



RIVER-BASIN AGENCIES & GROUNDWATER

KEY MESSAGES

- groundwater bodies are of critical importance to the management of many river-basin systems
- groundwater systems are storage dominated and completely different to those of most surface-water bodies
- river-basin agencies need to be aware of the economic and ecological services being provided by the principal groundwater systems in their operational area, and their relevance to water-supply climate-change adaptation
- the need for groundwater management can be even more pressing when aquifer systems cross international territorial boundaries
- existing river-basin agencies (both national and international), where they exist, will usually be the preferred vehicle to promote key facets of groundwater management and protection

Why should river-basin agencies pay more attention to groundwater ?

The main objective of this overview is to draw the attention of surface-water managers, hydrologists and others to :

- the critical importance of groundwater systems to basin-level management of water resources, both in the case of national and international river systems
- the vital water-supply role played by the large natural storage of groundwater systems, especially in adapting to climate-change impacts on surface-water.

It is very important that surface-water specialists recognise the completely different flow regimes of groundwater systems and do not conceptualize them as 'underground rivers' (details of aquifer types are given later in this overview).

Surface-water bodies tend to be flow-dominated, whilst most aquifers are characterized by large natural groundwater storage and much lower flow rates. This reality has very important practical implications for integrated water resource management, since surface-water resources simply cannot be effectively managed unless the task is performed on an integrated basis with groundwater resources. Conceptual models need to be developed which clearly reveal the relevance of groundwater to the functioning of the river basin.

RIVER-BASIN AGENCY STAFF RAISING AWARENESS OF YOUNGER GENERATION





Groundwater systems are critical to the baseflow of most major rivers, and to the economic and ecological services that these provide. Thus aquifer management is the key to conserving so-called environmental flows. Moreover, many important fresh-water ecosystems are totally dependent upon groundwater discharge, and can suffer serious ecological damage if groundwater flow systems are not adequately conserved in the interest of their protection.

More than 50% of the global population and a large number of socio-economic activities (notably agriculture) are dependent on groundwater, which is widely under increasing pressure from excessive abstraction and polluting discharges to the ground.

River-basin agencies need to pay careful attention both to avoiding excessive groundwater abstraction and to promoting land conservation for groundwater pollution protection, since aquifer discharge is highly relevant to environmental and dry-weather riverflows and to safeguarding environmental services.

Does concern about groundwater systems apply equally to internationally-shared river-basins ?

The need for groundwater management can be even more pressing if aquifer systems cross international boundaries, but until now much greater efforts have been put into managing transboundary surface waters. Today some 468 transboundary aquifer systems have been identified by UN-IGRAC and the UNESCO-ISARM (Internationally-Shared Aquifer Resources Management) Program, many of which are quantitatively and/or qualitatively affected by human activity.

To avoid the irreversible degradation of these systems and prevent potential conflicts between countries it is crucial to establish active dialogue and collaboration under the umbrella of an international river-basin agency. Moreover, the extension of aquifers can sometimes transcend basin-agency boundaries, and this will require groundwater management through polycentric governance arrangements enabling interaction between widely-differing institutions sometimes pertaining to separate ministries.

SUMMARY OF KEY GROUNDWATER RESOURCE MANAGEMENT FUNCTIONS

FUNCTION	MAIN COMPONENTS
Catchment/Aquifer Level Resource Planning and Allocation	<ul style="list-style-type: none"> • establishing sensible boundaries for groundwater management • translating national plans to the appropriate territorial level • providing a unified vision of groundwater and surface water resources
Land Surface Zoning for Groundwater Conservation and/or Protection	<ul style="list-style-type: none"> • making provision for declaration of 'special control areas' (critical in resource terms or especially vulnerable in pollution terms) where exceptional measures to avoid degradation can be implemented
Facilitating Stakeholder Participation and Engagement	<ul style="list-style-type: none"> • active involvement of groundwater users and potential polluters, and other interest groups, will be necessary to promote balanced management on-the-ground with enforceable regulations
Management of Groundwater Use	<ul style="list-style-type: none"> • according to an over-arching allocation plan (including waterwell drilling/construction activity, waterwell registers and abstraction rights/permits/charges (together with sanctions for non-compliance)
Licensing of Wastewater and Waste Discharge to the Ground	<ul style="list-style-type: none"> • subject to conditions that prevent or limit groundwater pollution (with effective sanctions for non-compliance)
Groundwater Monitoring and Information Provision	<ul style="list-style-type: none"> • ensuring appropriate standards for monitoring (aquifer water-levels, groundwater use and quality) with periodic status evaluation • arranging open exchange of data and provision of information



Existing organizations for the management of transboundary surface water are logical vehicles to address the management of transboundary aquifers that concern them, since they generally have the best institutional contacts for this purpose. They need to pay attention both to avoiding excessive groundwater abstraction and to promoting land conservation for groundwater pollution protection, partly in the interests of the users of the aquifers themselves and also because of their relevance to the control of environmental and dry-weather riverflows.

