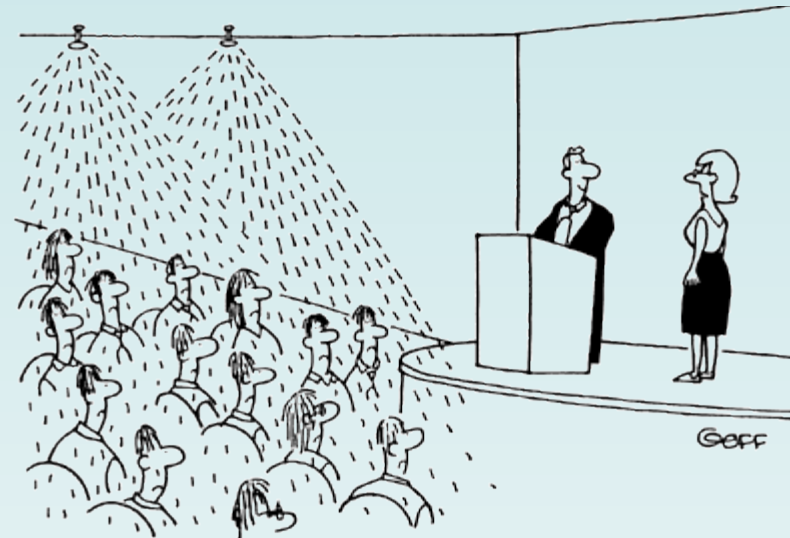


Towards a Methodology for Assessment of Internationally Shared Aquifers

Content of the presentation

- Introduction to IGRAC (an UNESCO/WMO Groundwater Centre)
- Introduction to ISARM (an UNESCO led programme)
- Announcement of DIKTAS project
- A TBA Assessment Methodology
- Concluding notes



"You're not allowed to use the sprinkler system to keep your audience awake."

What is IGRAC?

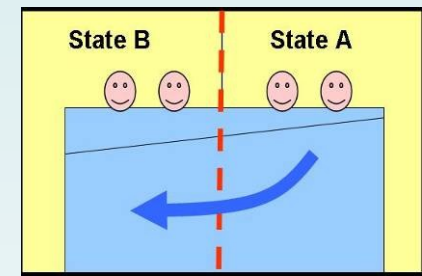
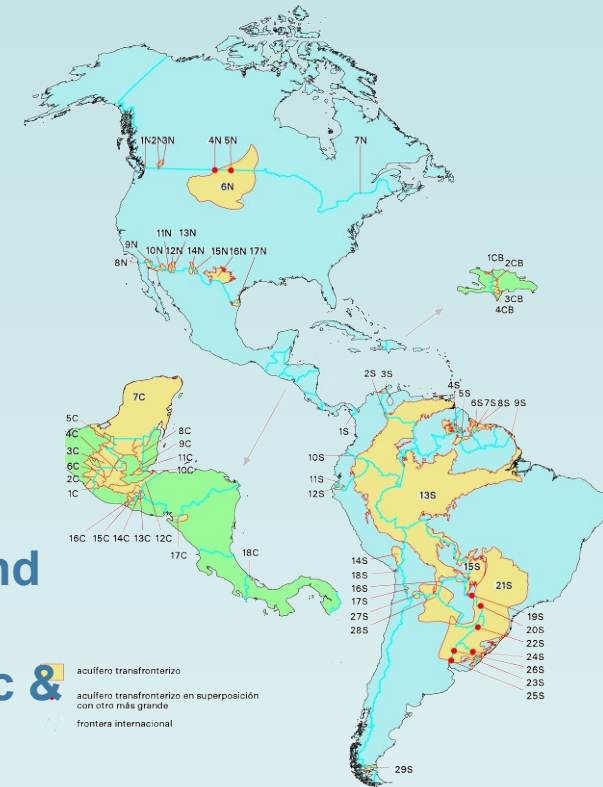
- A non-profit centre that facilitates and promotes global sharing of information and knowledge required for sustainable groundwater resources development and management.
- An initiative of UNESCO and WMO from 1999,
- Launched at WWF3 in Kyoto in Spring 2003,
- Receives financial support from the government of The Netherlands
- Hosted by the DELTARES in Utrecht, The Netherlands.





