

Rainwater utilization for sustainable development in north China

by Haisheng Mou

China's population continues to grow, while her economy expands at an unparalleled rate. Can her water resources cope with the new demands? Ancient rainwater harvesting techniques may yield even more in the future.

A COMBINATION OF the threat of global warming, the ever-growing population, and rapid economic development is likely to make regional water shortages progressively more serious in many semi-arid parts of northern China over the coming decades. This, in turn, may constrain development in a region which supports a population of tens of millions who depend primarily on subsistence agriculture for their survival.

The increased utilization of rainwater may be the only way to ensure sustainable water-resource development in this region. With this in mind, researchers from Shijiazhuang's Institute of Agricultural Modernization have conducted experiments with various kinds of rainwater harvesting techniques in Yuanshi county, a part of Hebei Province.

Yuanshi — land and rainfall

Yuanshi county is typical of north China. The western part is distinguished by undulating hills and valleys while, in the east, a sloping alluvial plain runs up to the Taihang mountains. Both the plain and the terraced lower slopes of the mountains are characterized by intensive, mixed semi-subsistence agriculture based on wheat, maize, bean, and vegetable production.

The area has a continental, monsoonal semi-arid climate with a mean annual temperature of 12.6°C — ranging between a summer maximum of 42°C and a winter minimum of -25°C. The mean annual rainfall is 589mm, and its distribution in time and space is uneven. The precipitation varies greatly between years; in the hills, 1963 saw a maximum of 1412mm; while in 1972, a minimum of only 189mm was recorded on the plain.

Water demand

Rainfall distribution throughout the year is also uneven. The mean rainfall in July and August is 304mm, account-

ing for 53 per cent of the total, a figure which plummets during the spring sowing period of April and May to below 5mm, accounting for 1 per cent of the total. So, for the people of Hebei, spring often means drought, resulting in restricted industrial and agricultural production. Assessments show that the rainwater resources of Yuanshi county are considerable, with mean annual totals of about 387 million cubic metres. Nevertheless, population growth and agricultural development have led to a rapid rise in people's need for water; as a result, water shortages have been increasing since the 1970s.

Three main rivers cross Yuanshi county; in the 1950s, each flowed without interruption but, by the 1960s, only seasonal flows were being recorded. Since the 1970s, the rivers have dried up, and the people have had to dig wells for their water supplies. Recently, however, the water level of these wells has been falling very quickly, and people are beginning to worry about the

water problem. The frequent droughts, together with the growing water shortage, have prompted the villagers of Yuanshi to adopt rainwater harvesting techniques to address the immediate problem, and for promoting development in general.

Pilot project

As part of an ongoing pilot project, about 50 household rainwater catchment systems have been installed in rural households in Yuanshi county. Each consists of around 100m² of roof and courtyard surface catchment area, and a 5 to 6m³ rectangular sub-surface, cement rectangular tank, and a hand-pump. To save money, the systems have been designed to work without wire reinforcement or metal gutters; the final unit cost is usually less than US\$100. A line of bricks laid on the sloping roof directs water into a plastic downpipe, and into the tank. So far, the systems have been highly effective, and the families — who work on installing the systems and provide certain materials — are very enthusiastic.

Techniques down the ages

Although there is a long history of rainwater utilization in Yuanshi county, and traditional techniques have continuously developed, it has still to achieve widespread popularity. Before the



Yuanshi families have welcomed the catchment systems enthusiastically.

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1950s, the 'first-level' utilization of rainwater played the major role, as various small projects for collecting and storing rainwater were constructed.

