locally available tools, materials, and labor</li><li>• Low cost</li></ul>	<ul style="list-style-type: none"><li>• Water table subject to seasonal variability</li><li>• May be subject to surface contamination if not well protected</li></ul>
<b>Borehole</b>	<ul style="list-style-type: none"><li>• High water quality and less susceptible to contamination than shallow wells</li><li>• More consistent supply of water if aquifer is penetrated</li></ul>	<ul style="list-style-type: none"><li>• Requires drilling equipment and skilled staff to identify sites</li><li>• May be high in minerals, affecting taste or water quality</li><li>• Pumps for extraction require operation and maintenance</li></ul>
<b>Spring or Seep</b>	<ul style="list-style-type: none"><li>• High water quality</li><li>• Lower operational costs if gravity-fed system is used</li></ul>	<ul style="list-style-type: none"><li>• Risk of contamination if spring is not adequately protected</li><li>• Flow may vary depending on season</li><li>• Location may be far away from population</li></ul>
<b>Rain</b>	<ul style="list-style-type: none"><li>• Lower risk of pollutants in rural and nonindustrial areas</li><li>• Low cost and easy to maintain</li></ul>	<ul style="list-style-type: none"><li>• Difficult where rainfall is limited or unpredictable</li><li>• Limited to available storage capacity</li></ul>





# What influences design of water scheme



- **Sources of water.** Detailed survey
- **Conveyance of water.** from source to water treatment units depend on the relative levels
- **Quality of water.** The analysis of the raw water quality should be made to know the various impurities present in it, and to decide on the required treatment processes.
- **Treatment works.** sizes and number of treatment units
- **Pumping units for treated water.**
- **Storage.** The entire city or town should be divided into several pressure zones and storage facility should be provided in each zone.
- **Distribution system.** The distribution system should be designed according to the master plan of the town, keeping in mind the future development.
- **Economy and reliability.** should be economical and reliable



# Water Quality and Treatment



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# Water Quality (Contamination)

*Water quality describes the condition of water.*



## Examples of Source Water Contamination

Below are examples of potential sources of contamination for surface water supplies.