TBA Activities at IGRAC

- **IGRAC-ISARM activities**
 - **ISARM Core Group participation**
 - **ISARM Portal development & maintenance** (www.isarm.net)
 - **UN ILC assistance in development of an International Legal Agreement on groundwater**
 - **ISARM transboundary aquifers Course Material**
 - **GEF IW-LEARN (also IW Science, TWAP and DIKTAS)**
 - **Comprehensive approach (socio-economic & environmental aspects)**
 - **ISARM Regional Activities (cooperation with OAS, SADC, INWEB, UNECE, OOS, GWP-MED, GEF, UNEP, UNDP..).**



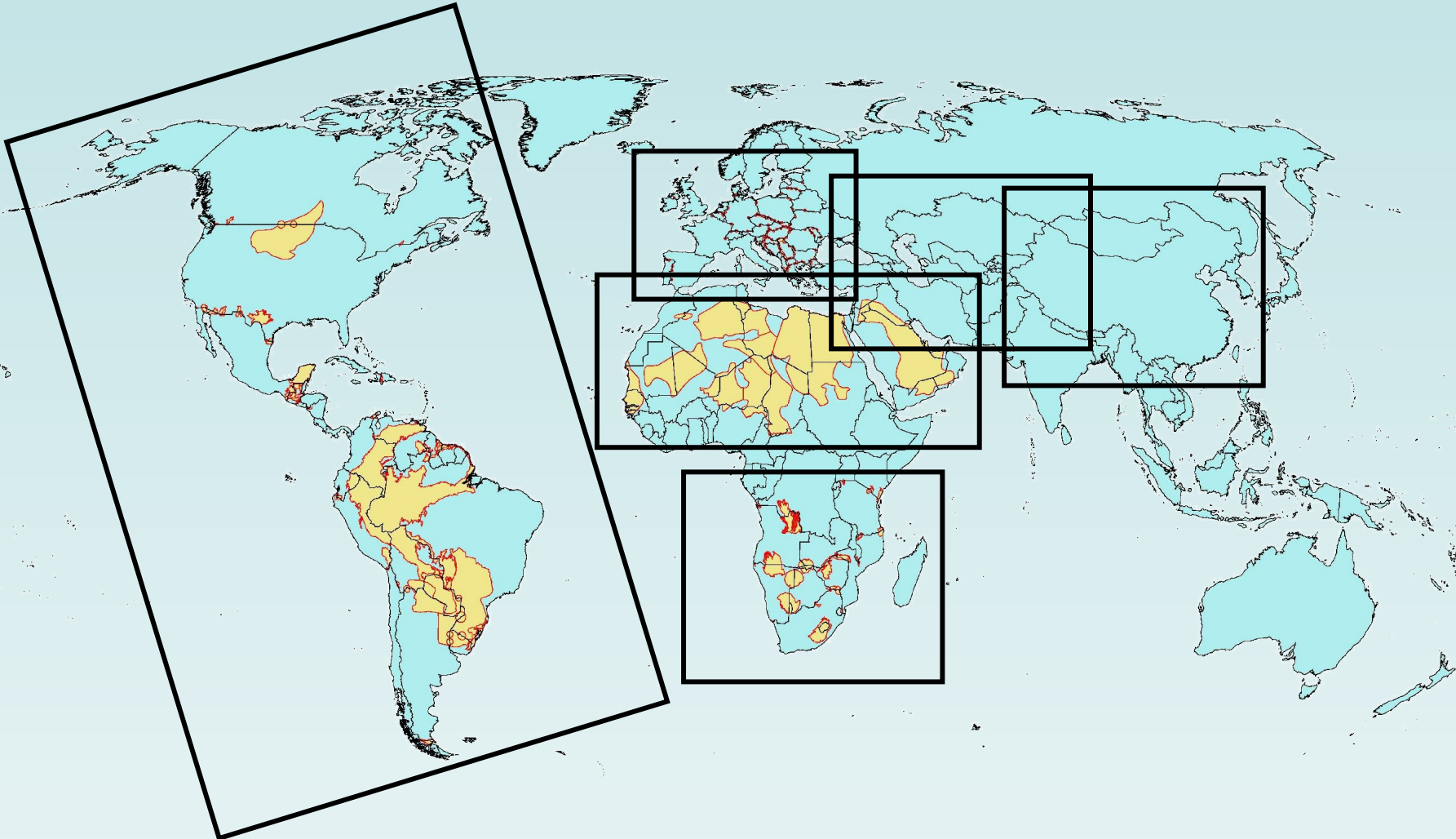
ISARM Programme

- The worldwide **ISARM** (Internationally Shared Aquifer Resources Management) Initiative is an **UNESCO** led multi-agency effort aimed at improving the understanding of hydrogeological, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers.



- Since its start in 2002, ISARM has launched a number of regional initiatives designed to assess transboundary aquifer systems and to encourage riparian states to work cooperatively toward mutually beneficial and sustainable aquifer development.

