Technology Innovation for Sustainable Development

Water and Sanitation Technologies

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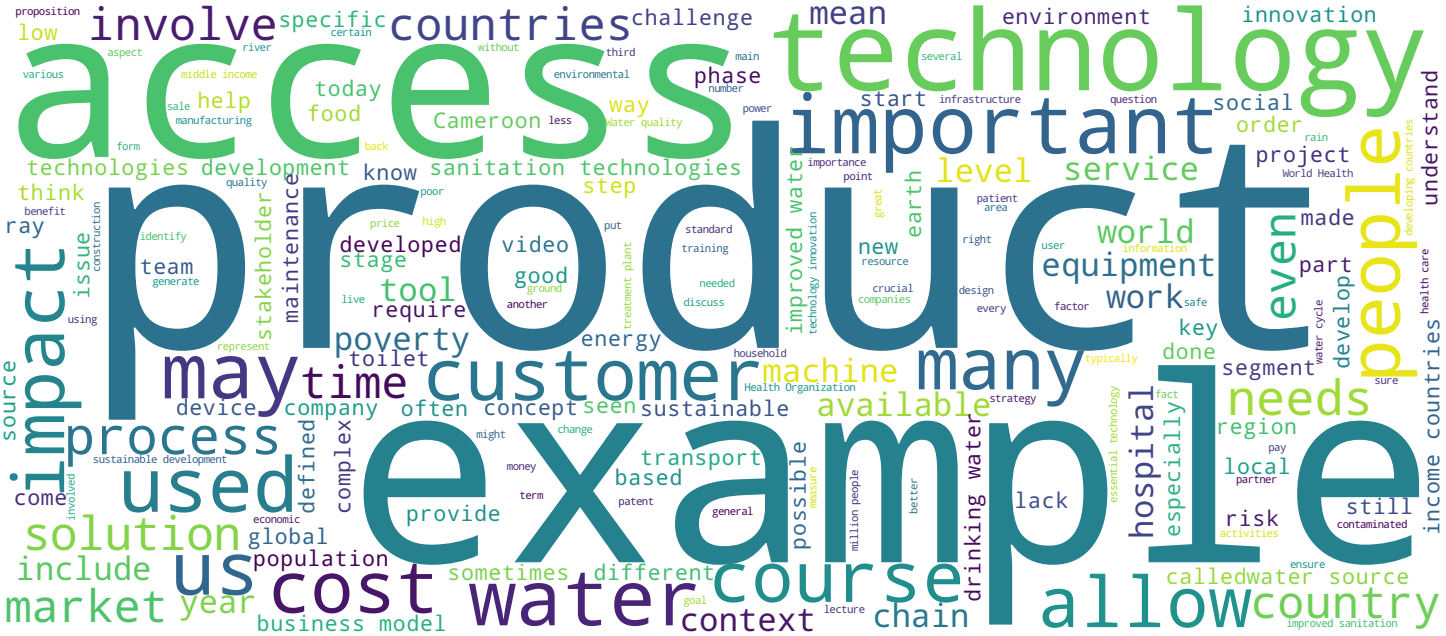
EssentialTech

