MedCrave
Step into the World of Research

International Journal of Hydrology

Mini Review

Open Access

CrossMark

# Traditional water technologies: future sustainability from historic practices

Volume 7 Issue 3 - 2023

Leanna Wigboldus
University College Dublin, Ireland

**Correspondence:** Leanna Wigboldus, PhD Candidate World Heritage, University College Dublin, Dublin, Ireland, Email leanna.wigboldu@ucdconnect.ie

**Received:** June 15, 2023 | **Published:** June 26, 2023

## Mini Review

*When the well's dry, we know the worth of water*. - Benjamin Franklin

As populations and industrialization increase on a global scale, demands for water, and the overuse of water resources, continue to rise. This is exacerbated by the increasing consequences of climate change that impact water resources through erosion of coastal areas, rising sea levels, flooding, droughts, desertification, land degradation, lack of drinking water, and unsustainable irrigation and draining systems.[1] It has been estimated that by 2070, 80% of the world's population will be dealing with 'high' threats to water security and severe water shortages.[2]

There is increasing awareness of an impending global water crisis, and as a result, the disastrous effects of climate change and depletion of water resources has become a growing focus for scientific study. Immediate and novel ways of approaching sustainable water management and protection are needed, and a range of new technologies have been developed to mitigate the effects of climate change and encourage sustainable water resources. However, there has been a recent shift in perspective and expanding interest in the value of ancient water management technologies and traditional knowledge systems around the world which have been used to protect and conserve water for thousands of years.

### The value of traditional technologies

Ancient technologies and practices related to the maintenance and management of water are considered to be some of the most innovative and environmentally-friendly technologies in the world. Many different communities and Indigenous peoples have used traditional knowledges, practices, and value systems to develop resilient, nature-based solutions for water security.[3] They include methods such as dikes, aqueducts, canal systems, waterways, and underground water storage, all of which can assist with flood management, protect freshwater supplies, create dry areas for agricultural practices, and minimize drought effects on landscapes.[3]

The link between traditional knowledge and water supports and relates directly to agriculture and agrobiodiversity. The FAO estimated in 2012 that global food production should rise by 70% by 2050 to meet the growing demands,[2] and this dramatic increase will require new approaches to meet the challenge. Large-scale industries and high-intensity agriculture have widely replaced traditional knowledge practices, and while increasing the volume of food produced, they have also contributed to a range of the adverse issues relating to water security and sustainable practices through increased use of artificial fertilizers, pesticides, water-dependent crops, and use of farming machines, among other practices. In contrast, traditional management systems adapt practices to suit and work with the landscape, integrating soil and water conservation practices using raised fields or terracing to encourage agricultural sustainability.[3] The result is "a set of ancient but ingenious farming systems developed by traditional farmers in many parts of the world [which] have stood the test of time".[4]

### Examples of traditional water management systems

Numerous examples of traditional water management practices exist around the world, including water harvesting and maintenance systems at the terraces and cisterns of Tunisia, the Karez systems of China, the Zahr-Karez of Pakistan, the *albarradas* infiltration basins in Ecuador, the sand dams of Kenya, the tank cascades of Sri Lanka, the mountain terraces of Yemen, and the Apatani rice cultivation in India. The following sections review three examples of traditional, innovative, sustainable and environmentally friendly water management techniques located in the Middle East, Asia and Europe.

### Qanat and aflaj systems

Drylands are particularly susceptible to variations in the environment and water cycles. With the increasing effects of climate change, these sustainable water management approaches have faced new challenges, especially in relation to desertification, flooding, coastal erosion, and increasing loss of biodiversity.[5] Ancient water sowing and harvesting technologies, many of which have existed for thousands of years in arid and semiarid regions, have helped maintain water supply systems and promote water and food security.[3] They are often linked to local rights and regulations, with water governance being determined through households and land ownership as well as through local consultation and sharing practices.[5] One example of traditional irrigation systems is the *qanat* or *aflaj* system which accesses groundwater from upland areas using gravity and subterranean streams to carry water to lowland farms and villages,[3] creating water management systems which have shaped landscapes culturally, environmentally, and infrastructurally. The *qanats* or *aflaj* systems create "a low-tech system based on the interaction of gravity, minimal waste of materials, sources of water, and labor",[6] and the use of underground tunnels for water transport ensures minimal evaporation, and natural recharge through aquifers to avoid over-exploitation of groundwater.[5]

