English version

EAU'DYSSÉE

The Water Puzzle Workshop

Adults v1.1

Atmosphere

Snowpack

Glaciers, ice caps and ice sheets

Oceans and seas

Rivers and lakes

Game 1 - The natural water cycle

Oceans and seas are the main stock of water, representing more than 96% of water resources available on Earth.

This water is available as salt water. Some lakes are also composed of salt water (1% of total water).

Freshwater on Earth represents less than 3% of the Earth's total water[1].

Game 1 - The natural water cycle

This card includes rivers, streams and lakes.

A lake is a a body of fresh or salt water of considerable size, surrounded by land.

Water contained in rivers and lakes represents 0.23% of freshwater on Earth[1].

Game 1 - The natural water cycle

Snowpack is snow on the ground, that remains until the arrival of warmer weather.

Precipitation fall in form of snow when temperatures are below or around 0°C, and accumulate to form snowpack. Its thickness evolves with seasons.

Water contained in snowpack represents 0.006% of freshwater on Earth[1].

Game 1 - The natural water cycle

Glaciers, ice caps and ice sheets are land-based masses of ice. They are formed by the accumulation and compaction of snow.

An ice cap is a type of glacier that covers a very large area. Masses of ice covering more than 50,000 km^2 are called ice sheets.

Water contained in glaciers, ice caps and ice sheets represents 53% of freshwater on Earth[1].

The Water Puzzle Workshop builds a global vision of the water cycle.

Participants, in group of 8, will place the following 4 sets of cards on a visual map:

- The natural water cycle (8+12 cards),
- The anthropogenic water cycle (influenced by humans, 7 cards)
- Human impacts on water (7+3x4 cards),
- Climate change impacts on those cycles.

Game 1 - The natural water cycle

The atmosphere is an envelope of gases surrounding the Earth. It is formed by different gases, including water vapor.

Water contained in the atmosphere circulates around the Earth through atmospheric circulation.

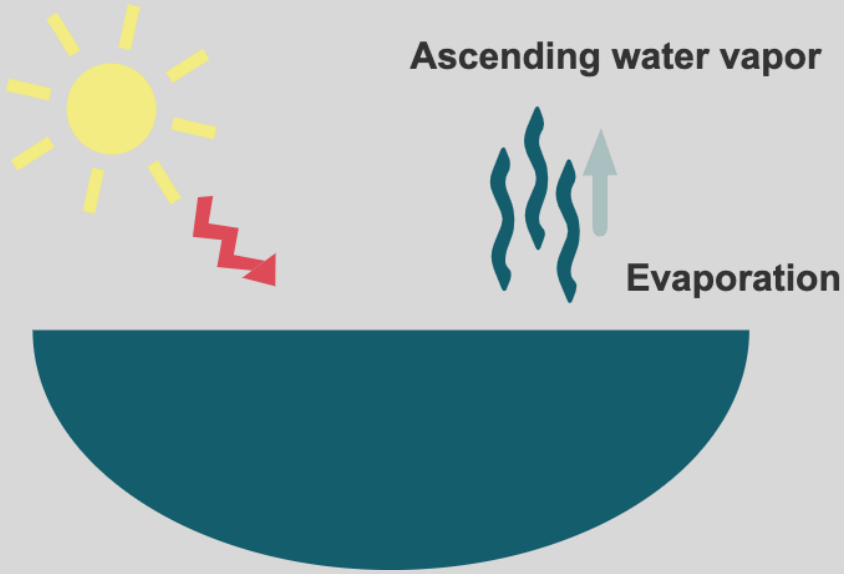
Atmospheric water represents 0.03% of freshwater on Earth[1].

