



International Association for Water Law
Asociación Internacional de Derecho de Aguas
ASSOCIATION INTERNATIONALE DU DROIT DES EAUX



Module E – Protection of Groundwater Systems

Class 9 – *Regulation of the Environment-Support Function of Groundwater Systems*

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Presented at the XVI World Water Congress

29 May 2017

AIDA Special Session

Presentation of the online Training Course on “The Greening of Water Law: Implementing environment-friendly principles in contemporary water treaties and laws”

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1. The Importance of Groundwater

Globally groundwater supply comprises:

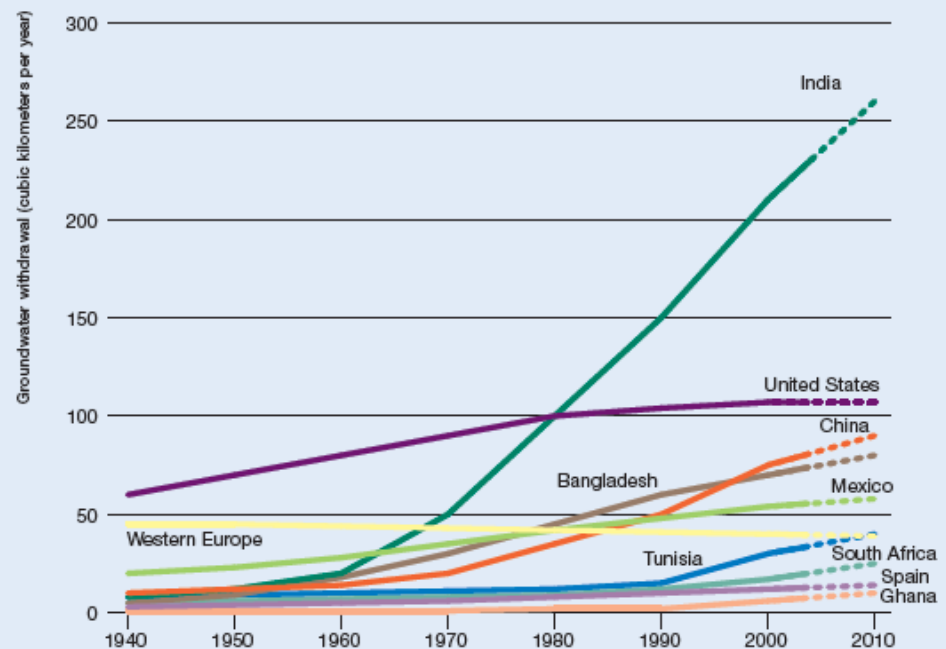
- 30% of all fresh water resources
- 98% of liquid fresh water resources

Global groundwater use

- Provides ~1/2 of humanity with freshwater for everyday uses such as drinking, cooking and hygiene
 - 60% to 99% of drinking water for Europeans
 - 50% to 97% of drinking water for Americans
- 40% of water used by industry
- 20% of water used in irrigated agriculture

