International Association of Hydrogeologists

Strategic Overview Series

WATER SECURITY & GROUNDWATER

KEY MESSAGES

- **the concept of water security clarifies how water-resource scarcity impacts at varying geographic scales and on different socio-economic sectors, causing allocation conflicts and environmental risks**
- **the large natural storage of most groundwater systems offers exceptional drought resilience and is well positioned to enhance water security for a wide range of water users**
- **to perform this role sustainably groundwater systems require better data and analyses to inform water-resource administration and effective pollution protection**

What are the basic criteria that define water-security and water-scarcity ?

'Water security' was defined by UN-Water in 2013 as < the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability>.

However, the related concept of 'water scarcity' has evolved considerably since definition of the 'Falkenmark water-stress index' in the 1980s, which led to 'absolute water scarcity' being defined as situations where local water resources are equivalent to less than 1,000 m^3/year/person of water availability.

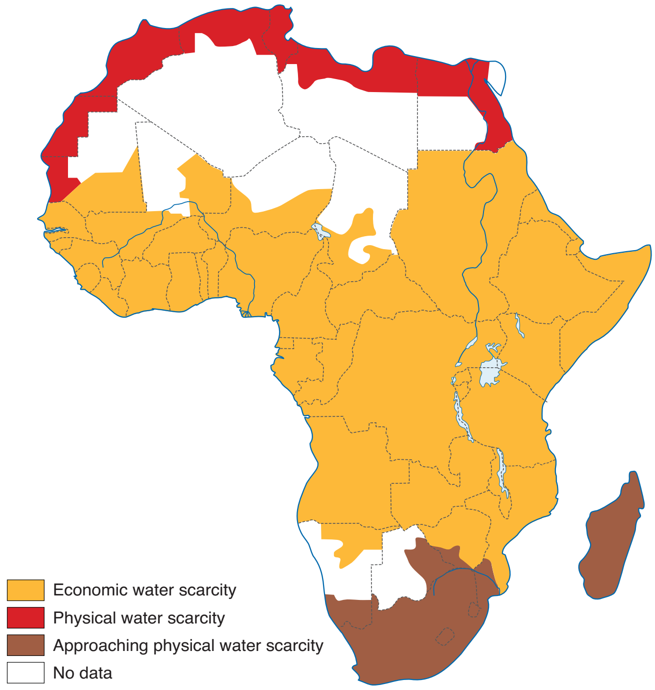
In reality the conceptualization of water scarcity needs to consider :

- the rate of freshwater withdrawals relative to renewable freshwater resources
- availability of natural water storage, especially ground-water, which can completely transform the water-resource situation at times of severe surface-water stress
- the seasonality of most rainfall regimes, which is also not taken into account.

QUEUE FOR DOMESTIC WATER-SUPPLY DURING THE CAPE TOWN WATER CRISIS

This Series is designed both to inform professionals in other sectors of key interactions with groundwater resources and hydrogeological science, and to guide IAH members in their outreach to related sectors.

AFRICA – PHYSICAL AND ECONOMIC WATER SCARCITY AT BASIN LEVEL IN 2007



It is also important to clearly distinguish 'physical water scarcity' from 'economic water scarcity'. Nowhere is this more apparent than across the continent of Africa, where only the northern and southern extremes exhibit physical water scarcity but much of tropical Africa currently suffers economic water scarcity as a result of lack of investment in the development and management of groundwater and surface-water resources.

In summary water scarcity indicators need to define water-resource availability levels below which serious allocation issues and environmental risks arise. These can impact at different levels – individuals, groups, states and countries – and relate to different geographic scales and socio-economic sectors, most notably the human population, environment conservation, food production and industrial activities.

How does the presence of groundwater affect water-security ?

Global warming is likely to increase the frequency of serious droughts in many environments and create increased anthropogenic pressures that impact the water-security landscape, resulting in aggressive political positioning and increased potential for local conflict or even violence.