The knowledge behind the construction of these water management systems was part of the daily life of the communities which depended on these technologies, and was taught to younger generations through oral and practical traditions.[6] The systems depend heavily on governance and management through local community structures, with

water allocation and distribution determined on a rotating schedule overseen by a community elder based on ancient regulations and laws governing fair distribution to avoid conflicts.[3] In several Middle Eastern countries, these types of water management systems have existed since the Neolithic time period,[3] although new types of pump technologies have been introduced in the face of increased scarcity of water resources since the advent of the 20th century.[6] The oases that result from the *aflaj* management systems are clear examples of how traditional water management technologies can create sustainable agricultural areas, as they "encompass a water distribution and management system, planting structure that helps regulate a micro-climate, cultivation of plants that are tolerant of aridity and salinity, waste recycling systems, and sand dune stabilization techniques".[3]

An interesting example of the *aflaj* water system is the World Heritage Cultural Landscape *Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and Oases Areas)*. The site dates to the Iron Age period and is home to one of the oldest examples of an *aflaj* irrigation system. The development of these *aflaj* irrigation channels were essential technological creations, producing sustainable water management systems throughout the region and supporting agriculture for over five millennia.[7] It has helped to develop sustainable farming practices for generations, and has created fertile agricultural regions in desert sand. In addition to being a World Heritage Site, the continuing importance of the traditional water management practices at Al Ain Oases is reflected in the fact that they are also inscribed on the list of GIAHS (Globally Important Agricultural Heritage System) sites by the UN Food and Agriculture Organization as an agroecosystem which has been maintained by local communities through traditional management methods to support socio-cultural interconnections with the landscape.

### Rice terraces

Another traditional water technique can be found in the *Rice Terraces of the Philippine Cordilleras*, also inscribed as both a World Heritage Site and GIAHS site, is a living cultural landscape that has been active for over two millennia. The terraces, with their irrigation and water harvesting systems, terraced pond fields and farming frameworks, have sustained the culture and productivity of wet-rice paddy agriculture for hundreds of years.[3] The techniques involve impressive water management, moving from mountain tops and forest areas into stone terraces and ponds, and flooded sections are used to cultivate rice and fish while also assisting with soil conservation, erosion control, groundwater recharge, runoff regulation, and microclimate regulation.[3] The upkeep and protection of these terraces are the result of local community cooperation based on a detailed knowledge of the local traditional management systems.[8]

Recent effects of climate change have created challenges for the management systems, including decreasing water resources resulting in dried out streams and ponds, and increasing earthquakes and heavy storms which have changed the location of water sources and caused the collapse of terraces and dams, resulting in a forced relocation of water distribution systems.[8] One of the greatest threats, however, relates to the loss of traditional knowledge, particularly in relation to water, agriculture, spirituality, and social governance, which is integral to the continuation of the irrigation and rice-paddy systems, as well as to the culture of the local Ifuago communities.[3]

### Water meadows

Another interesting example of traditional water management relates to the so-called 'water meadows'[9] which were used throughout the continent until the 20th century to promote longer growing seasons. These water meadows were irrigated by flooding areas of land to ensure consistent temperatures for grass to grow, resulting in increased plant and livestock growth by producing early spring harvests, as well as increased winter animal fodder. Dams, catchworks and bedworks were integrated into water management systems to collect water, with scheduled flooding and draining acting as phosphorus and nitrogen sinks, which meant that along with a reduced need for fertilizers, many of the smaller pests (mice, insects, grubs) were removed from the fields while the plants were growing.[9] With agricultural intensification and changes to land use in recent years, maintenance of these water meadows was discontinued in favour of the use of artificial fertilizers on drier, agricultural land, although there has been a recent shift by ecologists and landscape historians to restore and maintain these water meadows.[9–16]