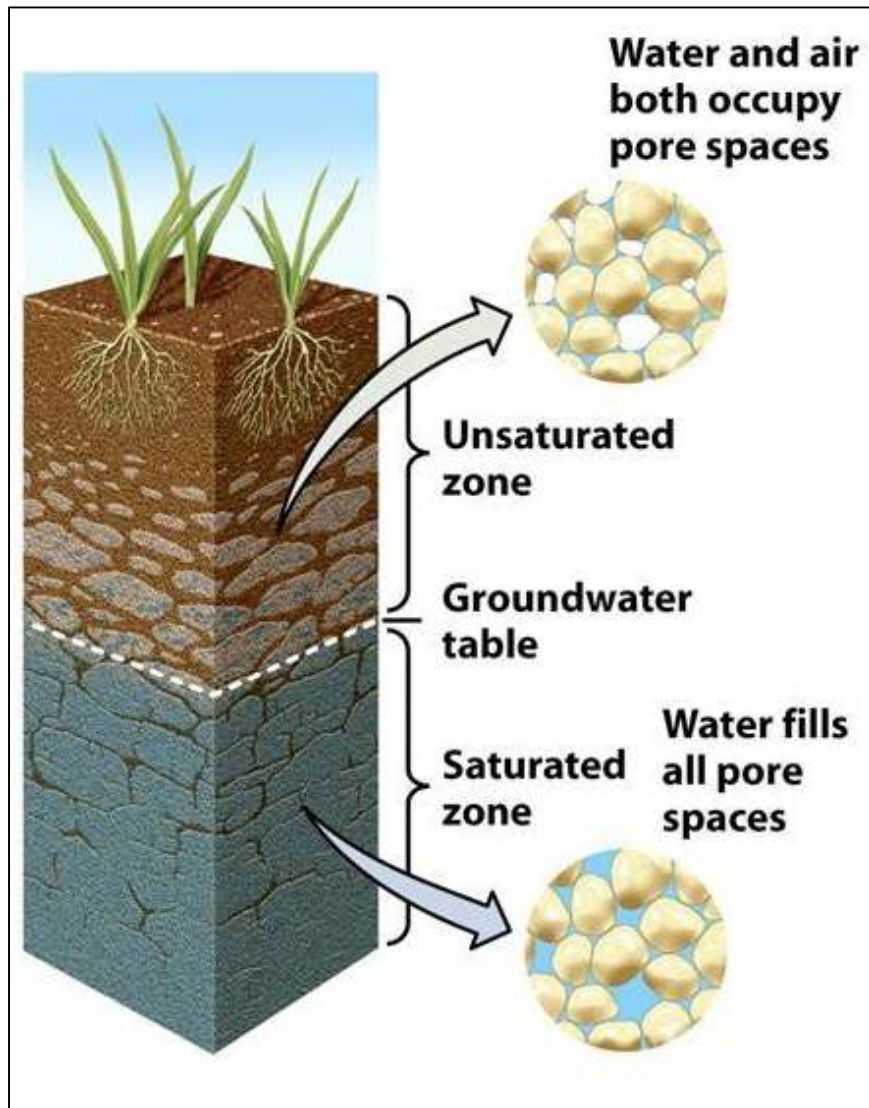
*The most extracted natural resource in the world
(982 km³ in 2015)*

figure 10.1 | Development in groundwater withdrawal in selected countries



Source: Shah 2005.

2. How Groundwater Functions



What is groundwater?

Water occupying voids, cracks and other spaces between particles of clay, silt, sand, gravel or rock within the saturated zone of a geologic formation

Where does groundwater originate?