Globally groundwater is the most abundant source of freshwater resources (representing 97% of non-frozen water), and an important component of the water-cycle that flows below the land surface in aquifers returning to the surface as steady flow to rivers and springs. It can also be accessed by waterwells. Aquifers hold very large volumes of freshwater naturally in storage, and their presence much improves local water-security during multi-annual droughts, for all types of water users with access to waterwells. Global inventories of waterwell abstraction are not up-to-date, but in 2010 groundwater provided 36% of potable water-supply, 42% of irrigation water-use and 24% of industrial water-supply – with larger proportions during extended drought.

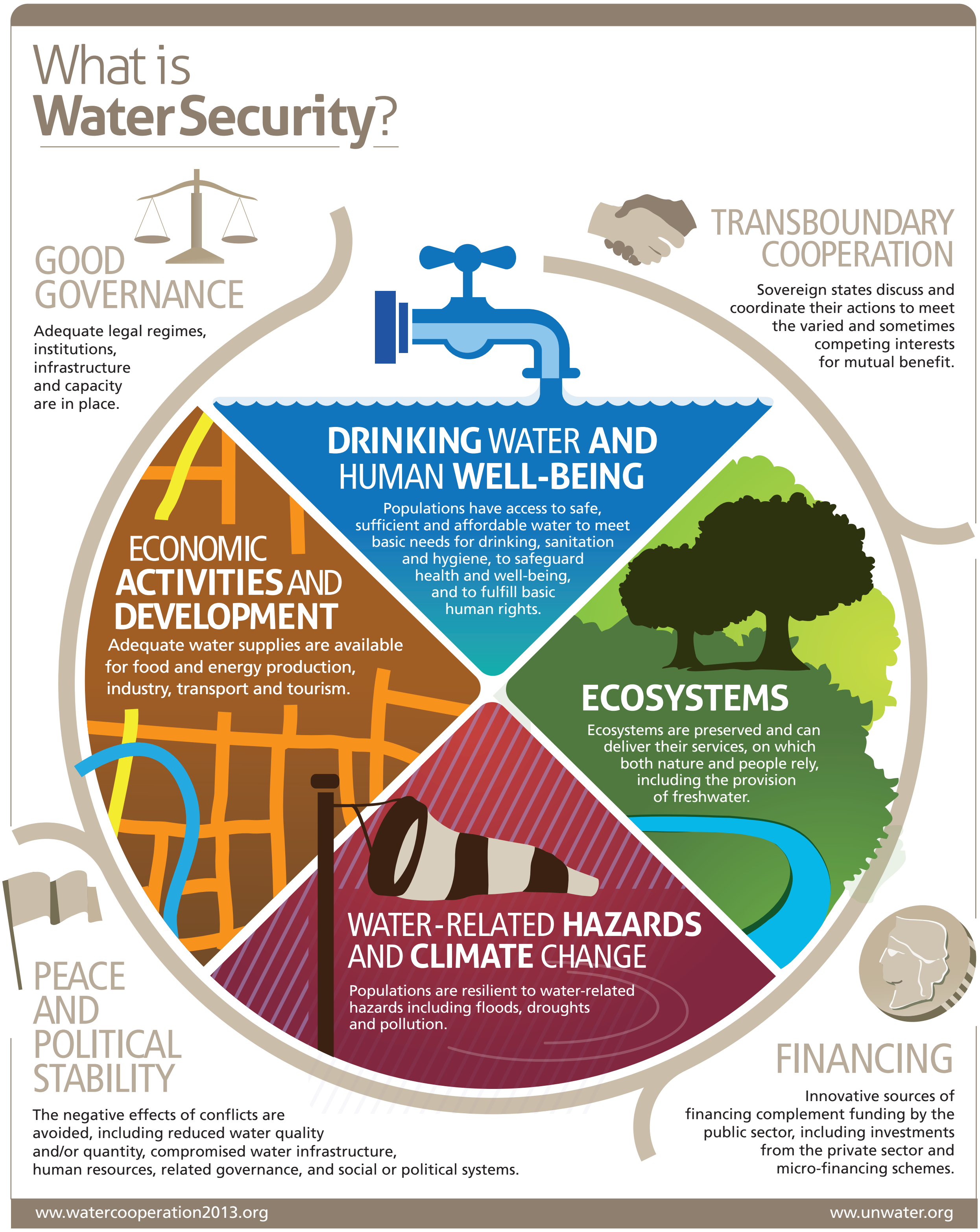
Groundwater systems for the most part exhibit exceptional resilience to drought impacts and be well positioned to enhance water security for a wide range of users. However, to perform this role sustainably they require:

- good hydrogeological understanding based on sufficient sound data to guide groundwater management
- careful administration of resource abstraction, and the already very high level of illegal waterwells in many countries is a serious complication in this regard
- effective protection against pollution, and the widespread occurrence of significant diffuse pollution by agricultural land-use practices and urban in-situ sanitation is a serious concern here.

A further complication is the occurrence and use of non-renewable groundwater resources, which requires explicit recognition and special provisions to govern the time-dependent use of the resource.

The quality of available groundwater can also have a direct effect on human health and thus on human security. Locally groundwater can also contain naturally-occurring elements at levels damaging to human health, and also has experienced pollution by agricultural practices and industrial effluents that render it problematic as a source of potable water-supply.

WATER SECURITY - THE KEY FACETS (from UN–Water 2013)



Can any lessons be learnt from historic groundwater conflicts ?

In recent decades disputes over groundwater resources have not generated any large-scale conflicts, but various local disputes have been further aggravated by attempts to deprive populations of access to drinking water, which is prohibited by international law. Prominent among these were :

- Sudan – during 2003-04 in a period of civil strife there was intentional bombing of water-wells in certain regions to deprive minority groups of access to water-supplies
- Kenya and Ethiopia – during 2004-06 scores of skirmishes were reported around water-wells, with one group trying to deprive another of access to drinking-water supply.

More widely groundwater overexploitation in parts of India, China and the USA has led to major water-table depletion, and the drying up of shallower waterwells, creating conflicts among groundwater users.

How does groundwater enter into international water-security issues ?

There are a very large number of transboundary aquifers (TBAs) around the world under exploitation to provide vital water-supplies. Despite the declaration of UN-SDG 6.5.2 for 2030, on the pressing need for transboundary cooperation on shared water bodies, only a handful of these TBAs have international agreements on groundwater use and data sharing between riparian nations. The majority of TBAs have not been subject to any negotiation about the shared use of their groundwater resources.

Other more complex issues also arise. For example situations where the main recharge zone of a TBA occurs in the territory of the country who is not the major user of its groundwater resources. Some claim that Israel has not protected adequately the recharge area of the Gaza Aquifer (nor shared its hydrogeological data) on which Palestine depends for its drinking-water. Some military advisers and security units around the world have expressed concern that groundwater disputes will potentially cause serious international conflicts in the future.

PROFILE OF THE CAPE TOWN WATER CRISIS

Cape Town has a population of about 3.8 million and a public water-supply demand of about 900 Ml/d. The population was faced by an extreme water crises in 2016-18 with the Cape Town WSD (Water & Sanitation Department) having to impose severe water-supply restrictions despite reducing distribution-system leakage losses to only 14%. The crisis was provoked by the 2015-17 drought, an extended period with total rainfall of less than 250 mm/a (compared to a 'long-term average' of over 600 mm/a). In June 2017, when the actual storage in its largest surface-water reservoirs fell to below 15%, the piped-supply was reduced to 100 lpd/capita, with subsequent reductions to 80 and 50 lpd/capita in September 2017 and February 2018, and a warning of the approach of 'Day Zero' when all household taps would be shut-off and people would have to queue for 25 lpd/capita from 150 collection points (equivalent to a total supply of just over 100 Ml/d). However strong rains occurred in June 2018 and this was averted.

The Western Cape Province public water-supply relies almost exclusively on surface-water reservoirs with a maximum capacity of about 900 Mm^3/a, 70% of which is held in the Theewaterskloof and Voelviel dams. Not pursuing greater water-source diversity was a serious policy error, especially given that Western Cape groundwater systems (the Cape Flats, Table Mountain & Atlantis Aquifers) have proven yield potential having been developed significantly by the private sector for self-supply. Although adequate resource assessment and management are still lacking, they would appear to offer the possibility of providing more than 200 Ml/d as a public water-supply reserve for drought.