Renewable groundwater

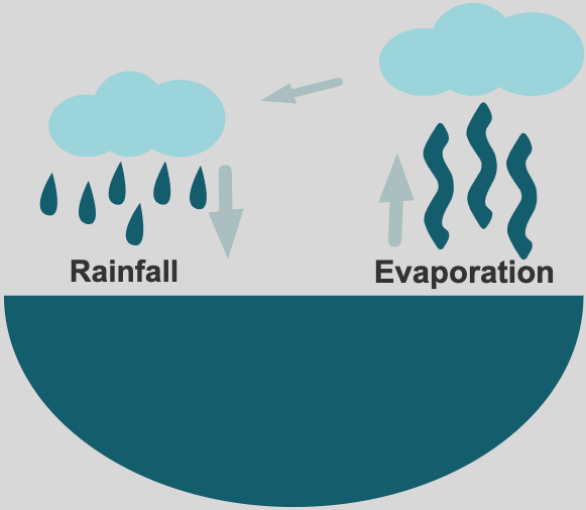
Non-renewable groundwater

Soils, plants and living beings

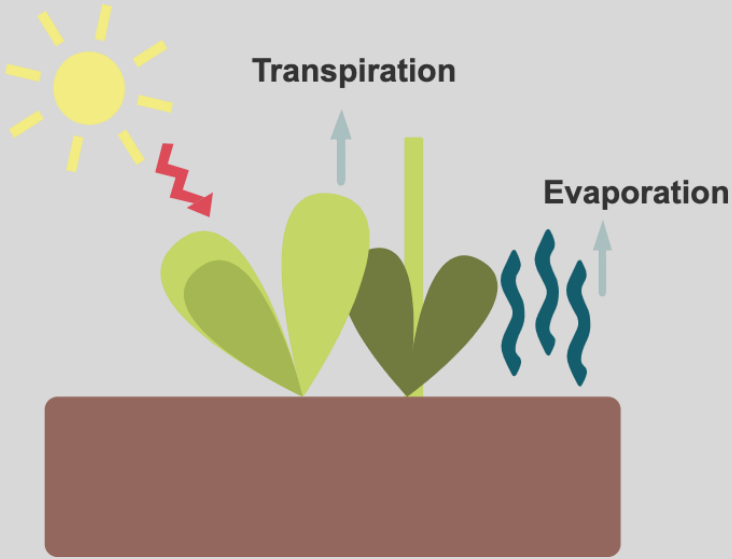
Marine evaporation



Precipitation over seas and oceans



Evaporation and evapotranspiration



Game 1 - The natural water cycle

Water contained in the atmosphere falls on land under different forms (rain, hail, snow, etc.). This is precipitation.

In this case, precipitation fall on seas and oceans.

Game 1 - The natural water cycle

This card includes evaporation from water bodies (lakes, rivers) and evapotranspiration.

Evapotranspiration includes water transferred to the atmosphere through evaporation from the soil and transpiration from vegetation.

Game 1 - The natural water cycle

Soils contain water that is stored in pores. Water can also be present in frozen soils (called permafrost).

Plants and living beings also contain water.

Water contained in soils and living beings represents 0.11% of freshwater on Earth. Permafrost contains 0.43% of freshwater on Earth[1].

Game 1 - The natural water cycle

Evaporation is the process by which water is transformed from its liquid state to its gaseous state. Water evaporates from the water surface and is transported by the wind.

It occurs here between seas or oceans and the atmosphere.

Game 1 - The natural water cycle

Groundwater is contained in aquifers (permeable or fractured rocks, sand...). Water infiltrates the soil, then percolates through the soil. It eventually reaches the aquifer.

There are also water exchanges between rivers and aquifers.

Renewable groundwater accounts for 1.3% of freshwater on Earth[1].