Global Overview of ISARM activities




Hydrogeological assessment of transboundary aquifers


Snapshot of regional ISARM activities

- 
- A world map with several white rectangular boxes highlighting specific regions: Americas, SADC, Northern Africa, South-East Europe, Caucasus and Central Asia, and Eastern Asia. The map is light blue and white, with the highlighted regions in white.
- **Americas:** Atlas of TBA in press, meeting in September 2007
 - **SADC:** Meetings in Pretoria, March 2007 and Windhoek in Namibia, July 2007
 - **Northern Africa:** Setting up Tripoli TBA regional centre
 - **South-East Europe:** Workshop in Thessaloniki, April 2007
 - **Caucasus and Central Asia:** Workshop in Almaty June 2007
 - **Eastern Asia:** First assessment completed. The second one in preparation.

ISARM Portal



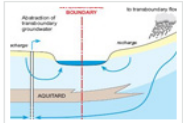
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ISARM - Internationally Shared Aquifer Resources Management

The worldwide ISARM (Internationally Shared Aquifer Resources Management) Initiative is an UNESCO and IAH led multi-agency effort aimed at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers.



The issue of shared international waters is as old as the national borders that make those waters international. During the last century, a significant progress has been made in regulation of joint management of surface watercourses; many international river-, lake- or basin commissions have been set up and the legal treaties signed. Although some of these activities address "a groundwater component" as well, major comparable efforts related to the invisible groundwater have started just a several years ago with the ISARM Programme.

Since its start in 2002, ISARM has launched a number of global and regional initiatives. These are designed to delineate and analyse transboundary aquifer systems and to encourage riparian states to work cooperatively toward mutually beneficial and sustainable aquifer development.

News & Events

September 9, 2008


- International Symposium on Transboundary Waters

January 4, 2008

- Roundtable on management of shared groundwater in South Eastern Europe in Slovenia

[more news »](#)


Partners



IAH

Transboundary aquifer systems of Americas


The UNESCO-IHP/OAS/ISARM Americas Programme is a regional initiative launched in 2002 at Mar del Plata, Argentina, and results from the joint...



[read more »](#)

Managing Shared Aquifer Resources in Africa

3rd International Conference co-organized by The General Water Authority Libyan Arab Jamahiriya UNESCO-IHP and Sahel and Sahara Observatory...



[read more »](#)

INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT

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Regional ISARM activities



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ISARM Africa

ISARM South-East Europe

ISARM Asia

Programa UNESCO/OAS ISARM Américas

[English](#)

[ATs en America](#)

Generalidades

El programa UNESCO/OEA ISARM Américas es una iniciativa regional lanzada en 2002, en el Congreso de IAH-ALHSUD en Mar del Plata, Argentina. Resultó de los esfuerzos conjuntos de PHI-UNESCO y la OEA para implementar el Programa ISARM en el hemisferio occidental.

El programa abarca tres actividades principales de carácter regional, los cuales corresponden a tres fases:

- El inventario exhaustivo de los acuíferos transfronterizos de las Américas, incluyendo la recopilación de datos relativos a sus características hidrogeológicas y la utilización actual de sus aguas subterráneas (fase I).
- El inventario de los marcos jurídicos e institucionales en los países de la región, en el contexto de los acuíferos transfronterizos (fase II).
- Inventario y análisis de los aspectos socioeconómicos de los acuíferos transfronterizos de la región y de su gestión transfronteriza (fase III).

Además, incluye algunos casos de estudio de acuíferos transfronterizos seleccionados de los en la región.

El Programa es coordinado por un grupo de expertos de la OEA y UNESCO-PHI y a nivel nacional es implementado por representantes nacionales designados por los Comités Nacionales del PHI.

INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT

Regional ISARM activities



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INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT

- ▶ ISARM Americas
- ▶ ISARM Africa
 - + ISARM in Southern Africa
 - + Tripoli Workshop 2002
 - + Tripoli Conference 2008
- ▶ ISARM South-East Europe
- ▶ ISARM Asia

Tripoli Conference 2008

On May 25th-27th, the 3rd International Conference on Shared Aquifer Resources in Africa was held in Tripoli, Libya. The conference was organized by UNESCO-IHP, the General Water Authority (GWA) of the Libyan Arab Jamahiriya and the Observatoire du Sahara et du Sahel (OSS). The conference was hosted by the GWA.



Objectives and scope

The conference provided valuable input to the 7th phase of the UNESCO-IHP program and contributed to the current debate on transboundary aquifer management. The outcomes of the conference provided beneficial information for some of the related activities to be organized by international organization the next few years.

Obviously, the conference provided the opportunity for collective learning (150 participants from more than 20 countries and national, regional and international organizations) and to build partnerships. Furthermore, the Regional Centre on Shared Aquifer Resources Management in Africa was introduced to the wider audience during the conference.