EPFL ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE



Search MOOC

Video

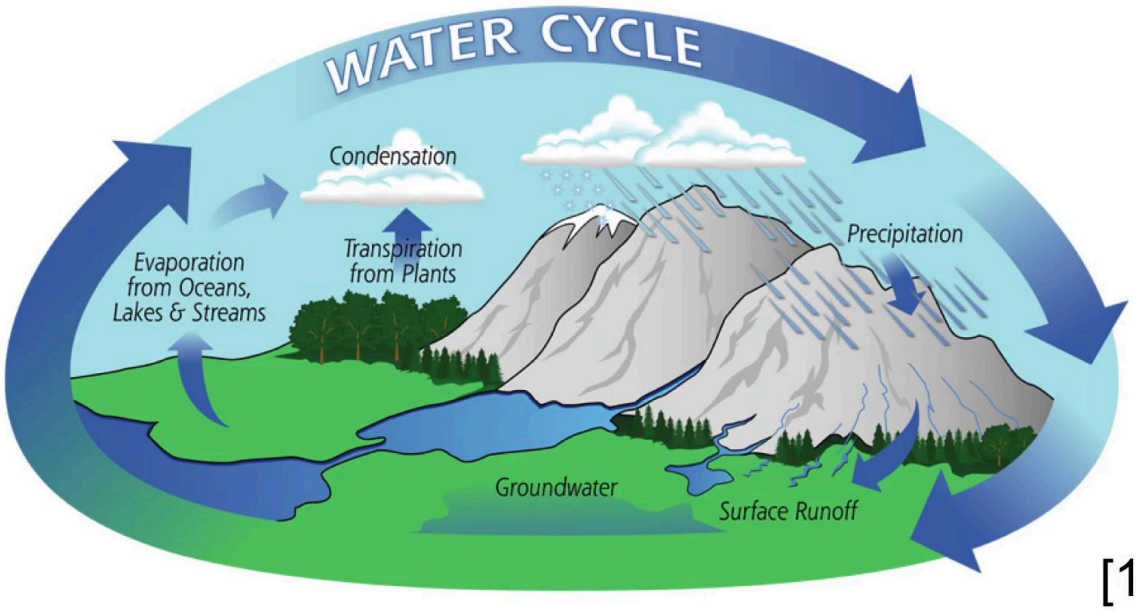
EPFL

Hello. This lady in Cameroon has to go fetch water at the river for her laundry. She doesn't have access to clean water, nor does she have access to basic sanitation. In this video, we will speak about the vast domain of water and sanitation technologies. Access to enough safe water is a precondition to human existence and technologies that help provide it are indeed essential. By the time water has been used by humans, however, it will be loaded with all sorts of household or industrial waste. It will thus need to be properly cleansed before it can be safely discharged into the environment. That is the role of sanitation technologies as we will see. Water is so closely linked to development that, for the SDGs, one specific objective has been defined just for water, Objective Number 6. However, water and sanitation technologies have also an important influence on almost all the other objectives. Take, for example, Objective Number 3, "Good Health": waterborne disease causes over 840,000 deaths each year from diarrhea, with almost half of them being children under five, as a result of unsafe drinking-water, inadequate sanitation and hygiene. A study by the World Health Organization in 2012 calculated that for every one dollar invested in sanitation, there was a return of $5.50 in lower health care costs, more productivity and fewer premature deaths.

Notes

Summary

0m 15s



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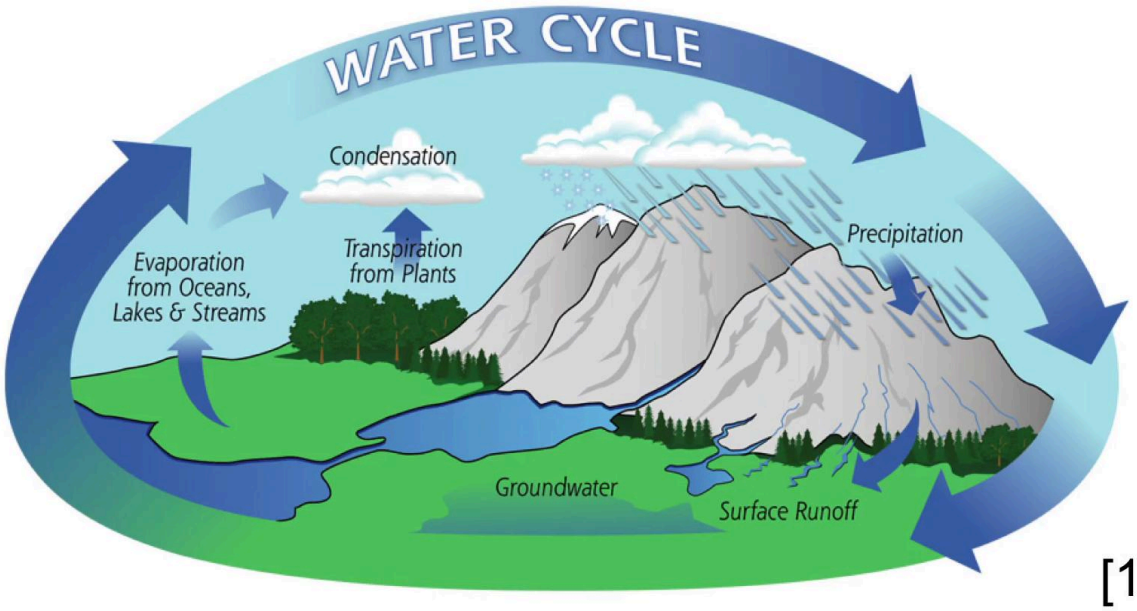
Water is also crucially important for food, which is our sustainable development goal number two. Agriculture accounts for 70% of all water withdrawn by the agricultural, municipal and industrial sectors. Before we talk about technologies related to water and sanitation, we need to briefly tell you about the hydrological or water cycle. In a very simplified view, the water cycle describes how water moves on earth, above earth and below earth. The sun drives the cycle by heating and evaporating water from the oceans and from lakes and streams. Water is also transpired by plants and evaporated by the soil. As the water molecule is less dense than other atmospheric components, the vapor will rise and cool down as the pressure is reduced at higher altitudes. It then condenses and falls back on earth in the form of precipitation which can be rain or snow. It can then accumulate as ice caps or glaciers and remain stored there for thousands of years. Some of the rain will flow directly as surface runoff and form stream and rivers which will, in turn, replenish lakes and flow back to the ocean. Another fraction of the rain will soak the ground, where it will replenish the groundwater.