Precipitation and surface water bodies that infiltrate into the subsurface

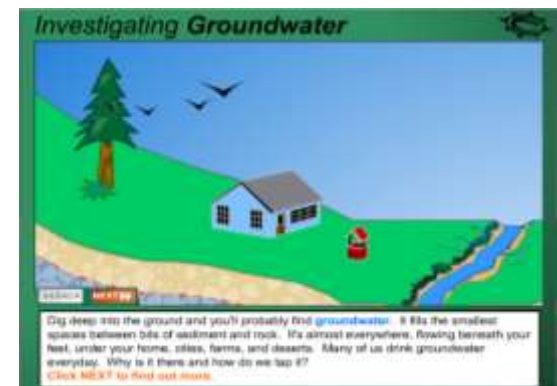
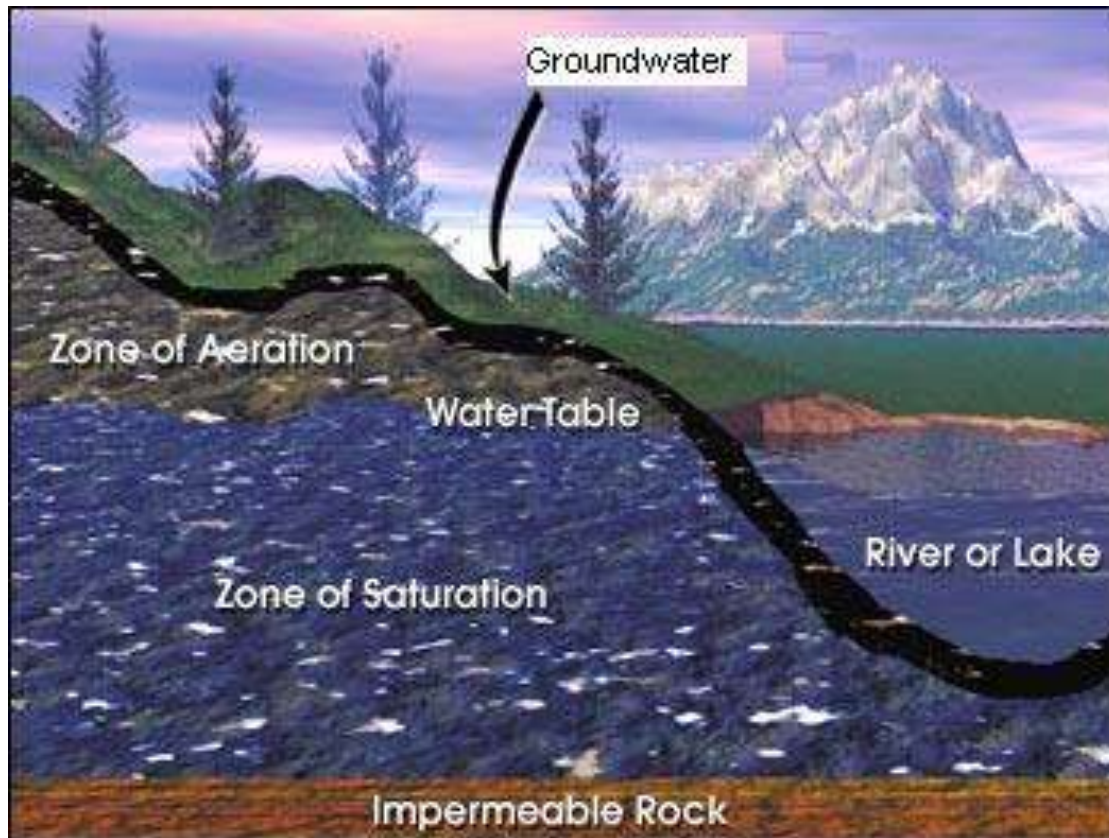
https://www.youtube.com/watch?v=0NWAerr_xEE



2. How Groundwater Functions

What is an aquifer?

- *A permeable geologic formation (such as sand or gravel) that has sufficient water storage and transmission capacity to provide a useful water supply via wells and springs*
- *The geologic “container” that holds and transmits groundwater*



<http://earthguide.ucsd.edu/earthguide/diagrams/groundwater/>

2. How Groundwater Functions



What is a recharge zone?

Area in which precipitation or surface water enters an aquifer by percolating through relatively porous, unconsolidated, or fractured soils to reach the saturated zone of an aquifer

What is a discharge zone?

Area in which an aquifer naturally discharges water from its saturated zone onto the Earth's surface



3. The Functions of Groundwater



Human Sustenance and Hygiene



Environmental Sustainability



Agricultural Production

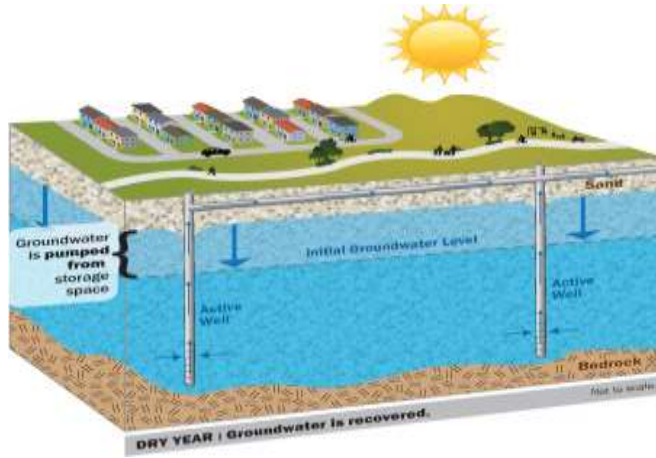


Energy Production (e.g., geothermal, fracking, cooling, etc.)