Africa

Regional ISARM activities



The screenshot shows the ISARM website interface. At the top left is the ISARM logo, and at the top right is the UNESCO logo. A navigation bar contains links for HOME, ISARM IN BRIEF, PROGRAMME, REGIONAL ACTIVITIES (highlighted), INFORMATION SYSTEMS, and NEWS. On the left side, there is a vertical banner for 'INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT' and a list of regional activities: ISARM Americas, ISARM Africa, ISARM South-East Europe, and ISARM Asia (selected). The main content area is titled 'ISARM Central & Eastern Asia' and contains text about the regional initiative, a section on 'Groundwater in Asia' with a map, and a section on 'ISARM Central & Eastern Asia activities' with another map. A large blue 'Asia' label is overlaid on the left side of the content area.

igrac

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isarm

UNESCO

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- ISARM Americas
- ISARM Africa
- ISARM South-East Europe
- ISARM Asia**

Asia

INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT

ISARM Central & Eastern Asia

ISARM Central & Eastern Asia is a regional initiative aimed at promoting the sustainable use of transboundary aquifers (TBAs) in Asia by promoting awareness on transboundary aquifers as vital natural resources, especially among the policymakers. And to enhance international collaboration when it comes to sustainable management of these shared aquifers.

Groundwater in Asia [View TBAs Asia](#)

Asia is the world's largest continent both in area and population. It has a large variation of topography, climate and precipitation and as a result also groundwater resources vary across Asia.

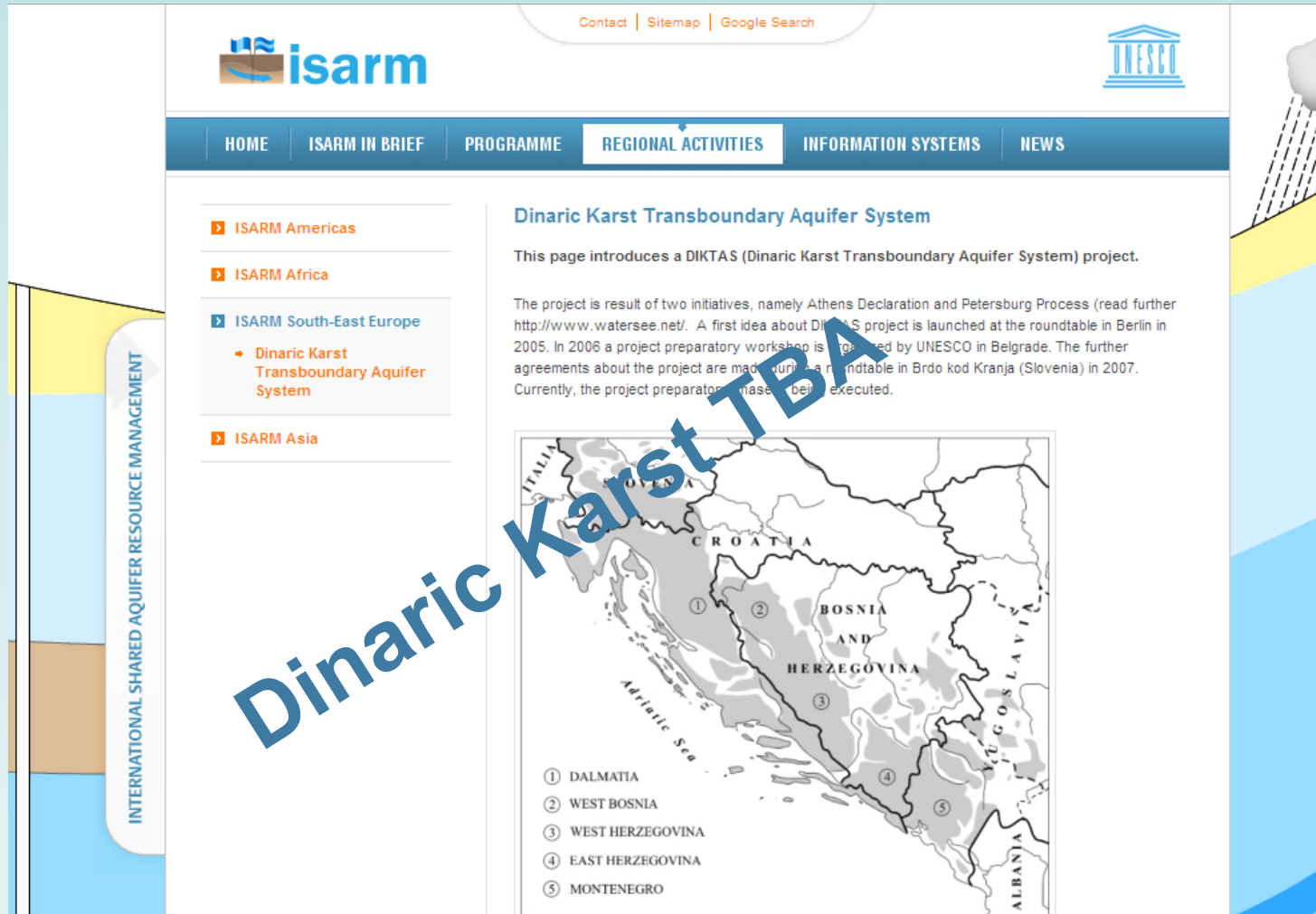
Groundwater plays an important role in Asia, amongst others in irrigated Agriculture and for domestic purposes. Correspondingly, groundwater demand has markedly increased in the past 30 years. Although groundwater often is of high quality, many Asian regions have to deal with groundwater problems like the occurrence of arsenic, fluorine or salt water intrusions. The practice of performing groundwater assessments however is not as widespread as desired so there are many opportunities to improve quality of life by promoting sustainable groundwater management practices.