# Water Quality Parameters

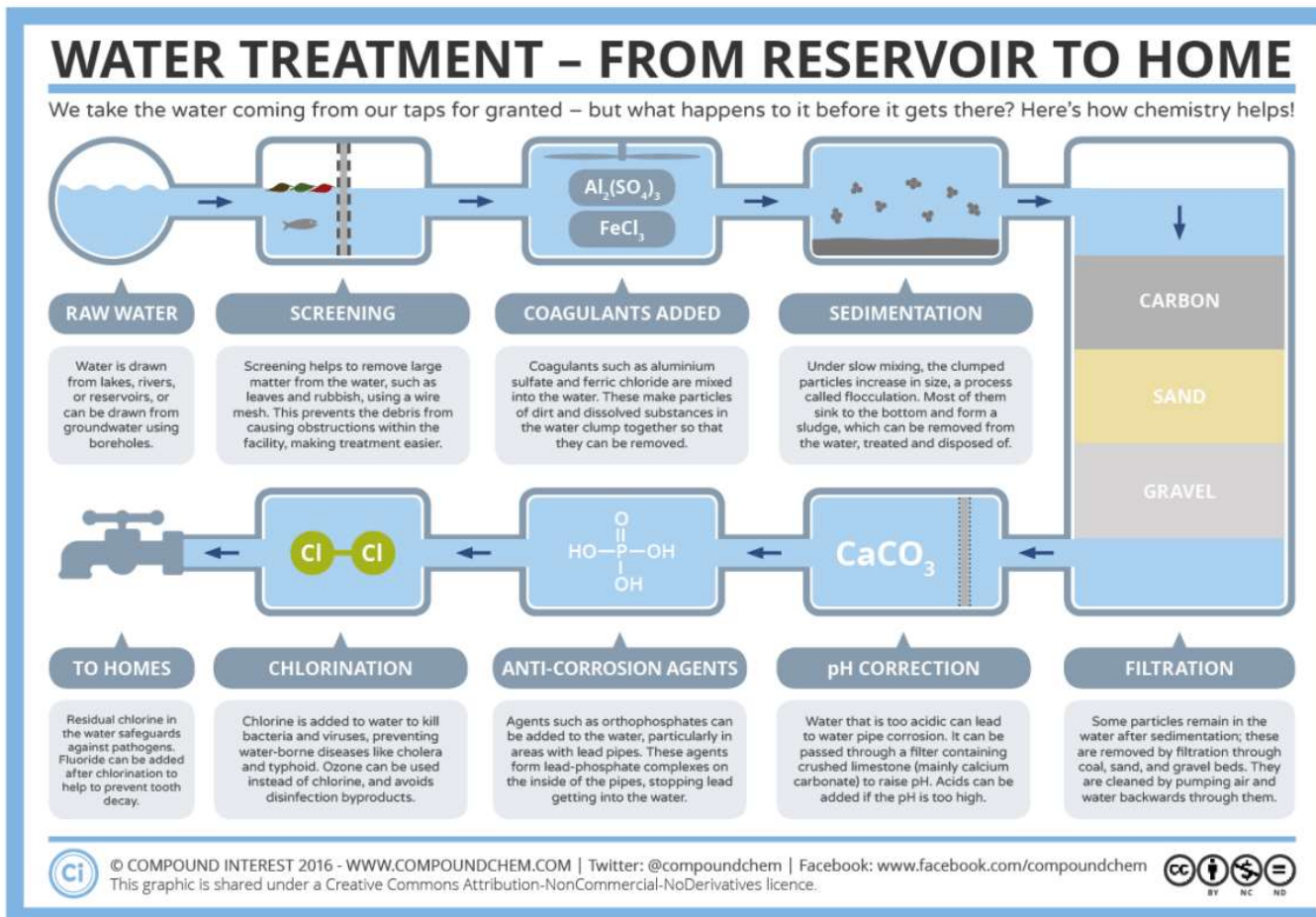


- Used to check safety of water for various purposes.
- Test can be carried out on site or in laboratory.
- Global standard is WHO drinking water standards.
- Many regional or national standards are available.
- There are various parameters but they are broadly classified as
  - **Physical** – Colour, Odour, Temperature, Solids (TDS,TSS), Turbidity, Oil and grease content
  - **Chemical**- pH, Conductivity, Dissolved oxygen (DO), Nitrate, Phosphates, Chemical oxygen demand (COD), Biological oxygen demand (BOD)
  - **Biological** – Algae, Viruses, Protozoan parasites, Bacteriological parameters (faecal coliforms, Ecoli, pathogenic bacterials causing cholera)





