



Support units: Geographical inquiry

Illustration 2: Water scarcity in West Asia – Year 7

## Water scarcity case studies

The concept of interconnection emphasises that no object of geographical study can be viewed in isolation. Geographer Jamie Linton maintains that the ways that we view the water cycle as a natural system, and view water as non-human or a completely natural element, is problematic. How might students investigate this idea? This part of the curriculum offers many avenues of inquiry, which should intrigue and inform Year 7 students. They might investigate:

- how every water body on earth contains minute anthropogenic substances and that snow contains particulates derived from human activity
- how the terrestrial flows of water are controlled by people to the extent that 80 per cent of river discharge in the Northern Hemisphere is regulated and controlled by dams
- how anthropogenic climate change has affected rainfall patterns in south-west Australia and summer pack ice in the Arctic.

### The water cycle

Linton believes that we should see the water cycle in social as well as hydrological terms. He maintains that a view of the water cycle from places that do not experience water scarcity leads to a preoccupation with big dams and water regulation. Linton refers to a 'blue water bias' (2008, p. 640) that emphasises overland flow that contributes to the idea that water resources should be seen as contained in lakes and rivers (called 'blue water' which is fresh water collected from natural run-off). How might students investigate the actual conditions (both social and hydrological) of places of water scarcity?

Blue water does not include the water that is involved in the growth of rain-fed barley in the semi-arid regions of West Asia, or water contained in soil moisture that is transpired by the barley plants. Swedish hydrologist Malin Falkenmark believes that we should shift our thinking from blue water to green water (rainfall that is stored in the soil or temporarily stays on top of the soil or vegetation). She sees this as particularly important in places that experience water scarcity. She believes that rain-fed agriculture will continue to be the mainstay of generating food in developing countries into the future but that blue water will merely augment available water supplies on a scale most relevant to farmers, the local scale.

### Qanats

It is here that qanats (that tap the blue water of the aquifers) become a useful avenue of inquiry.

Falkenmark believes that irrigation canals should be engineered to minimise evaporation losses. Qanats become an interesting area of inquiry in this regard because they do just this.

Falkenmark does not believe that virtual water trading (where food is exported from areas of water surplus to those of water deficit) is sustainable in economic terms. She maintains that integrated land and water management schemes would be more effective in places with water scarcity. The controversy over virtual water trading opens up another area for inquiry for Year 7 students:

- How might an investigation into the qanat system illustrate ideas about water scarcity?
- To what extent do qanats reveal some of the connections between people and places?
- How sustainable are these water supply systems?
- How do they minimise water losses?
- If they can only withdraw water that is available in the aquifer through natural recharge, does this system avoid any over-exploitation of groundwater resources?
- What will the consequences of climate change be on the qanat system?
- There are some 30,000 qanats in Iran, how important are they as blue water systems?
- Are qanats worth preserving in World Heritage terms?
- To what extent do qanats support social systems in terms of the provision of water for religious purposes, for social cohesion and sustainable livelihoods?

## Interconnections

In the qanat system, people, irrigated areas, subterranean tunnels, vertical shafts and aquifers are all connected to each other through environmental processes that stretch out from place to place. There are intricate networks of underground water channels that provide valuable gravity-fed irrigation water to some places to the detriment of other places. The interconnections evidenced in the water cycle generate a sequence of cause-and-effect relationships where changes in inputs reverberate through the system. The qanats are rendered more sustainable as a result of persistent winter rainfall in the higher parts of West Asia than they would be in places that experience sporadic summer storms when much more of the water would be lost through evaporation.

Both the qanats and the operation of the water cycle can be envisaged as complex flows of materials, energy and information through biophysical and human-organised systems. These flows vary over time and space, but they also form an integrated whole, a physical or conceptual boundary that defines the system.

The qanats are also a remarkable social phenomenon. In Iran the leaders of the multi-family collectives, the Bunehs, decide how the fields are distributed, what is to be grown, who sows the seed, who supervises threshing the grain, who are muganni (well and qanat diggers), who are barbers and bath-keepers? The qanat system has been supported by the tenets of Zoroastrianism and Islam where nature is central to the former and stewardship important in Islam. 'According to Muslim teaching, water is a gift from God that should be freely available to all' (Balali et al 2009, p. 25).

Inquiry approaches into the operation of the water cycle and the functioning of the qanats should encourage questioning, investigation and critical thinking about water and the ways it connects places as it moves through the environment and how the operation of the qanats affects people's lives now and into the future. Geography should be about explanation rather than description.