[View TBAs of China](#)


ISARM Central & Eastern Asia activities

In the context of ISARM Central & Eastern Asia a number of activities have been undertaken aimed at assessing where transboundary aquifers occur in Asia, what state they are in, and to implement close cooperation between relevant ministries, departments and commissions responsible for development and management of groundwater and transboundary issues in Asia.

DIKTAS Project



The screenshot shows the ISARM website interface. At the top left is the ISARM logo, and at the top right is the UNESCO logo. A navigation bar contains links for HOME, ISARM IN BRIEF, PROGRAMME, REGIONAL ACTIVITIES (highlighted), INFORMATION SYSTEMS, and NEWS. Below the navigation bar, there is a sidebar on the left with a vertical label 'INTERNATIONAL SHARED AQUIFER RESOURCE MANAGEMENT'. The sidebar contains a list of regional activities: ISARM Americas, ISARM Africa, ISARM South-East Europe (with a sub-link for 'Dinaric Karst Transboundary Aquifer System'), and ISARM Asia. The main content area features the title 'Dinaric Karst Transboundary Aquifer System' and a paragraph introducing the project. Below the text is a map of the Dinaric Karst region in the Balkans, with five numbered sub-regions: 1 DALMATIA, 2 WEST BOSNIA, 3 WEST HERZEGOVINA, 4 EAST HERZEGOVINA, and 5 MONTENEGRO. The map also shows neighboring countries like Italy, Croatia, Bosnia and Herzegovina, and Albania, and the Adriatic Sea.

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- ISARM Americas
- ISARM Africa
- ISARM South-East Europe
 - Dinaric Karst Transboundary Aquifer System
- ISARM Asia

Dinaric Karst Transboundary Aquifer System

This page introduces a DIKTAS (Dinaric Karst Transboundary Aquifer System) project.

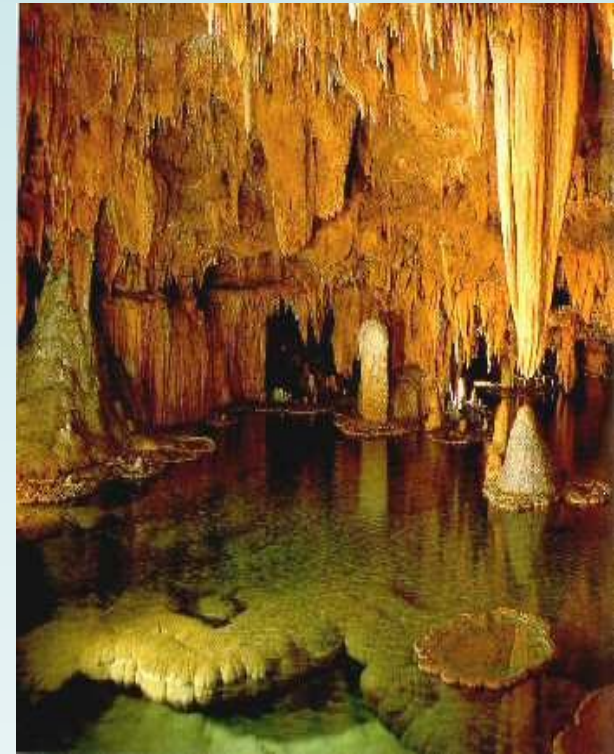
The project is result of two initiatives, namely Athens Declaration and Petersburg Process (read further <http://www.watersee.net/>). A first idea about DIKTAS project is launched at the roundtable in Berlin in 2005. In 2006 a project preparatory workshop is organized by UNESCO in Belgrade. The further agreements about the project are made during a roundtable in Brdo kod Kranja (Slovenia) in 2007. Currently, the project preparatory phase is being executed.