Economic Development

4. The Functions of Aquifers



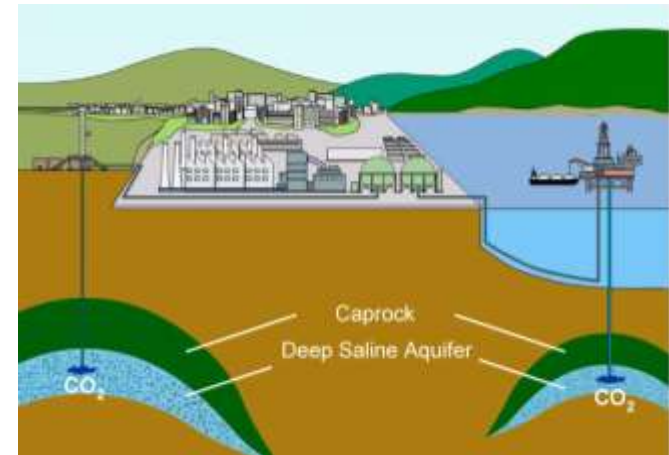
Storage



Natural Filtration



Ecosystems and Habitats



Carbon Sequestration

5.a. Domestic Groundwater: Challenges



Groundwater overdraft / mining



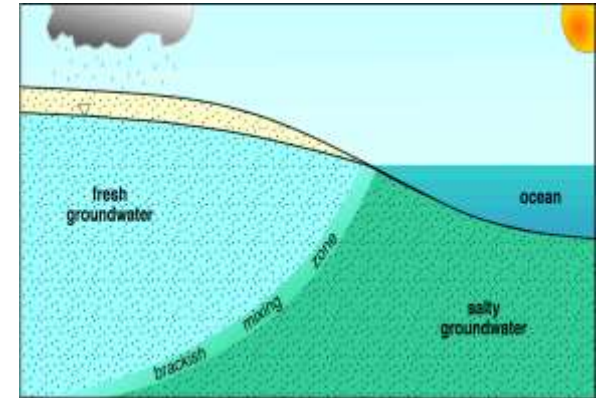
Subsidence



Mining of aquifer matrix



Groundwater Pollution



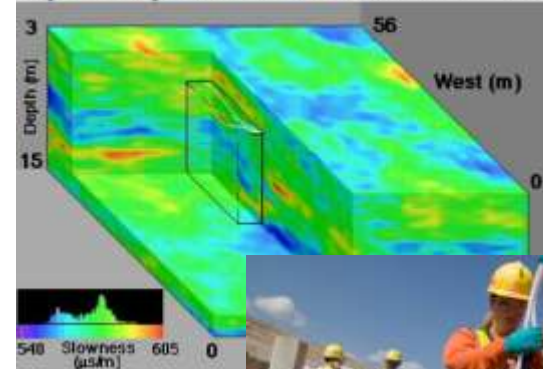
Seawater Intrusion

5.b. Domestic Groundwater: Legal Mechanisms

Protecting Groundwater Supplies

- Regulations requiring the quantification of groundwater supplies, including natural recharge and discharge, and extractions for human and economic purposes*
- Regulations managing and restricting extraction*
- Regulation requiring metering of wells*
- Restrictions on activities that use or affect groundwater resources*

Aquifer Properties from Seismic & Tracer Data



5.b. Domestic Groundwater: Legal Mechanisms



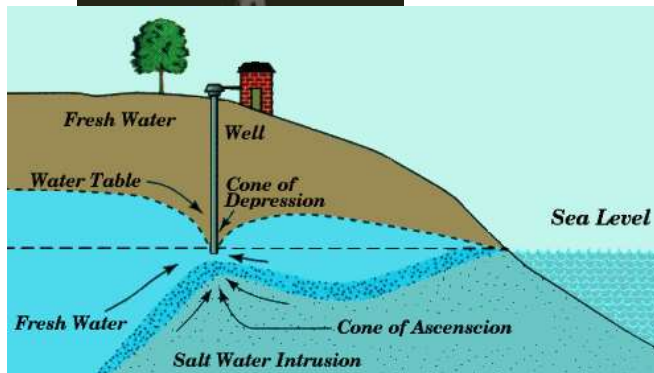
Protecting Against Groundwater Contamination