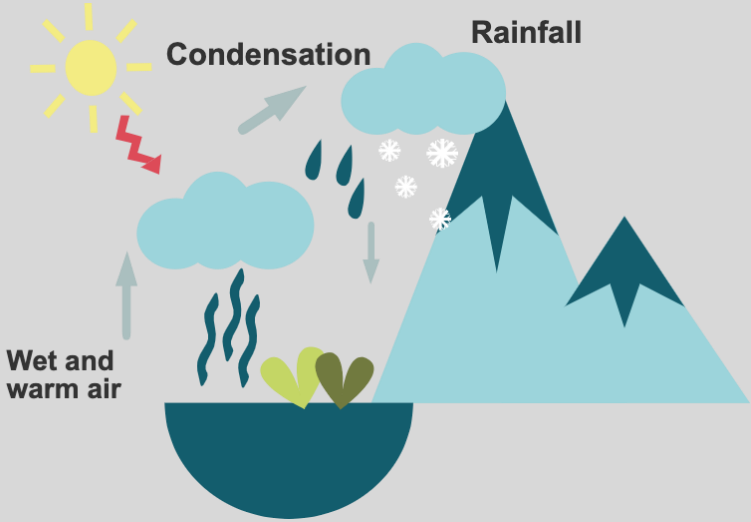
Game 1 - The natural water cycle

Non-renewable groundwater is water contained in aquifers with a low rate of renewal, but large storage capacities. Their renewal period is typically several 100 or 1000 years. Geology and climatic conditions (essentially aridity) impact the rate of renewal.

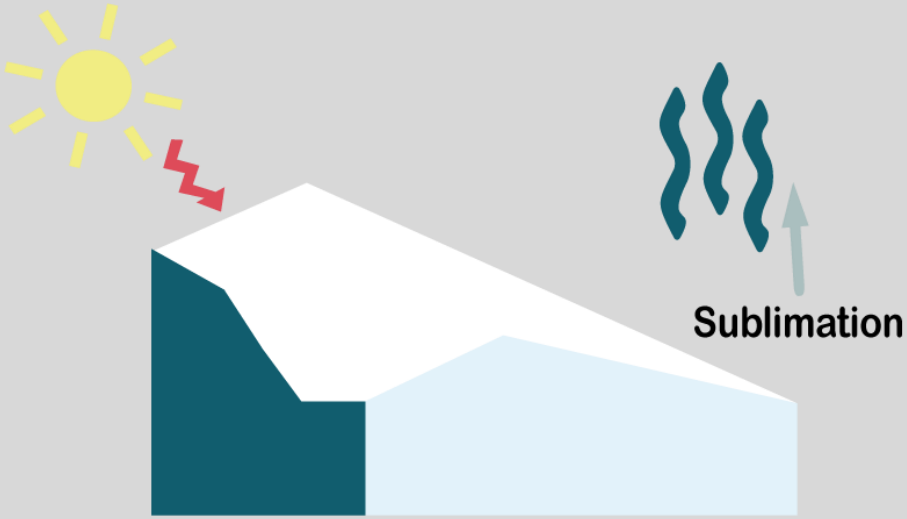
Some major aquifers containing non-renewable resources include aquifer systems in the Sahara, or the Great Artesian Basin in Australia.

Non-renewable groundwater account for 45% of freshwater on Earth[1].