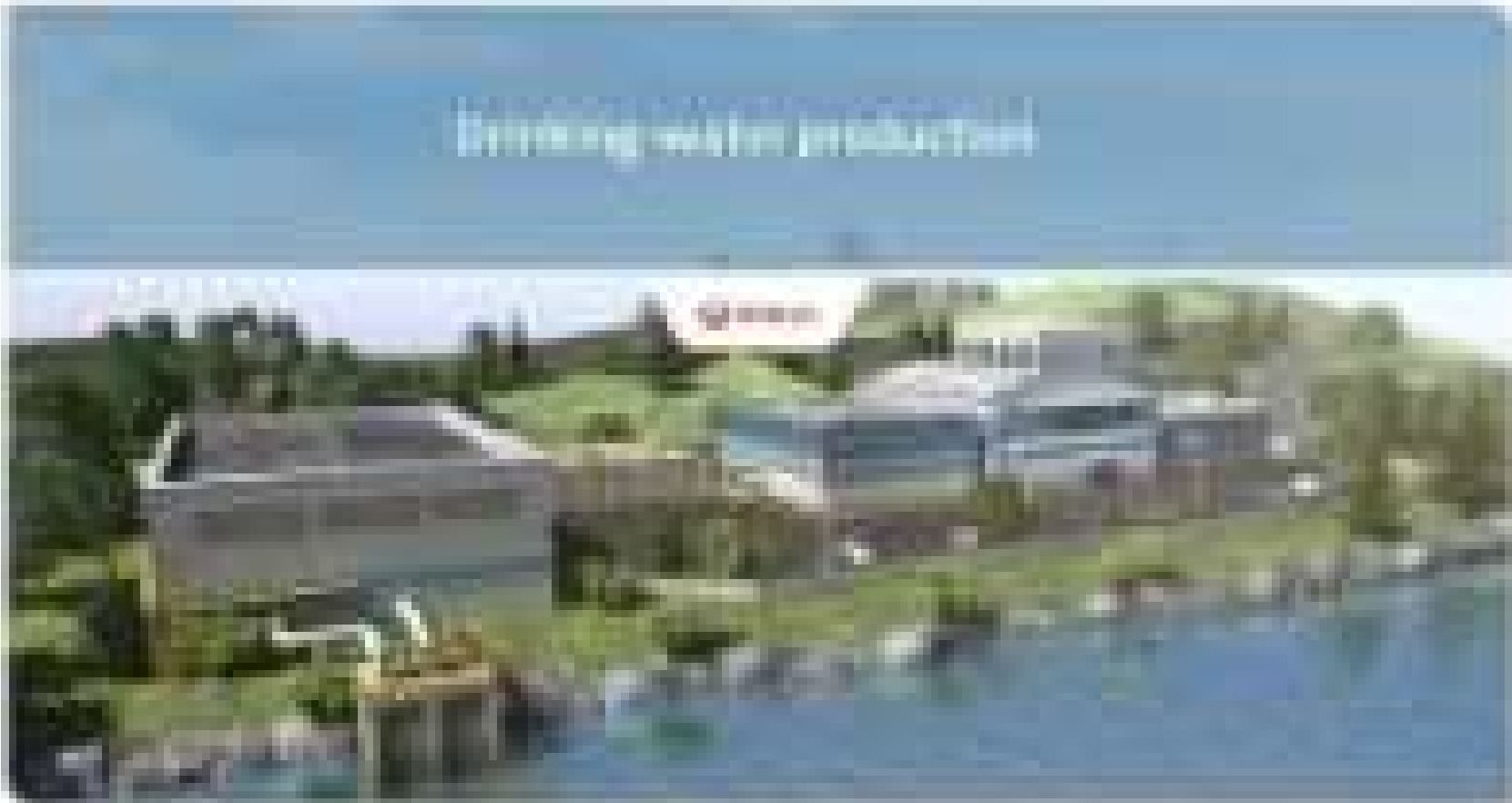
# Water Treatment Plant



Severn Trent Water Works



# Water Treatment Video



Source:<https://youtu.be/RZpZkMMrKAc>

# Desalination

- Removal of dissolved substances from water particularly sea water.
- Goes through evaporation and reverse osmosis.
- Residue is often returned to sea as brine (salt water)
- Project is capital and energy intensive.
- In 2013, more than a third of Israel's tap water came from the Mediterranean Sea and briny wells.
- Israel supplies water to Jordan and the Palestinian Authority.
- Between 2005 and 2020, Singapore had 5 desalination projects.



## UAE to construct world's largest sea water RO desalination plant

Modified date: Dec 30, 2019



# Low Cost Water Treatment Methods



Boiling



Solar water disinfection (SODIS)



Addition of chlorine



Fabric and Fibre filtration



Coagulation using Alum/Iron



Water filter jugs

# Innovations in Rural Water Purification



The LifeStraw is a small cigar-shaped tube designed to purify water from potential pathogens like typhoid, cholera, dysentery and diarrhoea - all before they reach your lips.



Ceramic Water Filters In 2008 UNICEF and the Water and Sanitation Program were given the Project Innovation Award Grand Prize by the International Water Association for providing Cambodia with ceramic water filters.



Water Purifying Bicycle Japan's Nippon Basic Company recently introduced what they are calling, the "Cycloclean," a water-purifying bike initially designed for use in remote villages and disaster zones.



