STORING WATER

The value of water to the user depends on having the right quantity, of appropriate quality, available in the desired place and time. Managing the supply of water to meet demand has everything to do with manipulating its availability in space and time through storage.

Frank Rijsberman • International Water Management Institute

During the twentieth century, the world’s population tripled and the use of renewable water resources multiplied six-fold. This enormous increase in water use was possible due to a massive investment in water-resources development — in most cases increases in water storage and associated infrastructure. However, it had a price beyond the direct cost of investment: half the world’s wetlands disappeared, groundwater levels in key aquifers are falling and many groups of people affected by water projects have raised their voice in protest.

Still, unsafe water remains the world’s number-one killer. Several million children die each year of diarrhoea. Malaria, closely linked to water-resources development, remains Africa’s most important cause of death. Hundreds of millions of malnourished people in the rural areas have insufficient access to water for productive purposes. To deal with these problems, and provide water security for all, Cosgrove and Rijsberman (2000) estimated that global investment in the water sector would have to double to $180bn/yr.

Dams are often regarded as a community resource.

The dam building boom
During the twentieth century the use of water for human purposes exploded. There are today over 45 thousand large dams, higher than 15m, estimated to have cost more than $2tn, providing water for 30–40 per cent of the world’s irrigated agriculture and 19 per cent of world electricity.

In the dry western part of the USA and in the huge Murray-Darling basin of Australia an enormous number of small, medium and large dams were built. These were built primarily for agriculture and hydropower purposes. In the mountainous parts of Europe dams were built primarily for hydropower and later for domestic purposes. Today the total constructed storage capacity in Australia and the USA is in the order of 5000m³ per inhabitant and the large majority of attractive sites for dam construction have been used. Dam construction in OECD countries has levelled off. The dam construction boom in Asia came later, starting in the 1960s, and has not yet levelled off.

Second thoughts
As the World Commission on Dams (WCD) writes:

From the 1930s to the 1970s, the construction of large dams became — in the eyes of many — synonymous with development and economic progress. Viewed as symbols of modernisation and man’s ability to harness nature, dam construction accelerated dramatically. This trend peaked in the 1970s, when on average two or three large dams were commissioned each day somewhere in the world (p xxix).

The same large dams also have displaced some 40–80 million people that lived where water storage has been created. They have also affected the flow of some 60 per cent of all rivers — causing considerable social and environmental impact. As a result, there have been increasing acrimonious debates over the desirability of new large dams. The Independent World Commission on Dams, jointly sponsored by the World Bank and The World Conservation Union (IUCN), has carried out a major review of large dams and has attempted to formulate guidelines for responsible dam construction. While many people and countries accept the WCD recommendations, important groups and some key countries, particularly those favouring dam construction, have not accepted the report. The debate continues. As put by the Global Water Partnership (GWP):

On the one hand, the fundamental fear of food shortages encourages ever-greater use of water resources for agriculture. On the other, there is a need to divert water from irrigated food production to other users and to protect the resource and the ecosystem. Many believe this conflict is one of the most critical problems to be tackled in the early twenty-first century (GWP, p58).

While large dams feature most prominently in the debate over water storage, there are other water-storage options. The four main
types of water storage are: the soil, groundwater aquifers, small reservoirs and large reservoirs.

While the storage in the soil profile is extremely important for the natural vegetation and crops, it is least amenable to manipulation. As land-use changes, however, through deforestation, desertification and urbanisation — the total usable storage capacity of the soil is altered considerably, but the nature and size of the impact is not well known.

**Dams — large and small**

The construction of large-scale dams and reservoirs has by and large been a national government responsibility because these are very large and risky investments. The period from drawing board to commissioning is often in the order of several decades. The projects are slow, visible and draw a lot of fire from opponents. Some of the largest projects, such as the Namadgi in India, the Three Gorges in China or the many planned dams on the Mekong, have gained international prominence in the debate among proponents and opponents of dam development.

By contrast, farmers, groups of farmers and municipalities, have constructed the majority of small dams. In Africa and Asia, small dams and rainwater harvesting structures are often constructed through efforts of non-governmental organisations, villages or even individuals. The smaller size is more manageable. The small dams are perceived to have a more ‘human’, or community, scale and their public reputation is often quite good. Scientists and engineers, however, tend to question the true value of small dams, as they may well evaporate more than they produce in areas where evaporation is high and reservoirs are very shallow. In river basins where a large share of the water is already used, in closed basins to be precise, new small dams upstream simply re-allocate the water from the downstream to the upstream user. Large numbers of small reservoirs also have a major impact on natural streamflows and, therefore, environmental impact and possibly negative health impact through water-related diseases such as malaria. Even less is known about the total costs and benefits of large numbers of small dams than is known about the impacts of large dams.