Groundwater, soil moisture, stored water and surface water connect places and people in various ways. Qanats are essentially underground canals that have been engineered to collect groundwater, but many places in Syria have been abandoned because of falling water tables (in turn caused by the increased use of diesel and electric pumps). Because the qanats are not able to provide sufficient irrigation water for large-scale agriculture they have been neglected. In order to keep the underground canals flowing in the long dry season they need regular maintenance, to be cleared of silt and to see that the roofs of the tunnels do not collapse. A chain of consequences ensues – young people abandon the qanat system seeking work in the towns, much Indigenous 'knowhow' is lost and the community cooperative efforts that maintained the qanats disappear.

### **Restoring qanats**

The qanats are in one sense a relic from the past, but they are also sustainable groundwater extraction systems. Some qanats still function in parts of China, Afghanistan, Pakistan, Iran, Iraq, Oman, Saudi Arabia, Syria, Egypt, Algeria and Morocco. In Xinjiang Province, China, local authorities are reviving ancient Karez systems (qanats have many different local names). In Oman, the renovation of qanats has proved to be a viable proposition. There are some 3000 Aflaj irrigation systems functioning in Oman.

Qanat restoration is important because they are sustainable systems in places of water scarcity. Qanats are frequently dug into hard subsoil, therefore there is very little seepage, waterlogging, soil salting or evaporation. They work through gravity alone requiring no fossil fuel resources.

In some places in Syria, the restoration of qanats in combination with modern drip irrigation techniques provides a viable means of growing fruit trees. In 2000, villagers living east of Aleppo cleaned out their qanat to provide their only source of drinking water. In Qarah, Syria, there are opportunities for young people to stay on the land and prolong the life of the qanats. It is also hoped that ecotourism ventures based around the qanats will provide alternative sources of income for farmers and ensure the sustainability of the system.

The qanats that are functioning most successfully are found around Damascus and Homs extending up into the semi-desert areas with less than 200 mm of annual rainfall. They are dependent on quite complex social systems where water rights are strictly enforced at a local level. Each household has an irrigation share, or 'dor' (turn). In a similar way to Australia, these shares can be traded.

### **Shallalah Saghirah project**

A renovated qanat near the village of Shallalah Saghirah, 65 km south-east of Aleppo, is dug into a limestone aquifer where the subterranean aqueduct connects up to a canal (saqe) that runs through the village into a water tank (birkeh). An outlet to the birkeh is systematically opened and closed using cloth and stones to irrigate a community garden. Water taken from the saqe was tested and proved to meet World Health Organization standards with regard to drinking quality.

The people of this village are descendants from one ancestor, and his family cleaned up the mother well and the qanat in the early years of the 20th century. Until the 1960s the people of Shallalah Saghirah consisted of five extended households descended from the original founder of the village. But subsequently things began to change. Many villagers began to leave to seek work opportunities in Beirut, Lebanon and the cities of Saudi Arabia. Furthermore, the village was totally abandoned in 1977 as a result of a dispute with a neighbouring village.

The elderly descendants of the five households still maintain their water rights to grow onions, cucumbers, tomatoes and other vegetables in the qanat garden, and to sustain the mulberry, pomegranate and fig fruit trees. During the 1990s these elders and the rest of the community met together to decide about the use, repair and maintenance of the qanat. There were disputes about using rubber pipes to irrigate directly from the saqeh, and as to who should clean out the qanat. Eventually, after a celebration to mark the end of Ramadan in 2000 they resolved their differences and agreed on a roster of duties to restore the qanat. This roster was particularly important because many young people were seasonal workers in many different places in West Asia. A schedule was set out for clearing out the airshaft tunnels, drilling another airshaft into the mother well, reinforcing the saqeh channel, and extending the source of the qanat into the limestone aquifer. Sixteen young men were trained to be experts in qanat cleaning.

### **Lessons learned**

The lessons learned from the Shallalah Saghirah renovation project with regard to any other qanat sites in West Asia or North Africa included:

- the need to protect the water table and not allow pumping within 3.5 km from the qanat tunnel
- the need for care with underground reconstruction (many workers have been injured or lost their lives in the long history of the qanats)
- the need for cooperation and social cohesion in the village
- the need for clear ownership agreements over the qanat and over water rights
- a willingness to undertake the work to keep the system sustainable.