Life Sack Jung Uk Park, Myeong Hoon Lee, and Dae Youl Lee are the industrial designers behind the ingenious water purification device know as the Life Sack. Not only does this clever design purify water -- it also doubles as a container for grains



"Pure" Water Bottle Filters Water With UV Raysa device that is capable of filtering soiled water in two minutes by using a combination of 4 micron-sized water filters and a wind-up ultraviolet light system.



Designed by Jonathan Liow, a graduate student at Monash University, the Solar Ball is a spherical shaped device that utilizes the power of the sun to purify water.

Source: <https://inhabitat.com/6-water-purifying-devices-for-clean-drinking-water-in-the-developing-world/>



# Conveyance and Distribution



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# Water Conveyance

- Open Channel
- Pipe Flow
- Water Tankers
- Rolling Water Barrels
- Buckets
- Jerry cans
- Pumping



# Storage Reservoirs

The reservoirs can be constructed either:

- Underground,
- Ground level
- Elevated (water towers).



Secret underground reservoir in London revealed in all its glory

02/01/2020

One of Thames Water's reservoirs - hidden under ancient woodland in London - was revealed in all its Victorian glory during work to maintain the standard of the company's drinking water.





# Drinking Water Distribution System



Source: <https://youtu.be/yBd8UF3vwDs>



# **Social and Ethical Issues in Water Supply**



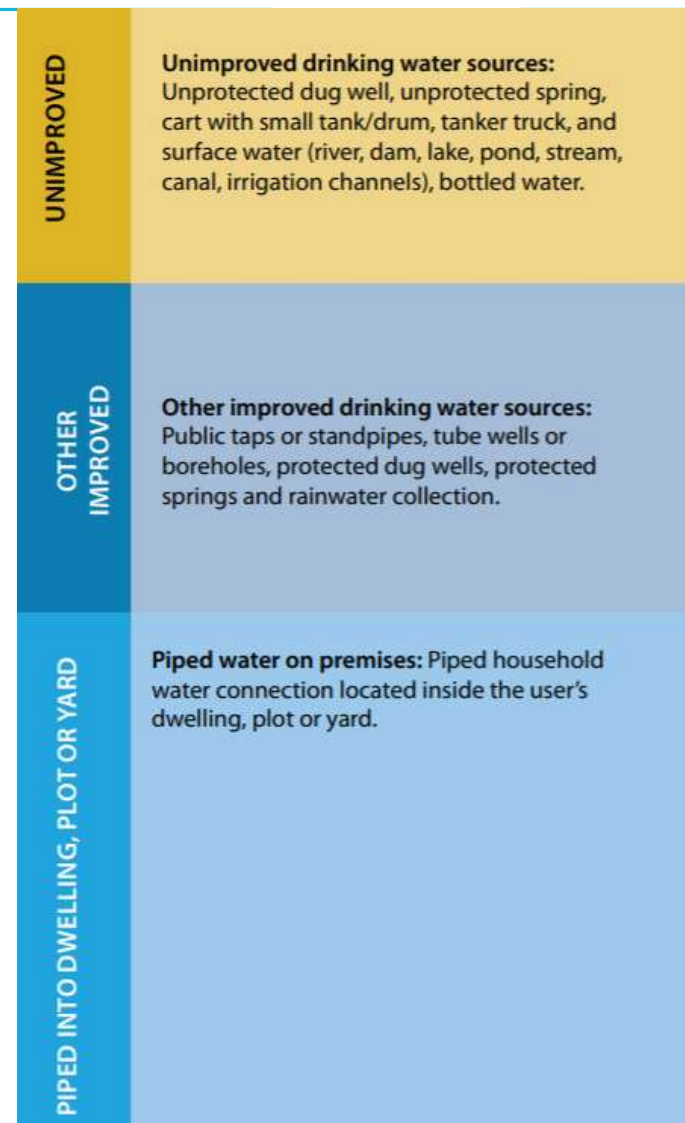
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# Access

- Access to water-supply services is defined as the **availability** of at least 20 litres per person per day from an **"improved"** source within 1 kilometre of the user's dwelling.
- WHO states that the category 'improved drinking water sources' includes sources that, by nature of their construction or through active intervention, are **protected from outside contamination**, particularly faecal matter.