The EU-Water Framework Directive (WFD) of 2000 requires 'good status' in all groundwater bodies to be achieved by 2027 at the latest, through implementing measures to prevent deterioration. In 2006, the EU Groundwater Directive entered into force, setting groundwater quality standards and introducing measures to prevent or limit inputs of pollutants into groundwater. Even though not all the countries

co-operating under the Danube River Protection Convention are EU-Member States, they decided to make efforts to implement the WFD throughout the whole basin, and groundwater management is comprehensively addressed in all Danube River Basin Management Plans issued 6-yearly since 2009.

In 1973 the USA and Mexico adopted an interim proposal for the regulation of groundwater withdrawals on both sides of the Arizona-Sonora border along the Colorado River system. Since then no further binational agreements have been signed, despite continued pressure on groundwater use.

The Guarani aquifer is a vast transboundary system (shared by Brasil, Paraguay, Uruguay & Argentina) which has been subjected to significant international study, from which it has been concluded that local management schemes should be implemented that are tailored to local conditions.



What is the effect on attitudes of river-basin agency scale and mandate ?

Existing river-basin agencies vary widely in geographic scale and operational mandate from, for example, the Niger Basin Authority with a catchment area of about 2,000,000 km² across 9 countries of 100 million total population, to the Kenya Water Resources Management Authority-Tana Basin Office with a catchment area of about 100,000 km² and population of less than 5 million.

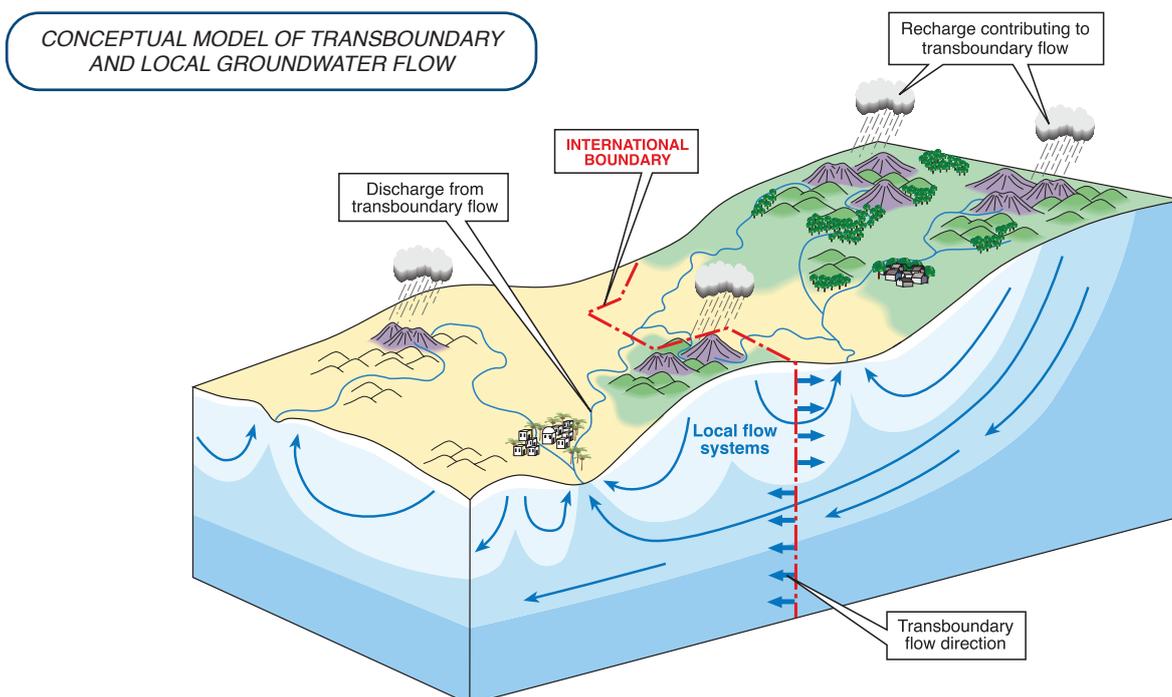
National level river-basin agencies usually have staff working locally, and performing or coordinating most of the groundwater management and protection responsibilities of the national ministry, whereas large transboundary river-basin agencies are normally mandated by participating national governments to perform specific coordinating and advisory functions at transboundary riverflow level. But without some authority over local aquifer systems they may not be able to protect baseflow in these rivers.

Nevertheless, it is important for large transnational basin agencies to have a clear overview of how such groundwater responsibilities are being

managed nationally and locally, and to encourage the deployment of effective legal provisions, economic tools and technical approaches. Moreover, groundwater institutions with effective stakeholder engagement are essential at all levels for adequate service delivery, but high-level coordination will also be needed in most cases.