- DALMATIA
- WEST BOSNIA
- WEST HERZEGOVINA
- EAST HERZEGOVINA
- MONTENEGRO

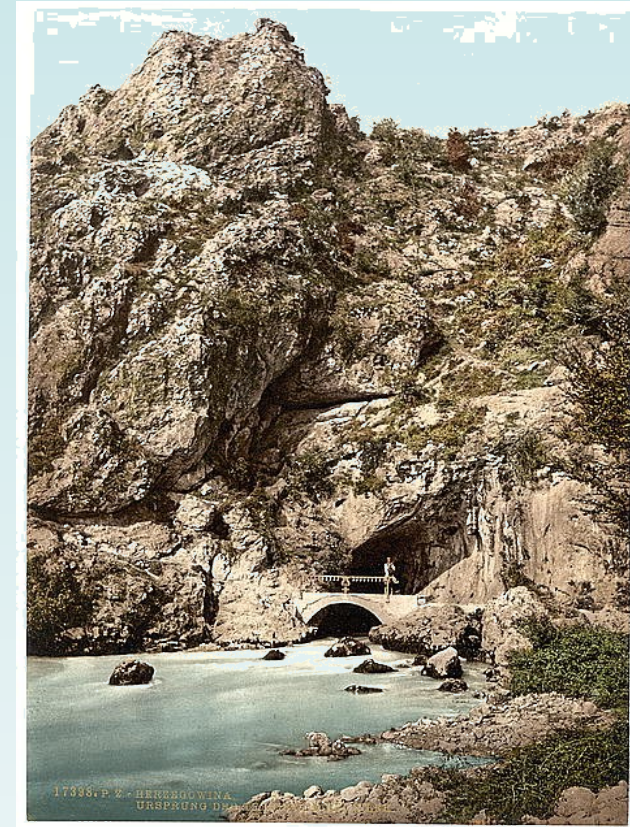
What is DIKTAS?

- **Initiative of GEF and UNESCO at the Petersberg Roundtable (Berlin 2005), an expert meeting (Belgrade 2006) and Ljubljana Roundtable (2007)**
- **A GEF project proposal ‘Protection and Sustainable Use of the Dinaric Karst Aquifer System’**
- **Preparatory phase (2008-2009) approved**
- **Project partners: Croatia, Bosnia & Herzegovina, Montenegro, Albania (and Italy, Slovenia and Greece as non GEF recipient countries)**
- **Project duration: four years (2009-2013), 2008-preparation**
- **Proposed budget: circa 5.8M\$ (GEF 3M\$)**



DIKTAS Objectives

- At the **global level** the project aims to increase attention of the international community on the huge but **vulnerable water resources contained in karst aquifers**, which are widespread globally, but poorly understood.
- At the **regional level** the project's objectives are to:
 - facilitate the **equitable and sustainable utilization of the transboundary water resources of the Dinaric Karst Aquifer System**, and
 - protect the **unique groundwater dependent ecosystems that characterize the Dinaric Karst region of the Balkan peninsula**.



DIKTAS Activities

Objectives are expected to be achieved through a concerted international effort involving:

- improvement in understanding of the resource and its environmental status
- building of political consensus and facilitating harmonisation around key reforms and new policies,
- enhanced and sustainable coordination among countries, donors, projects and agencies,



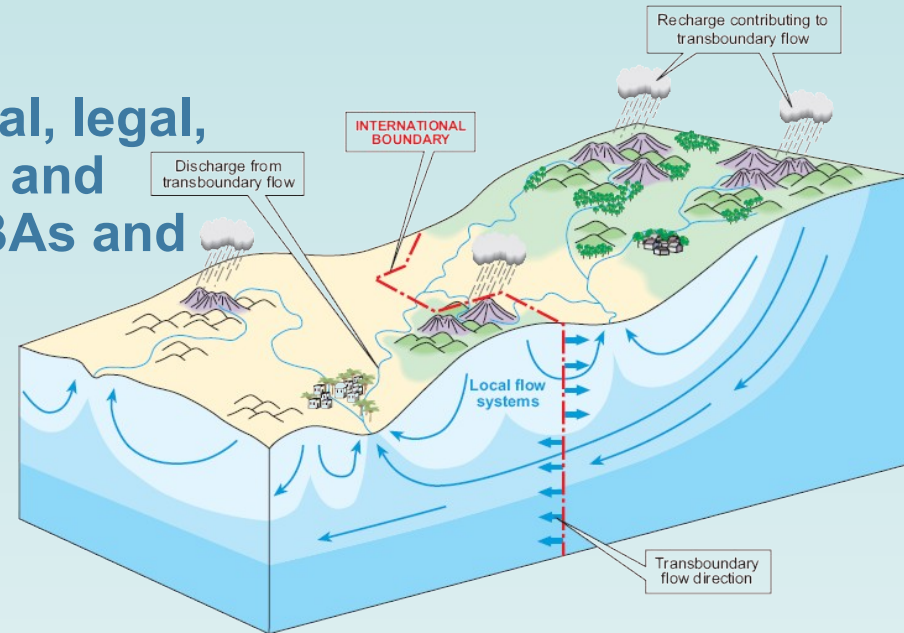
Content of the presentation

- Introduction to IGRAC (an UNESCO/WMO Groundwater Centre)
- Introduction to ISARM (an UNESCO led programme)
- Announcement of DIKTAS project
- **A TBA Assessment Methodology**
- Concluding notes