Service level	Definition
<b>Safely managed</b>	Drinking water from an improved water source which is located on premises, available when needed and free of faecal and priority chemical contamination
<b>Basic</b>	Drinking water from an improved source provided collection time is not more than 30 minutes for a roundtrip including queuing
<b>Limited</b>	Drinking water from an improved source where collection time exceeds over 30 minutes for a roundtrip to collect water, including queuing
<b>Unimproved</b>	Drinking water from an unprotected dug well or unprotected spring
<b>No service</b>	Drinking water collected directly from a river, dam, lake, pond, stream, canal or irrigation channel

**JMP household Ladder for household drinking water**



**Drinking Water Ladder**

Source: [https://www.who.int/water\\_sanitation\\_health/monitoring/water.pdf](https://www.who.int/water_sanitation_health/monitoring/water.pdf)



## Progress on household drinking water, 2000-2020





## Progress on household sanitation 2000-2020





## 5 years into the race to the 2030 Targets



In 2020  
**2.3 billion people**  
lacked basic hygiene  
services, including soap  
and water at home



Between 2015 and 2020  
**547 million** gained  
access to basic hygiene  
services at home



By 2030, at this rate,  
**1.9 billion people**  
will still lack basic  
hygiene services at home

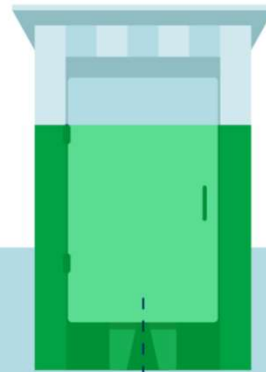
## Progress on basic hygiene 2000-2020



**At the current rates of progress,**  
by 2030, the world will only reach:



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**81%**  
coverage

Leaving  
**1.6 billion people**  
without safely managed  
drinking water

**78%**  
coverage

Leaving  
**1.9 billion people**  
without basic  
handwashing facilities

**67%**  
coverage

Leaving  
**2.8 billion people**  
without safely managed  
sanitation services

**Progress on household drinking  
water, sanitation and hygiene  
2000-2020**



Source: <https://www.who.int/multi-media/details/at-the-current-rates-of-progress-by-2030-the-world-will-only-reach>

# Women and Water



- *“Without safe drinking water, adequate sanitation and hygiene facilities at home and in places of work and education, it is disproportionately harder for women and girls to lead safe, productive, healthy lives.”- UN Water*
- *Reducing the time it takes to fetch water from 30 to 15 minutes increased girls’ school attendance by 12% according to a study in Tanzania. (UNICEF)*
- *Way out: Gender-sensitive approaches by both focusing on and involving women in the facilities’ design, implementation and management.*

*Source: <https://www.unwater.org/water-facts/gender/>*

*Source: [https://www.unicef.org/esaro/7310\\_Gender\\_and\\_WASH.html](https://www.unicef.org/esaro/7310_Gender_and_WASH.html)*

*Source: <https://www.unwater.org/publications/water-sanitation-and-hygiene-in-health-care-facilities-practical-steps-to-achieve-universal-access-for-quality-care/>*

# Access to Clean Water in Rwanda | UNICEF USA



Source: <https://youtu.be/isJNqosfX6w>



# Water Safety Issues in the News



## Class Action Lawsuit launched against the City of Thunder Bay for Leaking Pipes

NEWS PROVIDED BY  
Roy O'Connor LLP →  
Nov 24, 2020, 14:41 ET



TORONTO, Nov. 24, 2020 /CNW/ - The law firm of Roy O'Connor LLP, working with the assistance of Erik Knutsen, have issued a proposed class action lawsuit against the City of Thunder Bay for damage alleged to be caused to pipes and plumbing systems following the City's introduction of sodium hydroxide into the municipal water supply. The damage alleged includes what are described as "pinhole leaks" in the plumbing, the significant costs to repair the leaks, and the resulting damage from the leaks.