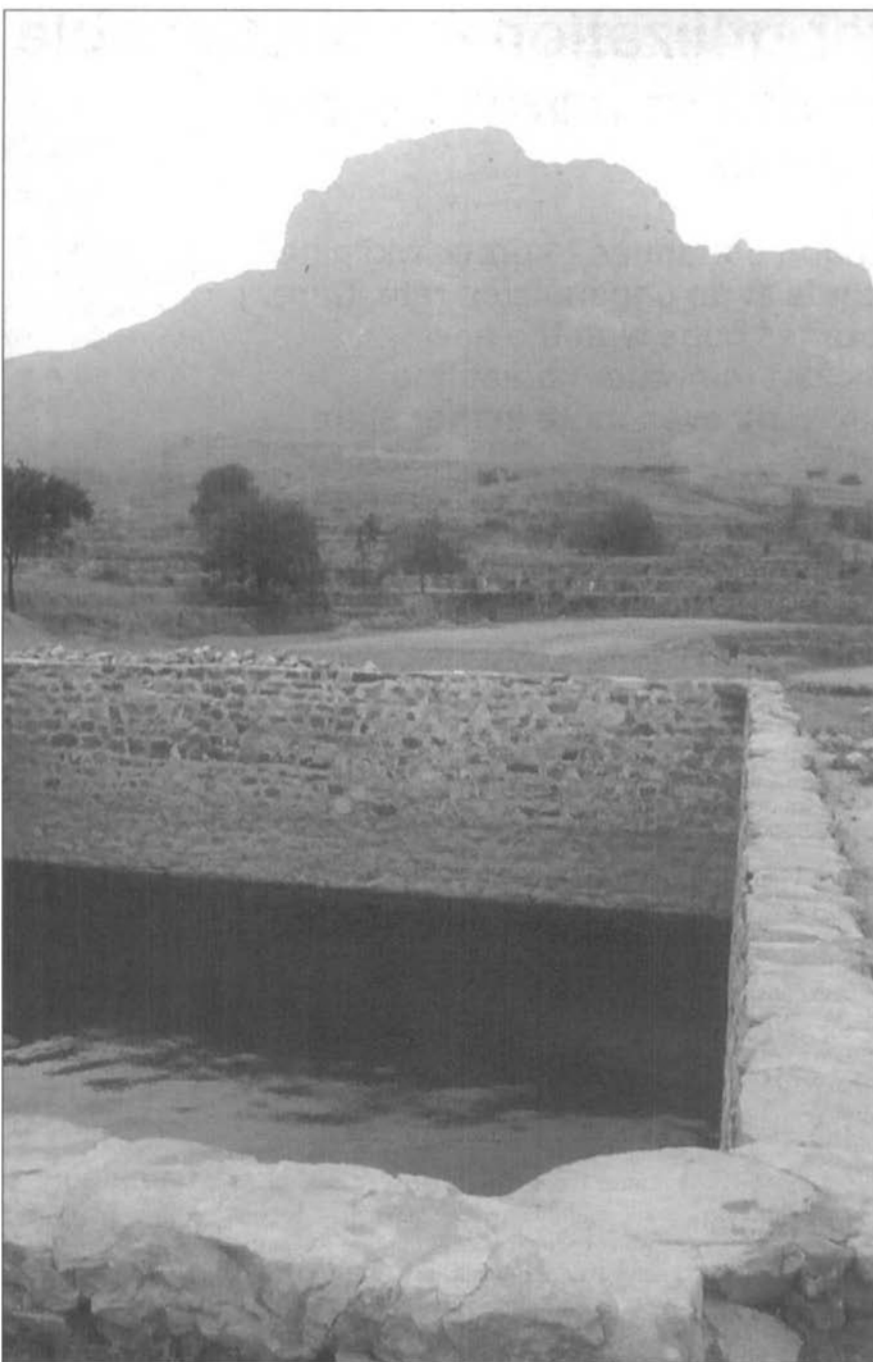
Subsequently, pond excavation, dam construction, and wells became the main forms of rainwater utilization. At present, the county is home to more than 2000 schemes for collecting and storing rainwater, such as dams, ponds, pools, water cellars, and *dangwas*. Small projects can be found all over the hilly region. The total storage capacity of all the schemes is about 100 million metres³ (about 25 per cent of the total rainfall). The techniques that local people favour are:

Water-jar well A traditional method for rainwater utilization in the Taihang mountains. The well (underground tank) is usually 1.5 to 3m in diameter, between 4 and 6m deep, and is either circular or

square. The structure comprises a well floor, a wall, and a semi-circular cover. The well is made of mixed soils, bricks, and concrete. Its wall has a 0.2 to 0.3m-thick seepage-proof layer; and there is a circular inlet in the wall for rainwater collected from tiled roofs and the courtyard. The water-jar well is mainly used to supply water for agricultural production, domestic use, and animals' drinking-water.