Notes

Summary

1m 52s



[1]

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Groundwater will sometimes find openings in the land surface and come out as freshwater springs. Human activity will generate a second, smaller cycle, where water pumped from the ground or from a river is used by humans for drinking, for flushing the toilets, or for irrigation in agriculture or in industry. Often, it will get loaded with impurities and waste in the process. It is then ideally treated and eventually discharged back into the natural water cycle.

Notes

Summary

3m 10s

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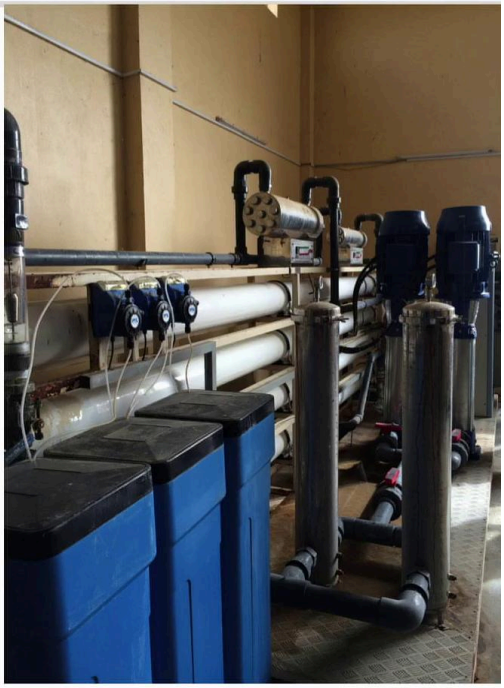
We will now take a closer look at some essential technologies involved in this human segment of the water cycle. There are many technologies allowing to catch water, which obviously depends on the source itself. One such technology is the water well. A well will allow you to get access to water that has percolated through the ground and is stored in the so-called "aquifer". An aquifer is a porous underground layer saturated with water. Water then needs to be retrieved. There are simple mechanical ways to do that, such as a mechanical hand-pump. Pumps can be electrically powered, for example, with solar panels. The well can be susceptible to yield fluctuations and there are technologies which allow to monitor and optimize the water use.

Notes

Summary

3m 40s



Then, water needs to be transported in a safe and hygienic way and stored so that it can be used on demand. Generally, water from any source will contain unwanted components. For example, a well can be contaminated by a pit latrine located nearby, as we will see. It will thus need to be treated before it can be safely used for human consumption. Here, you can see a reverse-osmosis water treatment plant serving a town of roughly 10,000 people in Iraq. There are many different technologies to remove living pathogens such as bacteria or parasites, or unwanted dissolved chemicals such as arsenic, or simply dissolved salt. Depending on the available water quality, the choice will be made between the different options such as filtration, ultra-filtration or reverse osmosis. UV light can also be used to kill bacteria. These water purification technologies are sometimes quite expensive, though, and complex to set up and maintain in proper function. Water also needs to be transported. Unfortunately, quite a large quantity is often lost in the process. There are sophisticated technologies to detect leakages, which is very important to maximize the availability of this precious liquid.