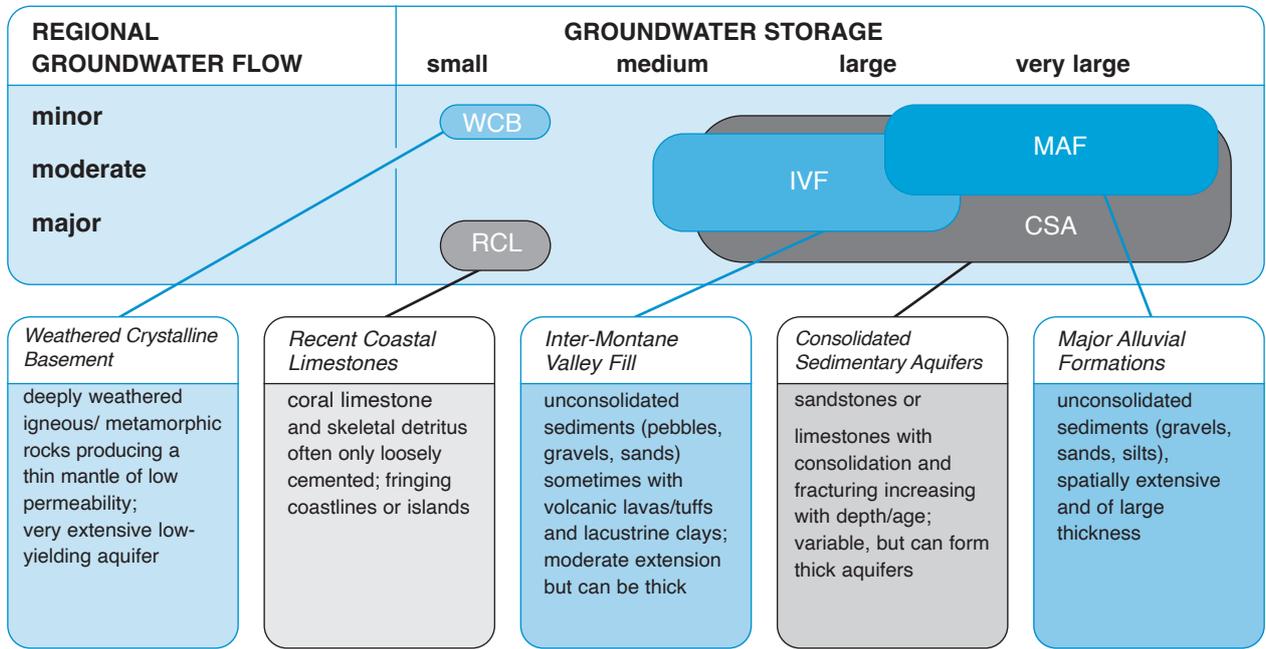
What approaches should river-basin agencies utilize for taking stock of groundwater ?

River-basin agencies need to be fully aware of the economic and ecological services being provided by the principal groundwater systems in their respective areas of operation, especially their control on river baseflow and functioning of freshwater ecosystems. They also need to characterize their aquifer systems by the type of groundwater storage they possess, distinguishing largely-unconsolidated formations with large volumes of intergranular storage, from low-porosity formations whose groundwater storage is in fractures. It is only in the specific case of karstic limestones that such fractures are enlarged by solution and the concept of 'underground rivers' has some





PROPERTIES OF WIDELY-OCCURRING AQUIFER TYPES



validity, but even in this case the remaining part of the rock-mass also contains significant dispersed groundwater.

Another important basic consideration is the spatial configuration of aquifers in the basin land-mass and their relation with surface water and the sea-coast, which can range from :

- extensive shallow aquifer systems underlying valleys and coastlines, which require a fully integrated approach to management
- aquifer systems crossing surface-water boundaries, which need coordinated monitoring and management between different basin agencies
- localized aquifers underlying only part of the basin which require an independent local groundwater management plan integrated within the river basin plan
- extensive deep aquifers in arid regions where the aquifer (and not the river basin) is the rational unit for water-resource management
- shallow patchy minor aquifers for which groundwater development impacts will be very localized compared to river basin dynamics.

If the groundwater system and/or the landscape incorporates significant areas with elevated salinity this will be a further basic consideration that will need to be incorporated in the overall plan.

River-basin agencies should recognise that groundwater resource assessments need to comprise three different components to inform management planning :

- **Technical** : reaching consensus on the compatibility of differing methodological and analytical approaches to data collection
- **Administrative** : assessing the differences between local-level communication, financing and decision-making
- **Legislative** : finding ways to coordinate the individual laws, rules and regulations by which each participating local agency is bound.

Groundwater level and quality monitoring, together with aquifer modelling, are essential assessment tools to establish groundwater behaviour and to support management decisions by river basin agencies.



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(in association with International Network of Basin Organizations)

Groundwater is essentially a 'local resource' when it comes to water use and protection, and to be effective its day-to-day management has to take place close to users and potential polluters. But at the same time management actions have to be balanced within a broader perspective. Thus local action on managing groundwater will always require top-down facilitation, and river-basin agencies need to play the role of promoting and supporting action in this regard.

FURTHER READING

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PRIORITY ACTIONS

- **conceptual models are required to reveal the relevance of groundwater bodies in the conservation of river baseflow and aquatic ecosystems**
- **river-basin agencies need to establish clearly the spatial configuration of groundwater bodies (aquifers) in the land-mass of their basins, and their relation with surface water and sea-water**
- **large transnational river-basin agencies need to develop a clear overview of how groundwater is being managed nationally and locally within their catchment area**
- **river-basin agencies need to promote and harmonise groundwater level and quality monitoring for the important aquifer systems in their operational area**

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