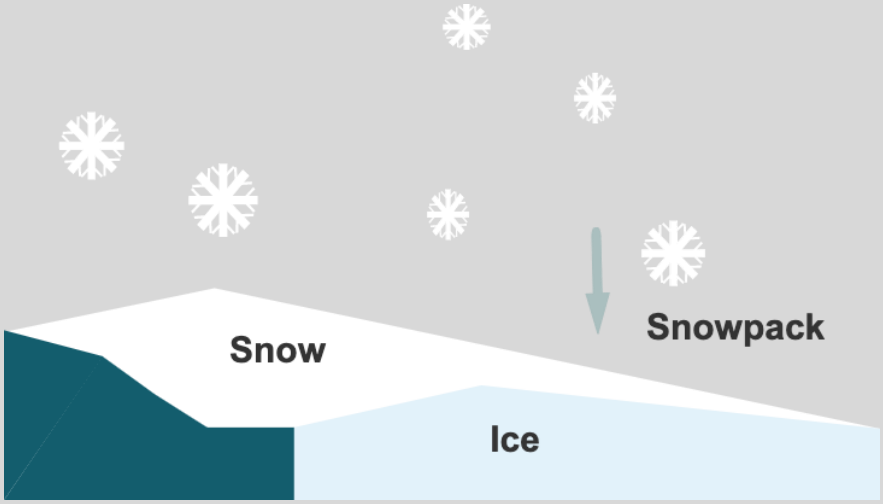
Precipitation over land



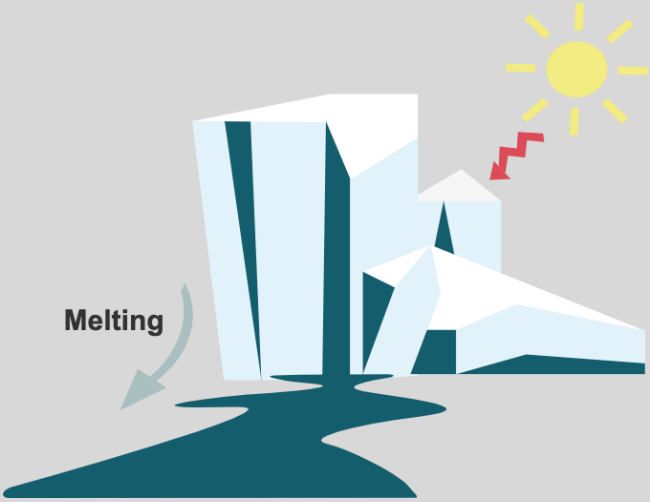
Sublimation



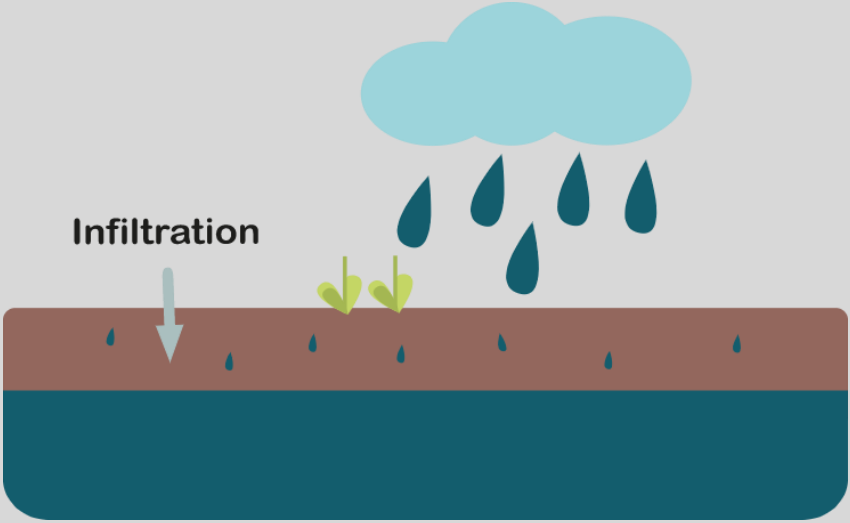
Compaction



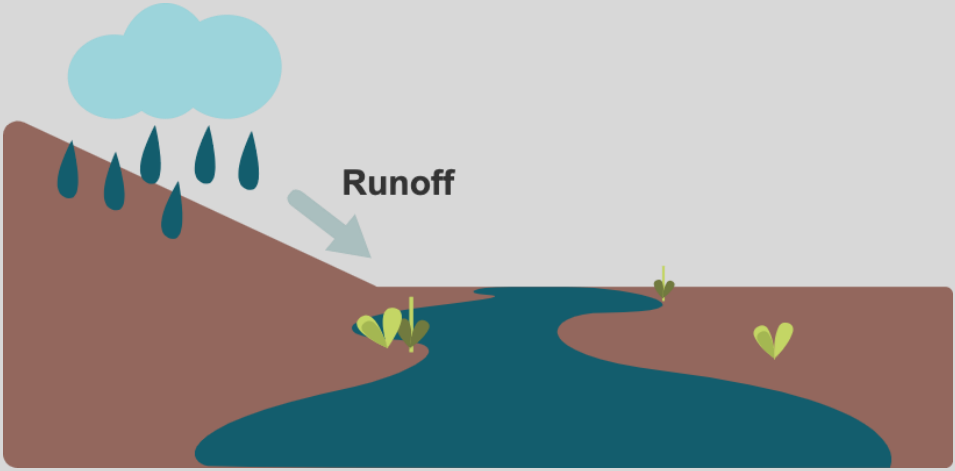
Melting



Water infiltration into the soil



Runoff



Game 1 - The natural water cycle

A portion of water that falls on land penetrates into the soil. This is called water infiltration. It eventually reaches the aquifer after percolation through the soil.

Game 1 - The natural water cycle

Runoff is the water flowing from the ground surface to rivers and lakes.