Notes

Summary

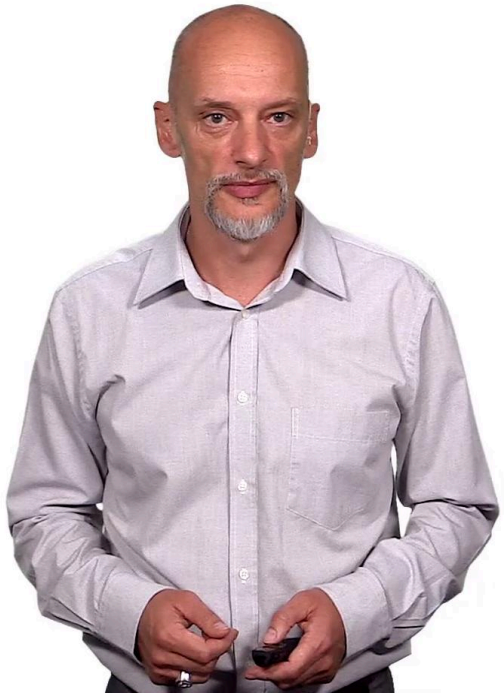
4m 32s

Once water has been purified, there is a risk that it won't remain safe. Usually, the addition of chlorine will allow to keep it protected against germs for a while. There are technologies that allow an automated dosage of this chlorine. Yet another set of important water technologies allow to assess the quality of the obtained water. Here, you can see a team from the International Committee of the Red Cross in Sudan assessing the level of chlorine in water with a very simple pool test. Water quality assessments can involve multiple parameters, which can be monitored with a variety of technical instruments, such as a spectrophotometer, which allows to analyze the chemical composition of the water. There are many more technologies related to water. However, drinking water technologies is just one segment in the cycle which includes also sanitation, hygiene, as well as waste management. Let us look at a few sanitation technologies. The toilet is really an essential technology! Here, you can see migrants in Mexico cleaning the latrines in a shelter before continuing their trip. There are several modes by which human excreta can be collected in a safe and hygienic way.

Notes

Summary

5m 57s



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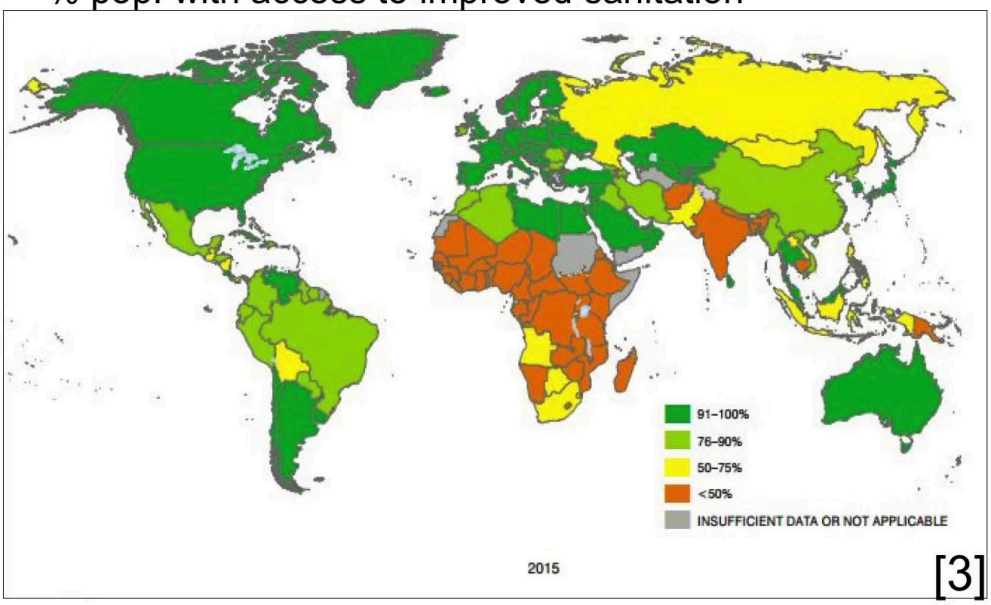
What happens with the excreta next is an important question as it will have to be stored, transported, treated and disposed of in a safe and convenient way. In many cases, mainly in rural environments, it is simply stored in the pit under the latrine. When the pit is full, it is closed and the latrine is moved to another place with a new pit. This will often raise concerns about pathogens infiltrating the groundwater. Generally, in fact, human waste is - or should be - transported to a wastewater treatment plant, such as the one shown here. In this plant, it undergoes a series of treatments until it can be safely released into the environment or utilized as fertilizer. In cities of industrialized countries, sewage systems will be used to transport the water to the treatment plants. However, this solution is expensive to build and maintain, and might be very complex to apply in poor areas such as slums. Fecal waste can also be put to use to generate biogas in a "digester", such as the one you see here under construction in Zimbabwe. Biogas can then be used as an energy source, for example, for cooking. We now understand the importance of water and sanitation technologies, but how widely available are they on a global scale?