**The Guardian**

## Flint review – a humanitarian disaster doc for toxic times

Lucy Mangan · 02/12/2020

It takes the Loren family – Tammy, Ken and their two sons – about four hours to shower. First, they have to empty bottles of water into pans, heat the water, then transfer it to the bathroom where a pump attached to a handheld sprinkler head can be pumped by the foot of the hopeful ablutioner until water begins to trickle out.

A screenshot of a news article from the 'Water' section. The article title is 'UK 'flying blind' on levels of toxic chemicals in tap water'. A yellow banner above the title states 'This article is more than 4 months old'. Below the title is a sub-headline: 'Government is not testing drinking water for PFAS, which studies have linked to numerous health issues'. The author is Rachel Salvidge (@rachsolv), and the article was published on Thu 25 Mar 2021 12:58 GMT. An image of a chrome tap is visible on the right side of the article.

## River pollution in Wales: Swimmers warned over sewage

By James McCarthy  
BBC News

3 days ago

# Dams

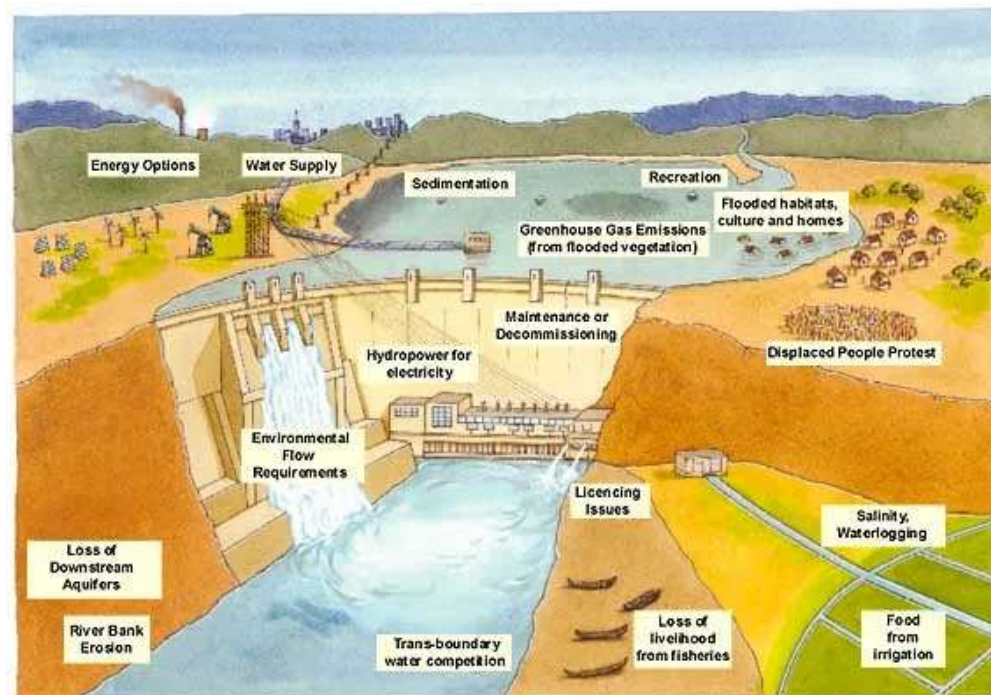
- Thousands of new hydropower dams are being planned or built around the world.
- Environmental costs – loss of biodiversity and decline in services provided by ecosystems
- Social costs – displacement of local people.
- A dam project can be deemed legally justifiable in view of the benefits (water supply, environmentally friendly, food production). Still, several requirements must be fulfilled for the project to be regarded as lawful under international law. Among those requirements is a genuine consultation.