Rationale

- What does a TBA assessment encompass?
- ISARM programme: hydrological, legal, socio-economical, institutional and ecological aspects/facets of TBAs and suggested guidelines
- In practice, mostly a hydrogeological assessment (to incorporate info on other aspects as well)
- Clear need for general guidelines (as a procedure based on facts and structured experience from elsewhere) in order to enhance and alleviate a TBA assessment



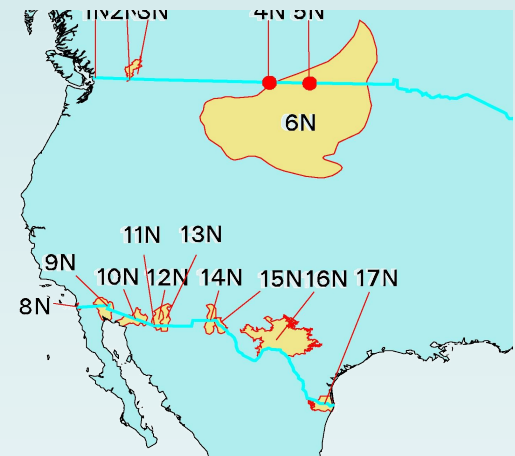
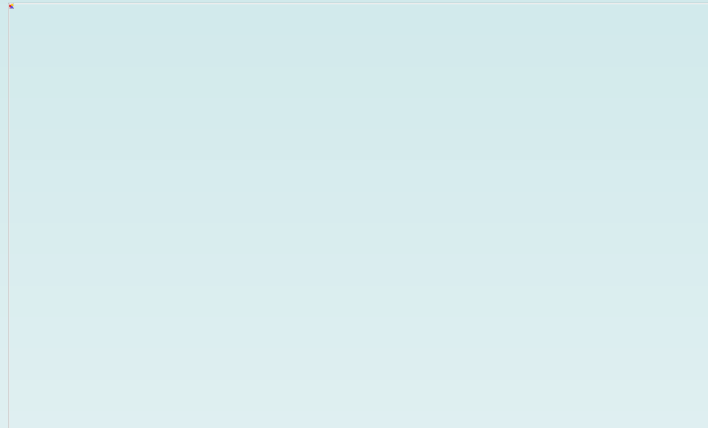
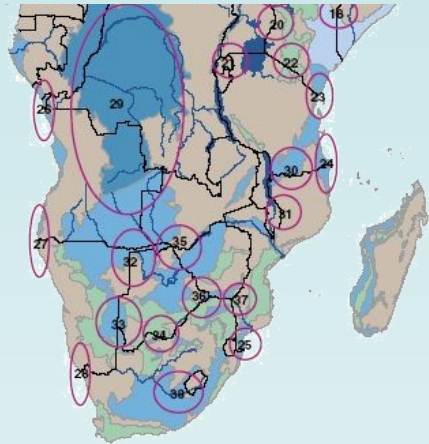
TBA assessment steps

- Delineation and description
- Classification, diagnostic analysis and zoning
- Data harmonisation and information management

- **Delineation and description**
 - “inventory” or “characterisation” (stage and scale dependent)
 - chiefly about collecting, combining and interpreting the field information
- **Classification, diagnostic analysis and zoning**
 - information necessary for decision-making (problems, opportunities, most responsive aquifers and aquifer zones)
- **Data harmonisation and information management**
 - Extra dimension in an international context (more difficult, more elaborated and politically sensitive)