Water tank Circular or square and widespread in this area for storing surface rainwater runoff. The tanks are about 2m deep, and can store up to several hundred cubic metres of rainwater. In the hills, the tanks are built into the rock, with mud linings to prevent seepage (see photo) while, on the plain, they are built using a three-soil mix.

Ponds Because rainwater in the hills infiltrates quickly into the sandy soil,



'In the hills, the tanks are built into the rock ... mud linings prevent seepage'.

the water-table level is high. It is easy to dig ponds in soft rock and these are filled from groundwater seepage. The ponds are usually 3 to 10m wide, and around 10m deep. They also collect and store rainwater runoff which supplies water both for irrigation and drinking — by people and their livestock.

Mini-dams These are built in small valleys and gullies. A mini-dam comprises waterproof walls and an outflow pipe; it is easily built, does not need seepage-proofing, and has a volume of less than 10 000m³. It is mainly used to store rainwater in valleys and gullies, and it supplies water for agriculture and animal husbandry.

Small reservoirs A key method of rainwater use, involving obstructing and storing floodwater. Depending on its design capacity, the reservoir can be

divided into small and medium-sized reservoirs with a common capacity of around 100 000m³.

Silt arresters

These are built in the middle and upper reaches of valleys, mainly to form small terraces in the valley bottoms of mountain areas, thus encouraging the utilization of floodwaters in the wet season by increasing soil-moisture storage, and to control soil and water loss.

Snow collection and spreading

Collecting snow to spread on their fields is another way in which the people of northern China utilize the winter precipitation. They collect the snow from roads and courtyards, and carry it to the fields, where they spread it over the winter wheat; it also increases the amount of water available for arable crops when the spring thaw arrives.

Roof-tank systems

A method available to every family in the area. From the

roof, and via the collection trough and downpipe, the rainwater enters a concrete, underground storage tank, typically with a volume of 6m³. In the past, the roof-tank system provided water for washing clothes, irrigation, and for the family's pigs. The current dearth of water resources has spurred on the people to make further improvements to their catchment systems; now they can usually supply drinking-water fit for human consumption.

Recharging groundwater using floodwater The River Baisha is one of the largest rivers in the county, yet it flows only in the wet season. Researchers who examined the groundwater recharge resulting from the 1990s damming of the Baisha in Yuan-shi, found that the total recharge in the region was over 16 670 000m³. They observed that the groundwater level

rose, on average, by 5.6m, benefiting 11 townships and 61 villages, within an area of 200km². This meant that 1200 wells received extra water, and 783 wells — dry for many years — could be used again. Plans to dig over 300 new wells were shelved representing savings of over 1.2 million yuans.

Future strategies

As outlined above, only around 25 per cent of Yuanshi's rainwater resources are currently utilized. Furthermore, only about half of the rainwater resources which could be used and developed easily are at present being utilized. As the water shortages increase in the region, the growing water crisis is certain to deepen.

A greater emphasis on water-conservation projects in general, and on tapping the potential of under-utilized rainwater resources in particular, is likely to emerge in response to the



A shallow well in the Taihang mountains — Yuanshi is home to over 2000 traditional methods for collecting and storing water.

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problem. In addition to developing rainwater catchment systems for water supply, a number of the systems described above may also play a vital role in soil-conservation efforts in sloping fields. A major effort to develop watershed-control and close hillsides to facilitate afforestation, sow grass, and

so on is also needed.

Integrated approach

In addressing the issues of how to best conserve and utilize the land and water resources of the rural areas of Hebei, an integrated approach is clearly appropriate. Rain-fed agriculture systems in hilly areas may also be improved by increasing the utilization of rainwater resources, both for greater soil-moisture storage, and by providing supplementary irrigation. Finally, improvements in roof and courtyard catchment systems will help to alleviate some of the daily difficulties each family faces in providing drinking-water for themselves and for their animals, especially in times of drought.

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