# Large Dams and Human Rights

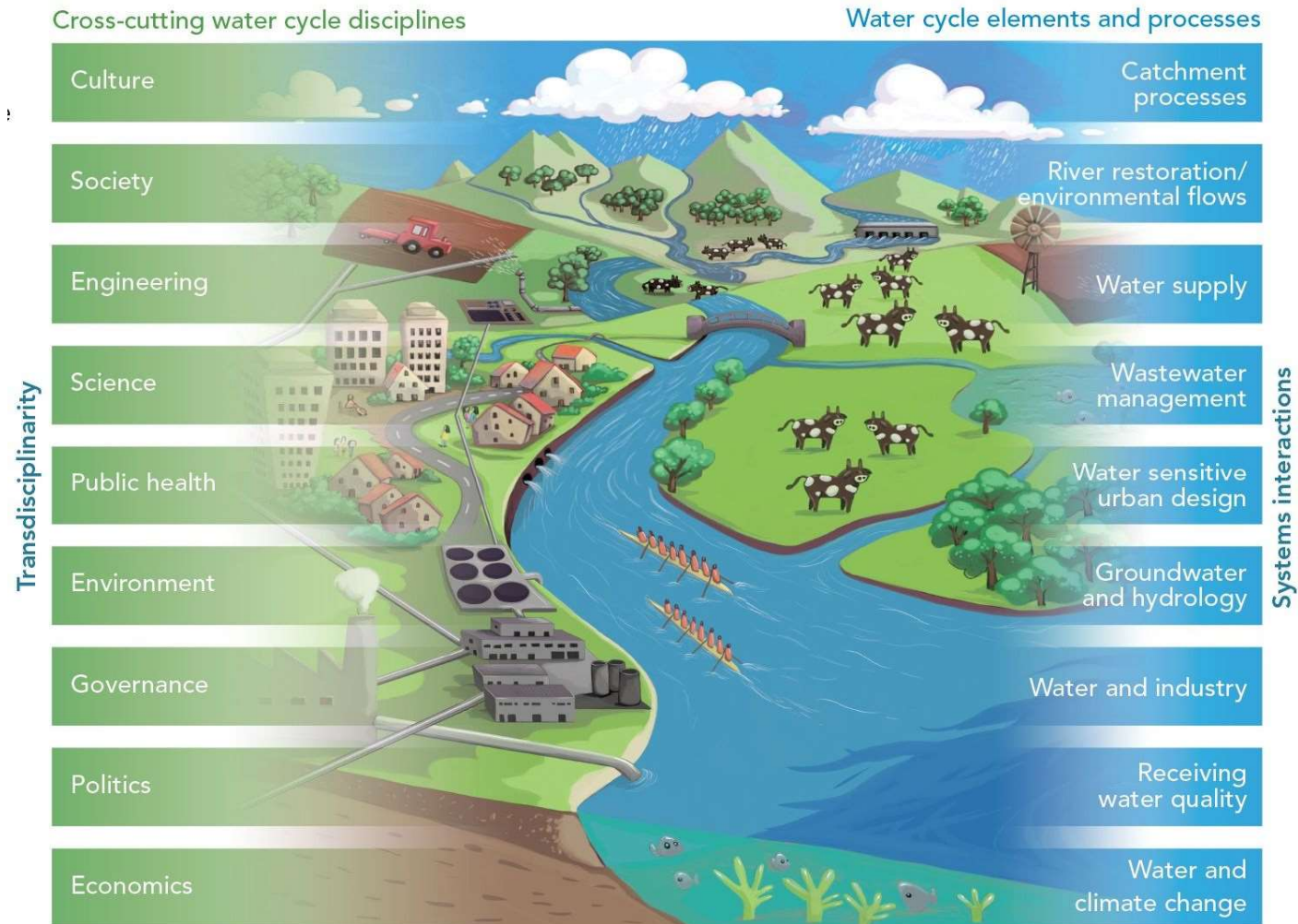
## **Human rights connected to Dam Projects**

- The right to adequate housing; and not to be forcibly evicted.
- The right to safe drinking water and sanitation.
- The right to a healthy environment.
- The right to adequate food.
- The right to education.
- Collective (procedural) rights of indigenous peoples.





# What Disciplines or Careers Work with Water





# Summary



- United Nations Sustainable Development Goal 6.
- Water use, source and supply system.
- Water quality and treatment.
- Conveyance and distribution.
- Social and ethical issues in water supply.

A scenic landscape featuring a calm, blue lake in the foreground, surrounded by steep, green mountains. The sky is bright blue with scattered white clouds. The text "Thank you for your engagement" is overlaid in white, bold, sans-serif font across the center of the image.

**Thank you for your  
engagement**