**Storing water in aquifers**

Since the development of small and affordable diesel and electrical pumps, these have rapidly become extremely popular to pump water for agriculture from the groundwater. In India, Pakistan and China alone there are approximately 20 million energised tubewells. Underground aquifers are crucial for farming in water-scarce areas.

Groundwater is often accessed through shared irrigation wells (deep-bored wells equipped with electric or diesel-powered pumps). The size of the groundwater economy in India, China and Pakistan is conservatively estimated to be $10bn.

The large majority of the tubewells are the result of private investment by farmers or groups of farmers. Almost wherever they have access to good-quality groundwater and the resources to invest in a (shared) tubewell, farmers prefer this direct access to stored water because of the greater control it provides to them. It provides water-on-demand, as opposed to water in surface water (canal) irrigation that is more or less successfully managed by irrigation managers. There is no question that tubewells, combined with the storage function of the aquifer, have produced large private benefits for their users and created enormous wealth in the rural areas.

It is proving to be extremely difficult, however, to avoid overuse of the groundwater storage function. Once the tubewells are installed. In key aquifers in India, Mexico, the USA and China — the countries where the majority of groundwater use is located — groundwater levels are falling by as much as 2–3m per year. Farmers in North-Gujarat, India, started using groundwater for agriculture some 30–35 years ago with bulb-out driven pumps from depths of up to 10m. They have seen the groundwater fall to depths of 150m during their lifetime. With 50hp diesel pumps installed in 200m deep tubewells, they know that the end is in sight. Already there are areas in India where over 60 per cent of the wells have been decommissioned. The wells have fallen dry.

Complicating the issue is that the groundwater boom has been driven in part by the provision of subsidised electricity and diesel fuel. As the energy sector is battling its own collapse under mountains of debt, prices go up and some rural areas now experience de-electrification. The linkages between the water and energy sectors are known but far from understood.

**Ecological alternatives**

There are ecological alternatives to building dams. Along the banks of rivers that flood seasonally, such as the Senegal, people have practised small-scale agriculture based on the natural flooding cycle for many centuries. During most of the boom period for large-scale dams in the last century, the benefits of this type of agriculture, or the services yielded by the wetlands or the fisheries in the river, were not well recognised. Recognition of the value of these pre-dam benefits may well render some storage construction projects
RELIABLE WATER STORAGE TANKS

As pollution and population both grow unchecked, the world faces unprecedented shortages of its most valuable resource - water. The economical storage of rainwater and ground water is a critical factor in the survival of the human race. Pioneer Water Tanks manufacture a water storage tank that is:

- Easily transported
- Robust
- "Fully knocked down"
- Earthquake and wind rated
- Easily assembled
- Available sizes from 25KL to 2.5 million litres
- Attractively priced
- Demonstrable and of relocatable
- Long lasting

During the last decade Pioneer Water Tanks have developed into one of Australia's leading tank manufacturers offering a complete service from sales to installation. A growing awareness of this fact has led Pioneer to set up new international markets. The modular tank design and convenient pack size makes the Galaxy water tank ideally suited to contamination, LCL shipments or even air transport. Tank sizes range from 20,000 litres - 2.5 million litres.

QUALITY      STRENGTH      HEALTH      VALUE

A helpful Pioneer consultant can provide information on all products available from Pioneer Water Tanks.

International Phone: +61 8 9274 4577 Fax: +61 8 9274 4588
email: info@pioneertanks.com.au or website: www.pioneertanks.com.au

DISTRIBUTORS: AUSTRALIA | MALAYSIA | PNG | UNITED ARAB EMIRATES | CARIBBEAN ISLANDS | TAHTI | SOUTH PACIFIC ISLANDS | SOUTH AMERICA | SOUTH AFRICA | FRANCE | NEW ZEALAND

INSECT/FROST PROOF VENTS

T.A.P. Co. patented vents provide the most effective protection against insect invasion and frost build up. Our vents are fabricated from carbon steel, aluminium or stainless steel and are installed on steel or concrete water storage tanks. Our vents can be used as replacement vents or new installations.

Standard vent sizes range from 4" to 40" but custom fabricated vents are available. All models are economically priced.

These vents have no moving parts and are virtually maintenance free. Replacement screens are readily available at most hardware stores.

Vents can be installed as replacements with minimal time and labor involved. In some cases a flat blade screw driver and a wrench are all that is needed.

Carbon steel models are blasted and prime coated with Tinnerc Serves 20 Epoxy.

Temper proof models are an option.

All of our vents meet AWWA Standards.

T.A.P. Co. 111 S. 4TH STREET P.O. Box 317 Rosebud, Mo. 63091-0017 Tel: 573-764-7255 Fax: 573-764-6255

TRIPLE CHECK POSITIVE RETENTION CIRCULATION SYSTEM

This patented system is designed to let your single piped water storage tank perform as a double piped system. Water is put into your tank through an extended fill pipe and is discharged through check valves near the bottom.