- *Well Bores*



- *Recharge Zone*

- *Injection Activities*



- *Salt Water Intrusion*



5.b. Domestic Groundwater: Legal Mechanisms

Protecting Aquifer Integrity and Aquifer Functions

- *Restrictions on activities in the recharge and discharge zones that would alter the aquifer's natural functioning*
- *Restrictions on the removal of any portion of an aquifer formation that would alter its natural functioning*



5.b. Domestic Groundwater: Legal Mechanisms

Example: *Namibia Water Resources Management Act No. 11 of Dec. 2013*

- *Para. 63 – Wastage of groundwater: A person may not cause or allow any groundwater to run to waste from a borehole, well, shaft, mine or other excavation ...*

- *Para. 66 – Protection of aquifers*
 - (1) For the purpose of promoting the sustainable use and protection of aquifers, the Minister may -*
 - (a) cause the groundwater potential of any aquifer to be investigated;*
 - (b) by notice published in a manner appropriate for the area, impose restrictions or limitations to ensure that the total abstraction of water permitted from an aquifer does not exceed the groundwater potential;*
 - (c) determine and define aquifer boundaries based on available hydrogeological information;*
 - (d) prescribe, or impose as licence conditions, special requirements and restrictions with respect to the drilling and use of artesian and subartesian boreholes for the purpose of preventing –*
 - (i) the wastage of water;*
 - (ii) the leakage of water from confined artesian aquifers to other aquifers;*
 - (iii) the contamination of the aquifer; or*
 - (iv) the reduction or loss of artesian pressure;*

 - * * **
 - (g) prescribe, or impose as licence conditions, special requirements for enhancement of natural recharge to lower the risk of aquifer pollution ...*

5.b. Domestic Groundwater: Legal Mechanisms

Example: *Namibia Water Resources Management Act No. 11 of Dec. 2013*

- *Para. 55 – Drilling or construction of borehole or well:*

(5) In considering an application for a borehole licence the Minister must have regard to -

(a) any recommendation of the relevant basin management committee made in relation to the application;

(b) the hydro geological conditions and expected groundwater potential of the area where drilling is to be undertaken, unless the purpose of the drilling work is to establish those conditions;

(c) whether the proposed use of water to be abstracted conforms to efficient water management practices; and

(d) the effect that the abstraction of water from the borehole or well to which the application relates is likely to have on -

(i) any customary rights and practices related to the water resource concerned or the needs of any community dependent on that water resource; or

(ii) any aquifer or the flow of groundwater.

5.b. Domestic Groundwater: Legal Mechanisms

Example: *Australia New South Wales Water Management Act No. 92 of Dec. 2000*

- *Para. 5(8) – In relation to aquifer interference activities:*
 - (a) the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and*
 - (b) the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.*
- *Para. 33 – Additional provisions*

The controlled activity and aquifer interference activity provisions of a management plan for a water management area may also deal with the following matters:

 - (a) the undertaking of work for the purpose of restoring or rehabilitating a water source or its dependent ecosystems,*
 - (b) protecting, restoring or rehabilitating the habitats or pathways of animals and plants,*
- *Para. 345 – Harm to aquifers and waterfront land*
 - (1) A person who harms an aquifer or waterfront land, and does so intentionally or negligently, is guilty of an offence: Tier 1 penalty.*
 - (2) A person who harms an aquifer or waterfront land is guilty of an offence: Tier 2 penalty.*
 - (4) In this section, "harm" , in relation to an aquifer or waterfront land, means any act or omission that adversely affects, the capacity of the aquifer or waterfront land to hold or carry water.*