Notes

Summary

7m 17s

% pop. with access to improved sanitation



[3]

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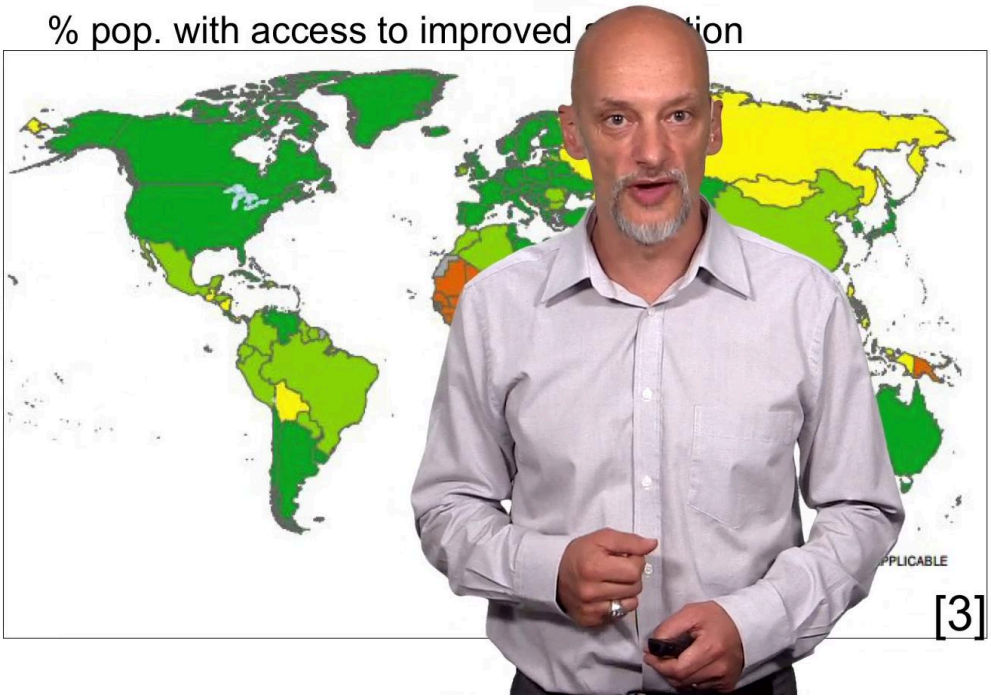
without access

Let's have a look. Global water scarcity is a crucial problem, which is made worse by demographics and climate change. Water quality is also a big problem as we can see in this map which shows the percentage of population having access to "improved" water sources. Improved water sources are defined as those which adequately protect the source from outside contamination, particularly fecal matter. For example, a well without a sealed protective top cover is not an improved water source. As you can see, there are still 660 million people who do not have access to such improved water sources at all. Having access to an improved water source doesn't mean it is safe. The World Health Organization estimates that, globally, at least 1.8 billion people use a drinking-water source which is contaminated with feces. Having piped water is often not an assurance of quality either, since a substantial proportion of water supplied through pipes is contaminated. This is especially true where water supply is intermittent, treatment is inadequate, or when proper sanitation isn't available. Let's look at the global access to sanitation. This map shows the percentage of global population which has access to "improved" sanitation facilities.

Notes

Summary

8m 41s



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without access

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"Improved" sanitation means that the facility is able to hygienically separate human excreta from human contact. According to the World Health Organization, in 2015, one third of the world's population had no access to such improved sanitation facilities. Of those, almost half - or 950 million people - still have to defecate in the open, for example in street gutters, behind bushes, or into open bodies of water. This perpetuates a vicious circle of disease and poverty, where people get re-infected again and again, by pathogens present in the population. Benefits of improved sanitation extend well beyond reducing the risk of diarrhea. It promotes dignity and boosts safety, particularly among women and girls. School attendance is also improved, especially for girls, with the provision of separate sanitary facilities. As you can see, we need innovative solutions for both provision of safe drinking water and adequate sanitation. I would like to conclude by telling you about an innovation that was developed to solve the problem of access to toilets in the poorest countries.

Notes

Summary

10m 08s

WatSan: example of innovation

www.bluediversiontoilet.com

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The Blue Diversion Toilet is an ambitious project conducted by a team at the Swiss Federal Institute of Aquatic Science and Technology, a design company EOS, the Paul Scherrer Institute, and several other partners, with funding from the Bill and Melinda Gates Foundation. It works without the need for grid electricity, nor running water, and was developed for the context of urban slums. One of the key efforts so far has been to design it so that it is culturally acceptable and appealing to people. This modular and sophisticated concept also involves a complete self-sustainable business model by which local entrepreneurs can earn some money from taking care of the installed systems. So, how does it work? The technology separates solid and liquid waste, or urine, and flush water. Flush water is cleaned by ultrafiltration and made available for re-use inside the toilet. Urine and sold excreta are separately recycled into fertilizing products which are then sold. I think this is an example of a very interesting essential technology project in a world where more people have mobile phones than a toilet.

Notes

Summary

11m 21s

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After this short discussion of water and sanitation technologies, I hope you will feel motivated to imagine and experiment many more inventions in this essential technology domain. Good bye.

Notes

Summary

12m 34s