## Conclusion

As global populations increase, so too does the demand for water. At the same time, modern agricultural and industrial processes, together with decreased global water supplies as a result of climate change, have contributed to water scarcity and reduced water security on a global scale. Water management systems, which have been developed and maintained for hundreds of years through traditional knowledge and practices, have proven to be effective in protecting and distributing water, adapting to environmental changes, and creating strong and sustainable communities. While the world faces new and increasing challenges due to climate change, "many of the current water issues have been solved before by our ancestors, and we should learn from them".[3] The use of traditional water management systems, and their associated knowledges and practices, could provide insights as to how to promote a connection and synergy between an increasingly industrialized world and the natural and cultural environments of past use.[10] Creating a holistic and collaborative approach towards climate change mitigation and water security, including the use and integration of both scientific advancements and traditional knowledge structures, is key in developing sustainable, low-energy, and economically friendly systems and solutions to address future challenges from climate change.

## Acknowledgments

None.

## Conflicts of interest

The author declares there is no conflict of interest.

## References

1. Hein C van Schaik H, Six D, Mager T, et al. 'Introduction: Connecting Water and Heritage for the Future'. In: Hein C, editor. *Adaptive Strategies for Water Heritage: Past, Present and Future*. Switzerland: SpringerOpen. 2020.

2. Wheater H. 'Delivering Water Security in a Changing World', *The UNESCO Courier*. 2019;56–58.

3. Cassin J, Ochoa-Tocachi B. 'Learning from Indigenous and Local Knowledge: The deep history of nature-based solutions', *Nature-based Solutions and Water Security*. 2019;13:283–335.

4. Altieri M. 'Agroecology: Creating synergies between human and natural capital in the management of agrobiodiversity for food provisioning and resiliency'. In: Paracchini M, et al., editors. *Reconnecting Natural and Cultural Capital: Contributions from science and policy*. Luxembourg: Publications Office of the European Union. 2018.

5. Bigas H, Adeel Z, Schuster B. *Seeing Traditional Technologies in a New Light: Using traditional approaches for water management in drylands*. Paris: UNESCO. 2009.

6. Bensi N. 'The Qanat System: A reflection on the heritage of the extraction of hidden waters'. In: Hein C, editor. *Adaptive Strategies for Water Heritage: Past, Present and Future*. Switzerland: Springer Open. 2000.

7. UNESCO. *Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and Oases Areas)*. 2011.

8. UNESCO. *Rice Terraces of the Philippine Cordilleras*. 1995.

9. Renes H, Centeri C, Eiter S, et al. 'Water Meadows as European Agricultural Heritage'. In: Hein C, editor. *Adaptive Strategies for Water Heritage: Past, Present and Future*. Switzerland: SpringerOpen. 2020.

10. Gadgil M, Berkes F, Folke C. 'Indigenous Knowledge for Biodiversity Conservation', *Biodiversity: Ecology Economics, Policy*. 1993;22(2/3).

11. Berkes F. 'Traditional Ecological Knowledge in Perspective'. In: Inglis J. editor. *Traditional Ecological Knowledge: Concepts and Cases*. Ottawa: Canadian Museum of Nature and the International Development Research Centre. 1993.

12. Biró M, Molnár Z, Babai D, et al. 'Reviewing historical traditional knowledge for innovative conservation management: A re-evaluation of wetland grazing'. *Science of The Total Environment*. 2019;666:1114–1125.

13. German Commission for UNESCO. *Traditional Meadow Irrigation in Franconia*. 2021.

14. Khumbane T. 'The Flow of Water and the Continuity of Culture: Water Imagery in the Landscape and Rituals of a Mountain Desert Oasis in Ladakh (Indian Himalaya)'. In: Boelens R, et al., editors. *Water and Indigenous People*. Paris: UNESCO. 2006. p. 82–96.

15. Mazzocchi F. 'Western science and traditional knowledge', *European Molecular Biology Organization*. 2006;7(5):463–466.

16. Olsson P, Folke C Berkes F. 'Adaptive Comanagement for Building Resilience in Social-Ecological Systems'. *Environmental Management*. 2004;34(1):75–90.

**Citation:** Wigboldus L. Traditional water technologies: future sustainability from historic practices. *Int J Hydro.* 2023;7(3):126–128.
DOI: 10.15406/ijh.2023.07.00347