5.b. Domestic Groundwater: Legal Mechanisms

Example: *Edwards Aquifer Authority Act of May 1993 (as amended)*

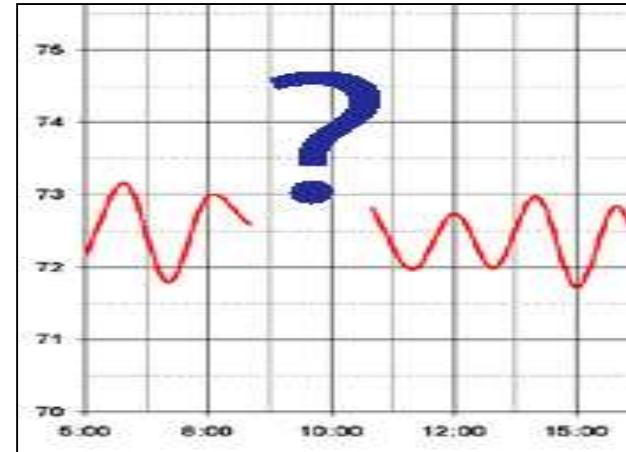
- *Sec. 1.14 – Withdrawals*

- (a) Authorizations to withdraw water from the aquifer and all authorizations and rights to make a withdrawal under this Act shall be limited in accordance with this section to:
 - (1) protect the water quality of the aquifer;*
 - (2) protect the water quality of the surface streams to which the aquifer provides springflow;*
 - (3) achieve water conservation;*
 - (4) maximize the beneficial use of water available for withdrawal from the aquifer;*
 - (5) recognize the extent of the hydro-geologic connection and interaction between surface water and groundwater;*
 - (6) protect aquatic and wildlife habitat;*
 - (7) protect species that are designated as threatened or endangered under applicable federal or state law; and*
 - (8) provide for instream uses, bays, and estuaries.**
- (c) ... the amount of permitted withdrawals from the aquifer may not exceed or be less than 572,000 acre-feet of water for each calendar year ...*
- (h) To accomplish the purposes of this article, the authority, through a program, shall implement and enforce water management practices, procedures, and methods to ensure that ... the continuous minimum springflows of the Comal Springs and the San Marcos Springs are maintained to protect endangered and threatened species to the extent required by federal law ...*

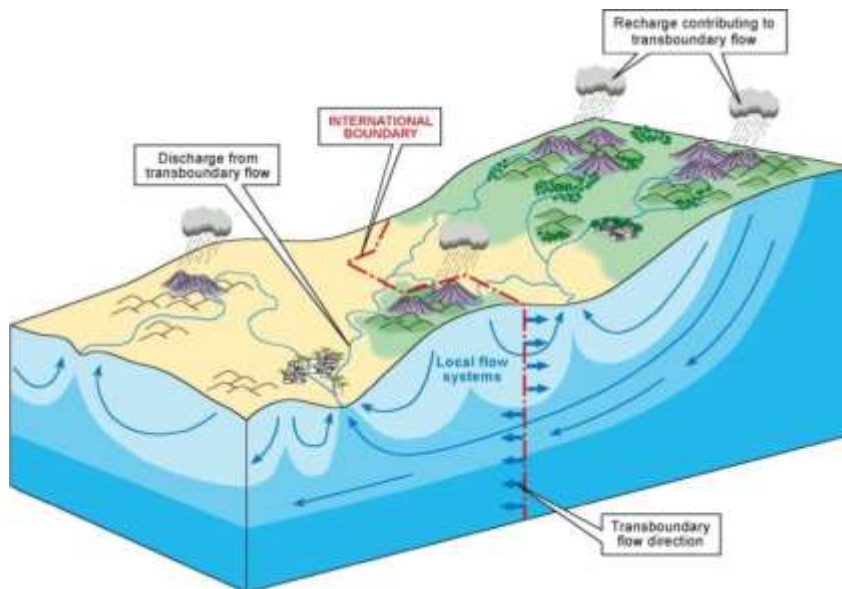
6.a. International Groundwater: Challenges



