Technology brief

Water storage

Community water reservoir tank, Timor-Leste.

The natural flowrate of a water source varies, but people need water at different times of the day and all year round, when the supply may not be sufficient. Storing water balances the supply to meet the demand.

Supply and demand

Water quantity

People are used to the idea of saving. We save money when we have some spare as we may need it later. We preserve crops after a harvest to eat when food is scarce. It is the same with water. What is available naturally may be more – or less – than we need at that moment. Water storage varies from small amounts in a household container for a few hours to large amounts in a reservoir for several months, and even larger amounts stored naturally in aquifers for years.

Aquifers provide a vast reservoir of naturally stored groundwater that is available when needed and can be developed close to the home by constructing boreholes and wells.

When demand exceeds supply, people may have to queue for water, limit their water use (with health and social implications) or even go without water.

On an annual scale, water resources such as rainfall or rivers that vary seasonally may not supply enough water at certain times of the year to meet demand. Storing water in the wetter months enables demand to be met when it is it drier.

The quantity of water people use – or would like to use – is called the demand. What is actually available is the supply.

On a weekly or monthly scale, rainwater harvesting systems only collect water when it rains. A tank is needed to balance rainwater supply with users' demands. Similar patterns result from water pumped by solar or wind power – storage is needed for when the sun does not shine or the wind does not blow.

Where people have water delivered by a tanker, storage is needed between deliveries. This is common in emergencies.

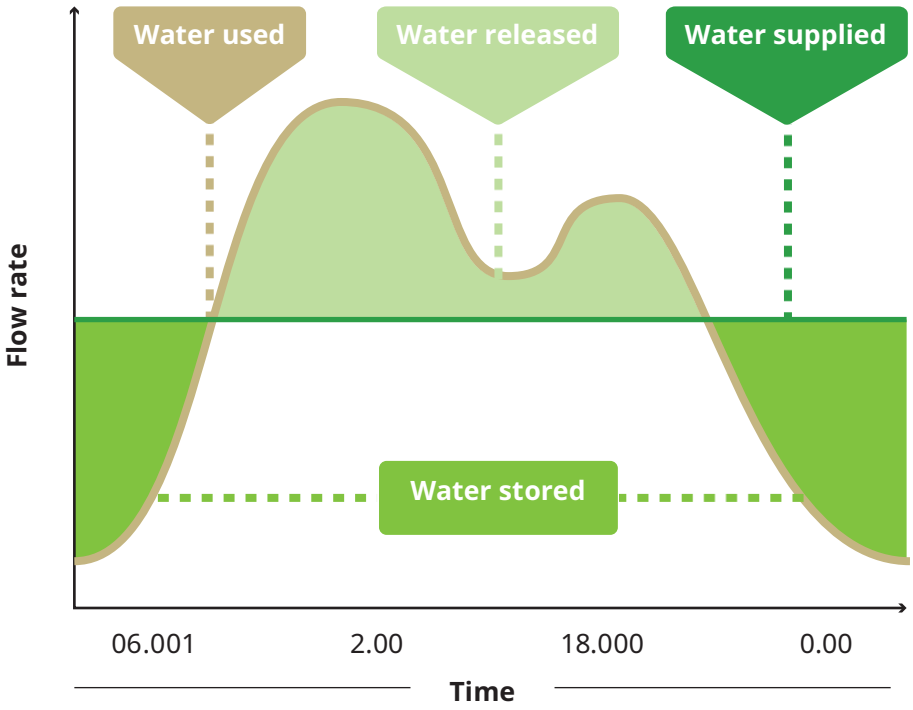
Storage provides some safety if a pump breaks down, a power supply fails or a pipe bursts. More storage means you have longer to repair the system. There can be unexpected increases in demand, such as water needed for firefighting or hot weather. The risk of running out of water during an emergency has to be balanced with the saving in capital expenditure.

On a daily scale, some sources, such as springs and rivers, flow constantly, day and night. Treatment works, pumping stations and water mains are designed to produce an average daily supply, operating 24 hours a day. It would be inefficient to build them larger to meet the demand during the day but then not use them much at night. Using these constant 24-hour flows, a **service reservoir** fills up at night and releases water during the day when it is needed. Our demand for water is low at night and varies during the day, with peaks in the morning and evening, before and after the working day.

Storage is also useful for regulating the pressure in piped systems. It can control high pressures in gravity systems, reducing leakage. By providing a constant pressure at a local level, the flow rate at a tap can be constant, preventing low flow rates and queues for water.

On an hourly scale, if people have to go outside to collect water, it is more convenient to do this when they are not busy and then store the water at home. Always having a spare container of water means people use more. Handwashing and other hygiene practices (such as menstrual hygiene) that have an impact on health may be reduced if there is little or no water available when needed.

Even if there is a piped supply, water is sometimes stored at the household in tanks or containers. This provides a buffer if the system only supplies water intermittently. It also helps when demand is high in the household (for example, when flushing toilets, having a shower and washing laundry at the same time).