Compaction occurs on glaciers. Snow layers from the snowpack accumulate, compact and finally form ice.

Game 1 - The natural water cycle

Melting is the process by which solid water is transformed into liquid water.

Some rivers and their riparian populations depend on snowmelt or ice melt.

Game 1 - The natural water cycle

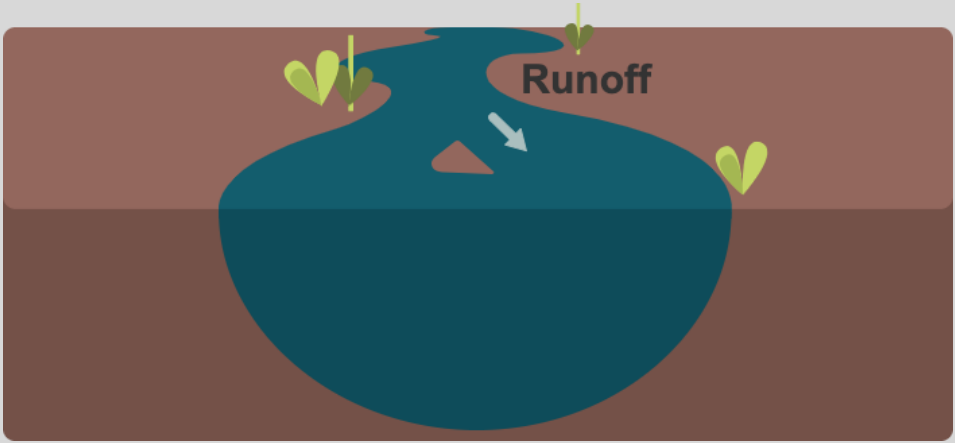
Water contained in the atmosphere falls on land under different forms (rain, hail, snow, etc.). This is precipitation.

In this case, precipitation falls from the atmosphere onto soils and rivers or lakes.

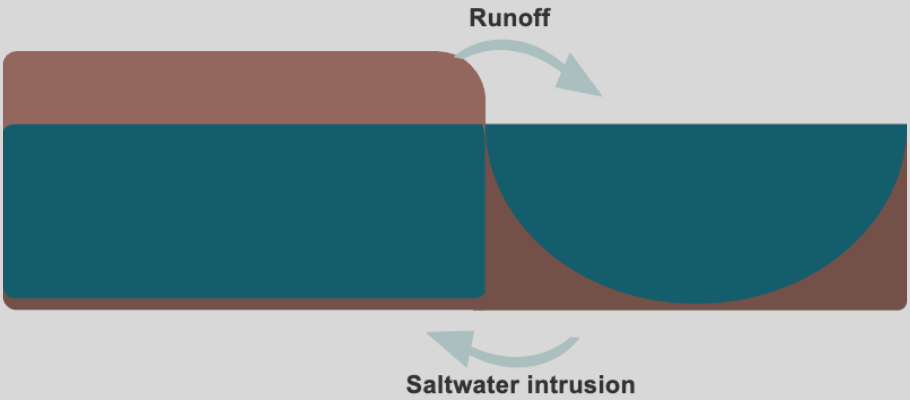
Game 1 - The natural water cycle

Sublimation is the process by which solid water (glaciers and snow) is transformed into water vapor.