Locating transboundary aquifers



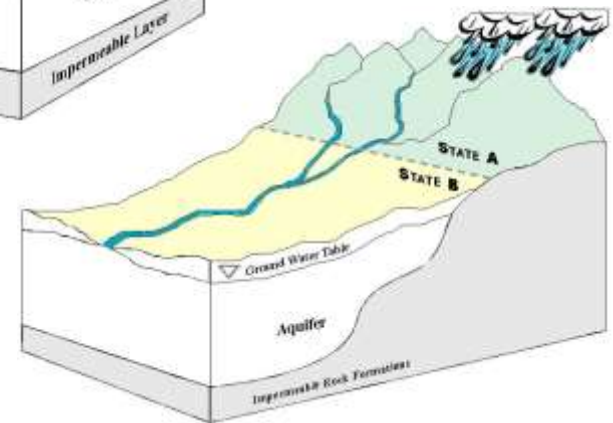
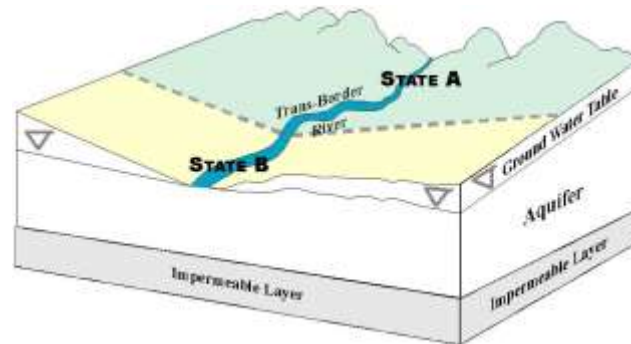
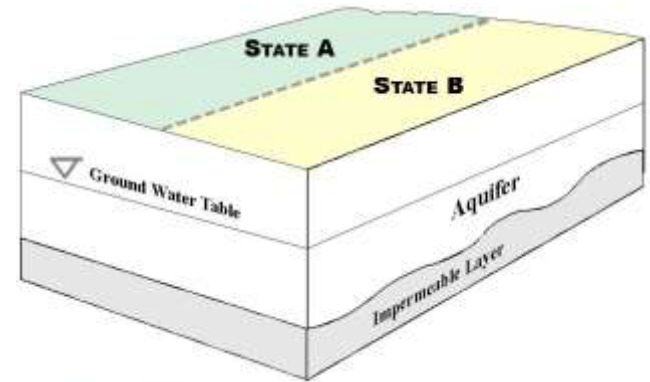
Data gaps and cross-border data incongruities



Sovereignty and relevance of existing international water law

6.a. International Groundwater: Challenges

- *Different aquifer scenarios with disparate transboundary implications*
- *Limited experience with transboundary aquifer cooperation*



Number of Transboundary Water Agreements

TB River/Lake Basin Agreements	+3600 treaties (since 805 AD)
TB Aquifer Agreements	5 treaties (4 in force)

6.b. International Groundwater: Legal Mechanisms

Formal International Agreements Over Transboundary Aquifers

- *2015 Agreement between the Government of the Hashemite Kingdom of Jordan and the Government of the Kingdom of Saudi Arabia for the Management and Utilization of the Ground Waters in the Al-Sag/Al-Disi Layer*
- *1978/2008 Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer*
- *2002 Establishment of a Consultation Mechanism for the Northwestern Sahara Aquifer System*
- *Combined agreements*
 - *2000 Programme for the Development of a Regional Strategy for the Utilisation of the Nubian Sandstone Aquifer System*
 - *1992 Constitution of the Joint Authority for the Study and Development of the Nubian Sandstone Aquifer Waters*
- *2009 Agreement on the Guarani Aquifer (not in force)*

Non-binding Arrangements Over Transboundary Aquifers

- *2014 Memorandum of Understanding for the Establishment of a Consultation Mechanism for the Integrated Management of the Water Resources of the Iullemeden, Taoudeni/Tanezrouft Aquifer System*
- *1999 Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas*
- *1996 Memorandum of Agreement Related to Referral of Water Right Applications between the State of Washington as represented by the Department of Ecology and the Province of British Columbia as represented by the Minister of Environment, Lands and Parks*

6.b. International Groundwater: Legal Mechanisms

Draft Articles on the Law of Transboundary Aquifers

- *Prepared by the UN International Law Commission*
- *Commended articles to UN Member States as “guidance for bilateral or regional agreements and arrangements for the proper management of transboundary aquifers”*
- *19 draft articles*

Model Provisions on Transboundary Groundwaters

- *Prepared under the auspices of the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes*
- *Provide interpretative guidelines for and facilitate the implementation of the UNECE Water Convention with regard to groundwater bodies*
- *9 model provisions*