This system provides a number of positive actions:
- Reduces or eliminates tank sweeping and consequently reduces mold growth and dirt accumulation. Exterior coating life is extended.
- Reduces ice build up inside the tank, preserves interior coating life and reduces other interior ice damage.
- Circulates water in the tank and prevents thermal stratification which reduces the probability of bad water samples by increasing chlorine retention time and stabilization of chlorine residuals.

This positive retention circulation system is at it's best in standpipes and ground storage reservoirs but it is adaptable to and beneficial in most water storage facilities. It is maintenance free and involves no actual operational costs.

T.A.P. Co. 111 S. 4TH STREET P.O. Box 317 Rosebud, Mo. 63091-0017 Tel: 573-764-7255 Fax: 573-764-6255

For further information circle 26
infeasible. At the same time, increased understanding of how environmental flows can be maintained after dam construction, such as those methods pioneered in the Lesotho Highlands project to transfer water resources to South Africa, can reduce the impact of storage projects on these other values.

In some cases even restoration may be possible. In Cameroon, a floodplain has been brought back to life through the Waza Logone Rehabilitation Scheme. A dam constructed in 1978 for rice irrigation greatly restricted the downstream flooding of the downstream floodplain along the Logone River. In 1988, the IUCN initiated a project to rehabilitate the floodplain, including the 171,000ha Waza Park. Pilot water releases through newly constructed openings in the main river levee have enabled restoration of approximately 60 per cent of the affected floodplain. The renewed flooding dramatically improved the living conditions for the people and their environment, without affecting the rice scheme.

**Finding solutions**

Managing water implies making it available when it is needed. But how much water should be stored and what type of storage provides maximum benefits for least cost, is a question that can only be answered by the stakeholders in each basin. However, there are some typical situations. First, in river basins where only a small proportion of the renewable resources are currently used for human purposes, such as in areas of Africa and Latin America, increasing storage through infrastructure development remains attractive. Second, in areas where infrastructure has been developed for much but not all of the resources, such as in Sri Lanka, improved management of the existing infrastructure may well yield ‘water savings’ to cover growing demands. Third, in closed basins, where all available resources are already used such as in north-west India and the China Plains, ‘saving’ water through infrastructure or improved management only increases the water use of the upstream user at the expense of the downstream user. In the last case only re-allocation of water to higher value uses, increasing the productivity of water, can create added value.

In all cases, as water becomes more scarce, the key to increasing its value to society lies in increasing the productivity of the water used, rather than in increasing the efficiency of its use. At the field scale, increased water productivity translates into ‘more crop per drop’. At larger scale levels, the definition of water productivity also needs to include other values. For example, for the Kirindi Oya basin in Sri Lanka, the fisheries in the irrigation reservoir upstream of the rice paddy generated an additional value equal to some 20 per cent of the rice production. The trees and home gardens downstream of the rice fields in the same Kirindi Oya basin evaporated more water than the rice, largely through recycling of the water coming off the paddy fields.

The increased focus on, and understanding of, all values produced by water resources should lead to better decisions on whether and how water should be stored. There will still be a need for dams — but we will want to build ‘good dams’, not ‘bad dams’. Good dams will be those where their impact has been recognised and properly accounted for and where all stakeholders have been heard and benefits are properly divided among all affected. At the same time, new increased recognition of the role played by other forms of storage, notably groundwater stored in aquifers. Designing institutions that sustain the groundwater boom may well be more difficult than designing good dams.

**References**


Molden, David and Rijberman, Frank; ‘Assuring water for food and environmental security’ Paper presented at the CGIAR Mid-Term Meeting. In Darfur South Africa on 26 May 2001

Renault, Daniel; Morji, Nokwane and Molden, David; Importance of water consumption by perennial vegetation in irrigated areas of the humid tropics: evidence from Sri Lanka’ in Agricultural Water Management 215-230:46 2001


Rijberman, Frank; ‘Troubled water, water troubles: overcoming an important constraint to food security’ keynote address at the IFPRI Conference on Sustainable Food Security for a Better 2020. 4-6 September 2001, Bonn, Germany

Rijberman, Frank and Molden, David; ‘Balancing the Need for Water in Agriculture and Nature’ Background paper prepared for the International Freshwater Conference, 3-7 December 2001, Bonn, Germany


---

**AUTHOR**

Frank Rijberman is director general of the International Water Management Institute (IWMI) in Colombo, Sri Lanka and Professor, IHE, Delft, The Netherlands. IWMI is one of the 16 research centres supported by the Consultative Group on International Agricultural Research (CGIAR). IWMI’s mission is to improve the management of water and land resources for food, livelihoods and nature. Frank Rijberman can be contacted at: Frijberman@cgiar.org