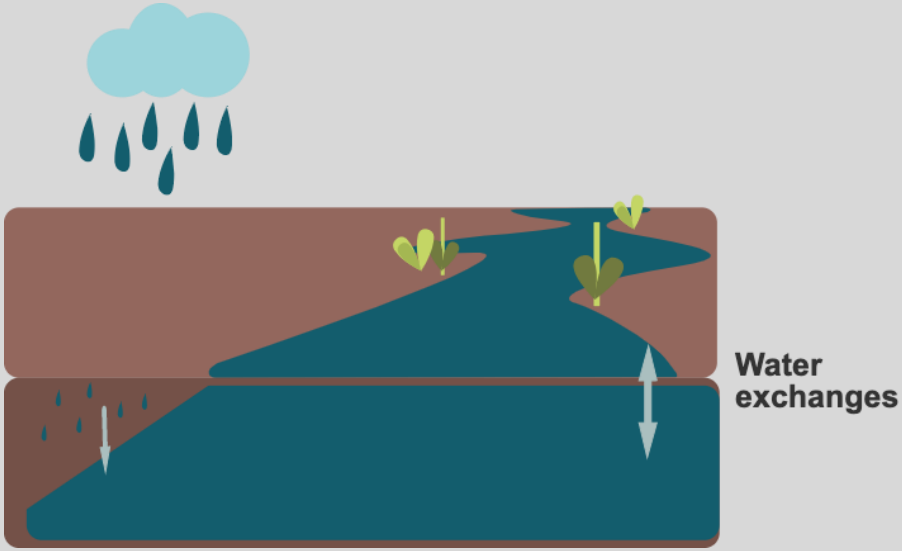
River contribution to seas and oceans



Exchanges: groundwater - seas and oceans



Exchanges: groundwater - rivers



Water stocks withdrawn

Extraction

Water purification

Game 2 - The anthropogenic water cycle

Water is extracted from surface water bodies (lakes, rivers, reservoirs), but also from aquifers (groundwater).

Each country has a specific water withdrawal mix depending on the water use and its geographical, climatic and technological conditions.

Game 2 - The anthropogenic water cycle

Water is used for many activities, including domestic use, and is generally treated to be fit for human consumption.

However 1 in 3 people globally do not have access to safe drinking water [2].

The purification processes require chemicals and energy, which themselves require water to be produced.

Game 1 - The natural water cycle

Groundwater and surface water exchanges proceed in two ways: groundwater flows into the river, and water from the river infiltrates into the groundwater.

Groundwater often feeds a river when the river level is low.

Game 2 - The anthropogenic water cycle

This card groups the different natural stocks, from which humans extract water for their main uses: rivers, lakes, groundwater, or even seas and oceans.

Game 1 - The natural water cycle

Most river systems flow to seas and oceans. But some don't and form either swamps or lakes ("endorheic basin").

Game 1 - The natural water cycle

Groundwater can directly flow to seas and oceans.

Seawater can also penetrate into groundwater (saltwater intrusion).

Uses

Return of water to the environment

Treatment

Consumed water

Electricity production

Industry

Game 3 - Human activities

Hydroelectric and thermal power plants are large users of water.

Hydroelectricity supplied 17% of global electricity generation in 2020. It is the third largest source of energy after coal and natural gas [4].

Thermal power plants use water for their cooling systems. Coal uses approximately 120 times the water needed to generate the same amount of electricity than solar or wind [5].

Game 3 - Human activities

Water is used by all industries: pharmaceutical, agro-industrial, automobile and even textile. After its use, water can be polluted and needs to be treated before being restituted to the environment.

For example, 4.000L to 11.000L are needed to manufacture 1kg of viscose, 100L for 1L of alcohol or 1 to 2L for 1kg of plastic [7].

Game 2 - The anthropogenic water cycle

After its use, water can be polluted. Water treatment plants treat wastewater before it goes back to the natural environment.

In some cases, or even countries, there is no wastewater treatment plants. The treated water can also be restituted at a different location than where it is withdrawn from.

Game 2 - The anthropogenic water cycle

Consumed water is the amount of water removed for use and not returned to its source.

For example, water can be absorbed by plants or evaporated into the atmosphere. It is not possible to know when or if this water will be available again to be reused.

Game 2 - The anthropogenic water cycle

Water uses are human activities that rely on water for their development. It represents the quantity of water withdrawn for each use.

Worldwide, water is used for agriculture (70%), industries (20%) and households (10%) [3].

Game 2 - The anthropogenic water cycle

Once used and treated, a portion of the withdrawn water is returned to the environment.

However, water can be returned at a higher temperature than when it was withdrawn.

Despite water treatment, it may also contain pollutants that can be harmful to the environment and to human health.