6.b. International Groundwater: Legal Mechanisms

Procedural Law Trends in the International Law of Transboundary Aquifers

- ***Regular exchange of data and information***

“aquifer States shall, on a regular basis, exchange readily available data and information on the condition of their transboundary aquifers or aquifer systems, in particular of a geological, hydrogeological, hydrological, meteorological and ecological nature and related to the hydrochemistry of the aquifers or aquifer systems, as well as related forecasts” (UN Draft Articles – Art. 8)



- ***Monitoring***

“Aquifer States shall monitor their transboundary aquifers or aquifer systems” and “should include parameters on the condition of the aquifer or aquifer system as listed in article 8, paragraph 1, and also on the utilization of the aquifers or aquifer systems” (UN Draft Articles – Art. 13)

6.b. International Groundwater: Legal Mechanisms

Procedural Law Trends in the International Law of Transboundary Aquifers

- ***Prior notification of planned measures***

“Before a State implements or permits the implementation of planned activities which may affect a transboundary aquifer or aquifer system and thereby may have a significant adverse effect upon another State, it shall provide that State with timely notification thereof ... accompanied by available technical data and information, including any environmental impact assessment” (UN Draft Articles – Art. 15)



- ***Creation of an institutional mechanism***

- *To facilitate and/or implement the arrangement*
- *To carry out tasks authorized under the arrangement*
- *“A joint management mechanism shall be established, wherever appropriate” (UN Draft Articles – Art. 14)*

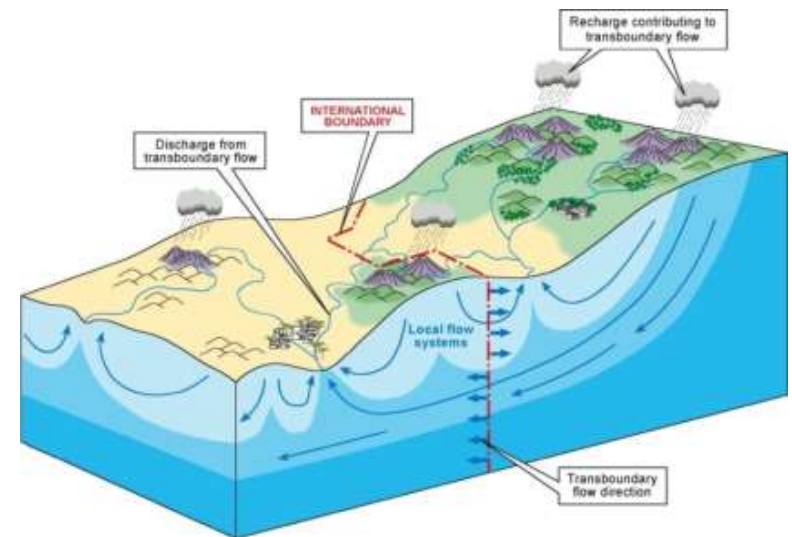
6.b. International Groundwater: Legal Mechanisms

Possible International Legal Norms for Transboundary Aquifers (substantive)

- *Prohibition on the use of transboundary waters in manner that would result in “significant harm” to territory of another*
- *Obligation to utilize transboundary waters in an equitable and reasonable manner*

Gaps in International Law

- *Protections for:*
 - *functioning of a transboundary aquifer*
 - *recharge and discharge zones*
 - *transboundary aquifer-dependent ecosystems*
- *Relevance of international water law principles*
- *Transboundary aquifer pollution*
- *Cross-border public participation*
- *Harmonization of metadata and methodologies*
- *Exploitation of non-recharging transboundary aquifers*



7. Conclusion

- *The importance of groundwater resources for people and the environment*
- *The proper functioning of groundwater resources and aquifers are critical to ensuring adequate clean water for people and the environment*
- *Protecting groundwater and aquifers and their functioning requires efforts focusing on*
 - *Water quantity and quality*
 - *Use of the aquifer as well as land use*
- *Challenges facing domestic and international groundwater resources greatly overlap. But the international dimension adds additional distinct issues.*
- *International law for transboundary aquifers is in a nascent stage of development. But trends can be identified, and knowledge and experiences from the domestic context are relevant.*



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