Storage in a service reservoir helps balance a constant flow rate from the source with how much people need on an hourly basis.

Water quality

Storage also has an impact on water quality. The quality of **raw water** (which needs to be treated before use) can improve in storage – provided the water is protected – as settlement and pathogen die-off can reduce contamination. Storage can also provide protection against pollution – if a river becomes contaminated (for example, by an oil spill), people can use stored water until the pollution is washed downstream and replaced by clean water.

Some treatment systems work on a **batch process**. A whole tank of water is treated at once, and only when it is all clean can it be distributed. This provides an **intermittent** supply, compared with a **continuous** system, so storage evens out the start/stop pattern of treatment.

Treated water should not be stored for too long, as this increases the risk of contamination. Chlorinated water in particular will lose the protection provided over time. People do need to understand how to store water safely at home, including covering and regularly cleaning the container. Lack of is a weak link in the provision of water. If clean water from a tap or hand pump is not protected properly, it can become contaminated.

Steps in providing storage

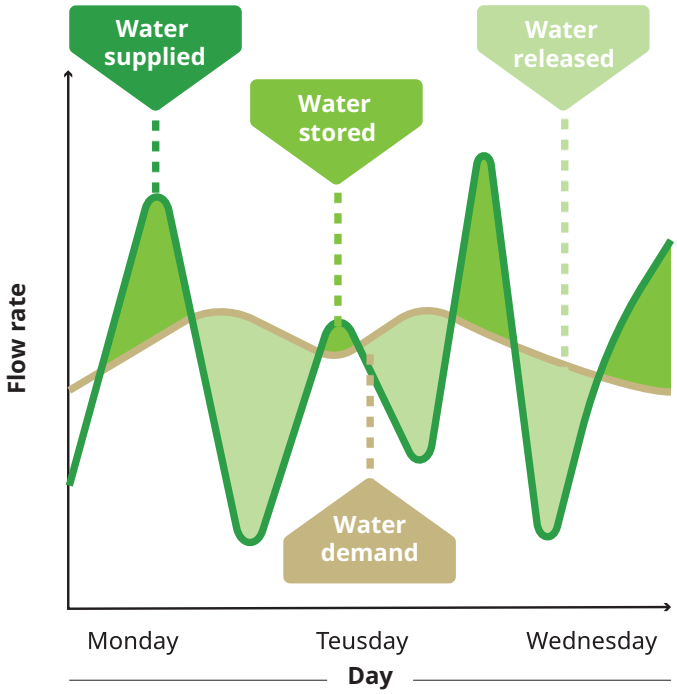
An engineer needs to work with the community to calculate the volume of water storage required. This volume depends on the average and variation of the water supply and the average and variation of the demand for water. You need to decide what risk is acceptable. A rainwater tank running dry one year in ten is not a major problem if there is a well nearby, but if there is no other source then extra storage is needed to reduce the possibility of running out of water. Having water for firefighting is another risk. Health centres also need a secure supply.

The supply rate may be continuous, variable, intermittent or batch, or a mix of these. Demand is also complicated, with daily, weekly and monthly patterns. The engineer has to examine these flows into and out of the water store, reducing the time the store runs dry or overflows to an acceptable level.

As the pattern can be very complex, a series of stores can balance supply and demand. A large reservoir will store water from month to month, with medium-sized tanks storing water on a daily basis. Containers in the home are the final stage.

When sizing tanks, it may be better to have several small tanks rather than one large one. This may cost more initially but allows for one tank to be cleaned or repaired without losing the supply totally.

Being resilient. Demand increases as populations grow and/or people use more water. The climate crisis means natural supplies are less certain. Extra storage can help people prepare for the future.



Storage helps balance a changing natural flow rate with how much people need on a daily basis.

Issues to consider

Physical issues

Water can be stored in artificial ponds or tanks made from concrete, plastic, metal or masonry. They may be underground or raised up on a mound or even a tower. A strong foundation is needed to support the weight of the water.

Environmental issues

To avoid lots of storage, choose a water resource that does not vary much or supplies more than the demand. An alternative is to use several water sources, switching between them as needed.

Aquifers store water naturally. Groundwater levels do not fluctuate as much as other sources. Increasing infiltration to groundwater (artificial recharge) can increase the volume stored in certain contexts but may not add value in others. Sand dams work in a similar way on a smaller scale. Lakes, ponds and even wetlands can regulate flows in rivers, evening out variations in the flow and reducing the need for storage.

Economic issues

Storage costs are mostly capital expenditure. There are some maintenance costs, mainly cleaning and occasional repairs. Well-designed storage can reduce overall costs, as other parts of the system do not have to be too large. Storage can be added to an expanding piped system as and where it is needed, delaying the need for other capital investments.

Social issues

Adequate storage is needed for equitable sharing of water supplies. Intermittent supplies or low flows in taps can mean some people have to queue for water. More constant flowrates speed up the collection of water, reducing the time taken and freeing people up for other activities – particularly women and girls who do the bulk of this work. Safe household storage is essential for maintaining water quality.