Agriculture

Household activities

References (1/4)

References (2/4)

References (3/4)

References (4/4)

References (a) – Climate Change (FR)

1. Convention Cadre des Nations Unies sur le Changement Climatique, Qu'est-ce que l'Accord de Paris ? | CCNUCC.
2. Météo France, (2020), Les nouvelles projections climatiques de référence DRIAS 2020 pour la Métropole.
3. Météo France, Réchauffement climatique et hausse du niveau de la mer, Article de presse.
4. ClimateCentral.org, https://coastal.climatecentral.org/
5. Météo France, Climat : l'évolution constatée en France | Météo-France, Article de presse publié le 28/02/2020.
6. Soubeyroux, et al., (2011), Projet ClimSec. Impact du changement climatique en France sur la sécheresse et l'eau du sol. .
7. Ministère de la Transition Ecologique, Impacts du changement climatique : Montagne et Glaciers (2020), étude réalisée par l'ONERC, Bilan de masse du glacier d'Ossoue (massif du Vignemale, Pyrénées françaises)
8. NOAA, https://www.ncei.noaa.gov/news/global-climate-202012

References (b) – Climate Change (FR)

1. EXPLORE 2070 (2012), Rapport A1 - Hydrologie de surface & Rapport Hydrologie souterraine https://professionnels.ofb.fr/fr/node/44
2. Habets, F., et al. (2019), Gestion des eaux souterraines: quelles ressources en eau pour demain? Géosciences Hors-série - Les géosciences au coeur des enjeux de demain | BRGM.
3. S. Planton, et al., (2012), Le climat de la France au XXIe siècle, volume 3 : Evolution du niveau de la mer.
4. G. Ouzeau, et al., (2014), Le climat de la France au XXIe siècle, volume 4 : Scénarios régionalisés : édition 2014 pour la Métropole et les régions d'Outre-Mer.

References (1/2)

1. Abbott et al., (2019), Human domination of the global water cycle absent from depictions and perceptions, Nature.
2. World Health Organization – News https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who
3. Our World in Data, Water Use and Stress, 2018.
4. IEA (2021), *Hydropower Special Market Report*, IEA, Paris https://www.iea.org/reports/hydropower-special-market-report
5. Clean Energy Council, Hydro, 2018.
6. UNESCO, International Initiative on Water Quality
7. Centre d'Information sur l'Eau www.cieau.com
8. Global Forest Watch, https://www.globalforestwatch.org/blog/data-and-research/global-tree-cover-loss-data-2019/
9. Food and Agriculture Organisation (FAO), Crop Water Information (Informations sur le besoin en eau de différentes cultures) http://www.fao.org/land-water/databases-and-software/crop-information/en/
10. https://architecture2030.org/why-the-building-sector/
11. Françoise Nicolas (2020), Commerce mondial : les nouvelles routes maritime, Institut Français des Relations Internationales, https://storymaps.arcgis.com/stories/7d3a7a1492564cb2aabea79287566745

References (2/2)

12. FAO, Status of the world's soil resources (2015)

13. World preservation foundation, Polluted Waters

14. World Health Organisation, 1 in 3 people globally do not have access to safe drinking water, 2019.

15. te Wierik, S. A. et al. (2021). Reviewing the impact of land use and land-use change on moisture recycling and precipitation patterns. Water Resources Research, 57, e2020WR029234. https://doi.org/10.1029/2020WR029234

16. Wang-Erlandsson, L. et al. (2022). A planetary boundary for green water. Nature Reviews Earth & Environment. https://doi.org/10.1038/s43017-022-00287-8

Water footprint:

1. Arjen Y. Hoekstra & Mesfin M. Mekonnen (2012) The water footprint of humanity, PNAS.
2. Water FootPrint Network https://waterfootprint.org/
3. Mekonnen, M.M. & Hoekstra, A.Y. (2011) National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No. 50, UNESCO-IHE.

Pictures: www.pixabay.com

Game 3 - Human activities

Agriculture provides food for humans and livestock.

900L of freshwater are required to grow 1kg of wheat [9]. The installation of agricultural plots modifies the vegetation cover initially present.

Water runoff and infiltration carry fertilisers and pesticides to rivers and groundwater aquifers, modifying their initial properties.

Game 3 - Human activities

Household activities are daily activities carried at home.

They all use water. After usage, water is often treated and released into the environment.

The UN recommends a minimum of 50-100L of freshwater/day/person. Nevertheless, depending on where your are, daily water use per capita ranges between less than 10 L/day to more than 200L/day [6].