How have inadequate groundwater management strategies aggravated urban water-scarcity issues around the world ?

The recent water-supply crises in São Paulo – Brazil (2016-19), Cape Town – South Africa (2016-18) and Chennai – India (2017-19) have highlighted the vulnerability of major cities to surface-water drought and the critical importance of using (and not ignoring) local groundwater resources to provide a more secure element in basic water-supply systems.

The case of São Paulo clearly illustrated the contrasting vulnerability of an urban water-supply from large surface-water reservoirs severely impacted by multi-annual drought with the relative resilience of a very large number of private self-supply waterwells which continued producing from a minor aquifer. The latter enabled the city to survive, despite the fact that many were at best irregular, or at worst illegal.

Is food-security significantly affected by groundwater considerations ?

Groundwater is estimated to provide some 44% of irrigation water-supply globally. Many aquifers in use by irrigation waterwells are being over-exploited, and there is significant risk of waterwell yield reductions or failures which would impact local food production.

This is the case in Peninsular India and North China, both of which have exceptionally large use of groundwater for agricultural irrigation, and widespread aquifer overexploitation and falling water-tables as a result. For the 180,000 km^2 of the North China Plain a 30% reduction in the area planted to irrigated winter wheat (with replacement by a lower-value rainfed crop) will be required for the corresponding aquifers to achieve water-table stability. Plans are underway to make this change primarily through compensation payments to farmers with satellite monitoring of compliance.

More positively, in the Barind Region of Bangladesh farmers are moving from rice to wheat production in response to declining water-table to reduce consumptive groundwater use.

Are any industrial production concerns linked to groundwater-related water-security issues ?

Groundwater is estimated to provide about 10% of industrial water-supply globally, with the proportion being much higher in developing countries where the public water-supply infrastructure is generally less reliable. Many of the aquifers involved are over-exploited and/or polluted causing risks for the security of local employment.

The industrial sector should develop proactive water stewardship programmes as a contribution to groundwater resource management, which would help to ease their integration into local water-user circles.

What is the way forward on minimising the risk of groundwater conflicts being the cause of water-security issues ?

There is a need to much improve the levels of field monitoring and data analysis for potentially-conflicting situations. Such activities are well worth financing to obtain the anticipated benefit of averting water conflicts. The data generated will serve as a basis for parties involved in potential conflicts to reach negotiated rational decisions on sustainable groundwater use.

This philosophy applies as much to local aquifer systems under exploitation for groundwater supplies by a range of local users as it does to large international aquifers (TBAs), which are more likely to bring riparian countries into water-resource conflicts. Good examples of groundwater data management by the local user community can be found in Morocco.

WATER SECURITY & GROUNDWATER

It is important that the groundwater data collected are stored on recognised databases, for future availability to all interested parties. UN-IGRAC can provide valuable advice on the establishment and maintenance of such groundwater databases.

The agreement to share data on the locally-stressed North-Western Sahel & Sahara Aquifer System by Algeria, Tunisia & Libya operated by the Sahara & Sahel Observatory, and that on the less exploited Guarani Aquifer between Brasil, Paraguay, Argentina & Uruguay, are good examples of the way forward for open international exchange on TBAs.

PRIORITY ACTIONS

- **various cities have experienced, or are at risk of experiencing, serious water security problems and urgently need systematic groundwater resource appraisal for drought water-supply strategy planning**
- **many more transboundary aquifers require international agreements on groundwater use and data-sharing to ensure their beneficial and sustainable use by the riparian nations**
- **the agricutural sector is easily the largest consumer and a significant polluter of groundwater resources, and as such, urgently requires engaging in a constructive dialogue about groundwater conservation**
- **potential situations of water security conflict require enhanced field monitoring and data analysis to facilitate negotiated settlements**
- **groundwater data collected in potential water conflict areas needs to be stored on recognised data bases and be accessible to all interested parties**

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