Intermittent supplies and poor flow rates may mean women and girls have to go out after dark to collect water, which may expose them to violence. Having water stored close to the house reduces this risk.

Large reservoirs are not just a water storage device but can be a community asset. While polluting activities need to be prevented, lakes can be used for recreation, sport, fishing, nature and enhancing the landscape. Very large dams can displace people and disrupt river flows, damaging the environment and people's livelihoods.

Management issues

Storage tanks do need cleaning out occasionally, but maintenance is mainly inspecting for damage or deterioration of the structure. For household storage tanks this can be done by household members, but for community tanks someone should be trained and supported to regularly check and maintain the tank.

Case study – Water storage in Madagascar

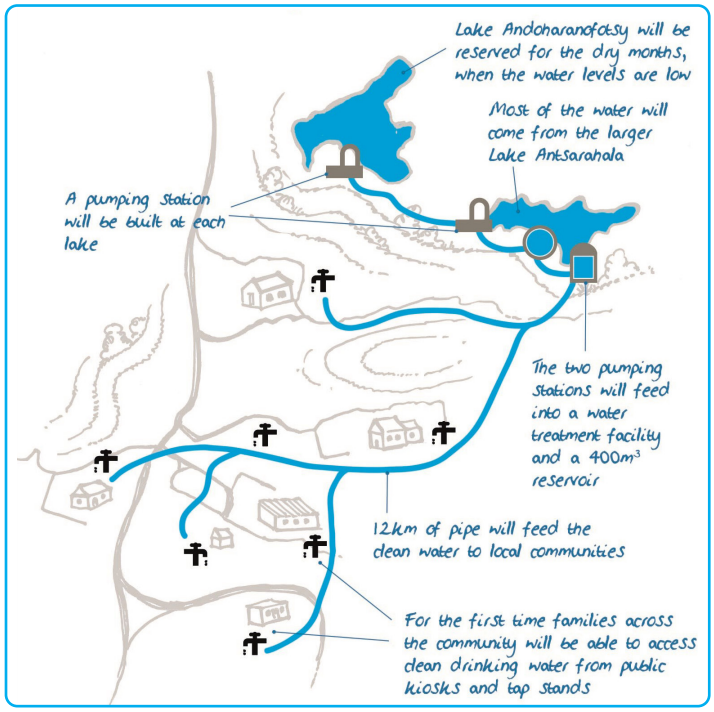
Improving the water supply is a high priority for the Manjakandriana commune in Madagascar, where only 27.31% of the population has access to clean drinking water (Source: SESAME, 2018). Water is available, but poor water quality means it is not drinkable. In collaboration with JIRAMA (the water and electricity company of Madagascar), WaterAid is constructing a large water supply system to collect, treat, store and distribute water from two lakes to provide drinking water to nine fokantany (communities) inside Manjakandriana.

As water demand will vary throughout the day, the huge 4,000m3 storage reservoir is an important part of the system. It will fill with treated water from the water treatment plant while the water demand is low, so that it is ready to provide water during periods of the day with high demand. If water was pumped directly from the water treatment system to the pipe network, there would be times where the demand would exceed the supply.

The storage reservoir is a semi-underground concrete reservoir, which has been constructed in partnership with JIRAMA. It is filled by water from the treatment plant (seen behind in the photos below) and feeds the gravity water pipe network to deliver water to communities.


WaterAid/Ernest Randriarimalala


WaterAid/Ernest Randriarimalala



- Top: Reservoir under construction (Mar 2020)
- Middle: Completed reservoir (Nov 2020)
- Above: Conceptual sketch of the water system design

Useful resources

For more information on the design and construction of storage tanks, see:

Skinner B and Shaw R (1999). Technical brief: Buried and semi-submerged water tanks. Loughborough University, UK. WEDC WELL. Available at: https://wedc-knowledge.lboro.ac.uk/resources/well/WELL_TB56_Buried_and_semi_-_submerged_tanks.pdf.

UNHCR. WASH technical designs; Designs and BOQs for ferrocement and elevated steel tower tanks. Available at: https://wash.unhcr.org/wash-tech-designs/page/2/?slg=wpdmpro&mdf_cat=-1&page_mdf=1295.

For more information on household water containers, see:

Reed BJ, Scott RE, Skinner BH and Jackson T (2011). Domestic water containers: An engineer's guide [online]. Loughborough University, UK. Water, Engineering and Development Centre. Available at: https://wedc-knowledge.lboro.ac.uk/resources/booklets/G004-Domestic-water-containers-online.pdf.

WaterAid is an international not-for-profit, determined to make clean water, decent toilets and good hygiene normal for everyone, everywhere within a generation.

Part of a series of WaterAid technology briefs available at www.wateraid.org/uk/technology

WaterAid (2021). Technology brief: Appropriate technologies for sustainable and inclusive water and sanitation services. London. Available at: washmatters.wateraid.org/publications/technology-resources

WaterAid