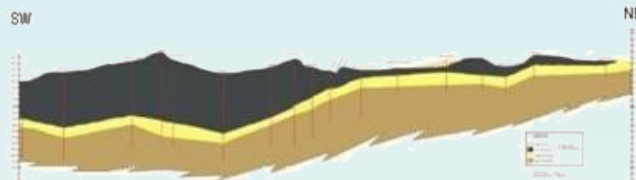
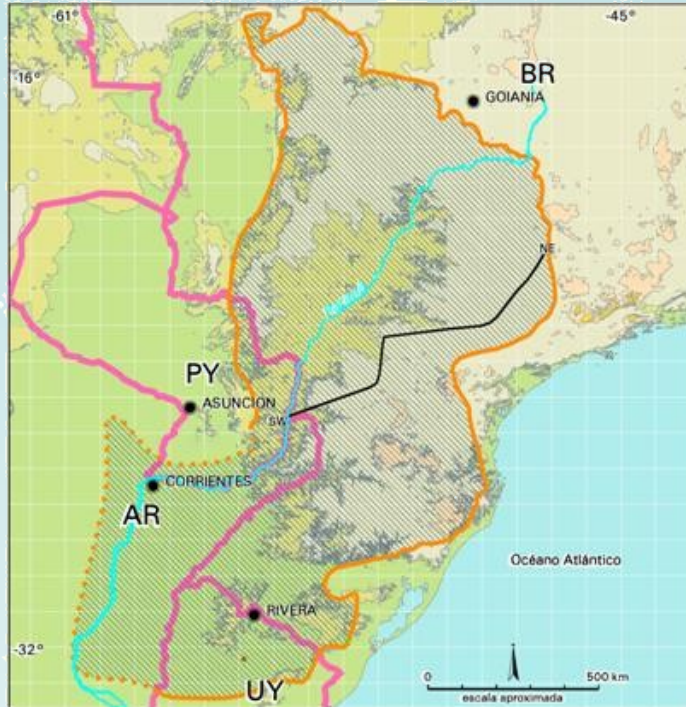
Delineation and Description

- chiefly about collecting, combining and interpreting the field information
- **“inventory” or “characterisation”** (stage and scale dependent)



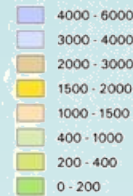
Standardised TBA Delineation

(TBA Activities Americas)



LEYENDA

Altura (msnm)















mar / agua superficial

extensión de acuífero

- ▲ Límite de acuífero transfronterizo, confiable
- ▲ Límite de acuífero transfronterizo, aproximado
- ▲ Límite de acuífero transfronterizo, inferido
- ▲ Límite de cuenca hidrológica transfronteriza, con acuífero(s) incluido(s), confiable
- ▲ Límite de cuenca hidrológica transfronteriza, con acuífero(s) incluido(s), aproximado
- ▲ Límite de cuenca hidrológica transfronteriza, con acuífero(s) incluido(s), inferido
- ▲ Límite de formación u otra unidad geológica transfronteriza, con acuífero(s) incluido(s), confiable
- ▲ Límite de formación u otra unidad geológica transfronteriza, con acuífero(s) incluido(s), aproximado
- ▲ Límite de formación u otra unidad geológica transfronteriza, con acuífero(s) incluido(s), inferido
- ▲ Límite de sistema hídrico transfronterizo no clasificado, confiable
- ▲ Límite de sistema hídrico transfronterizo no clasificado, aproximado
- ▲ Límite de sistema hídrico transfronterizo no clasificado, inferido
- ▲ río
- ▲ frontera internacional
- ▲ ubicación de la sección
- ciudad

Standardised TBA Delineation

<i>Type of unit :</i>	<i>Legend for boundary</i>		
	<i>reliable</i>	<i>approximat</i>	<i>inferred</i>
'Real' aquifer			
Hydrological catchment			
Geological formation			
Other system/unknown			

Tested in the *Atlas of transboundary aquifers of Americas*

Delineation and Description

- A TDA description should a.o. include info recharge/discharge mechanism and hydraulic properties of aquifer to
 - determine direction and velocity of groundwater flow and its interaction with other water bodies (rivers, lakes, seas).
 - to assess aquifer's vulnerability to overexploitation and pollution.
- Superimposed on these hydrogeological characteristics are the anthropologic influences such as abstraction and pollution from various sources.
- ISARM and EU ECE TBA inventories vary substantially in their content

Aquifer No. 1: Osh Aravoij		Shared by: Uzbekistan and Kyrgyzstan
Type 5, Medium links to surface water systems, groundwater flows from Uzbekistan to Kyrgyzstan		
	Uzbekistan	Kyrgyzstan
Area (km ²)		
Water uses and functions (percentage of total abstraction)	Drinking water supply (25-50%), irrigation, mining, livestock (<25%)	Drinking water supply (25-50%), irrigation
Pressure factors	Agriculture, industry, waste disposal	Agriculture
Problems related to groundwater quantity	Polluted water drawn into aquifer	Lack of relevant data to be quantified
Problems related to groundwater quality	Serious problems with pesticides, moderate problems with heavy metals, slight problems with hydrocarbons and radioactive elements	Lack of relevant data to be quantified
Transboundary impacts	Decline of groundwater level, groundwater pollution	Lack of relevant data to be quantified
Groundwater management measures	Need to be improved: transboundary institutions, monitoring of groundwater quantity and quality, need to be applied: abstraction management, efficiency of use, mapping, good agricultural practices, integrated river basin management, treatment of industrial effluents, data exchange	Need to improved: transboundary institutions, monitoring of groundwater quantity and quality
Status and what is most needed	Improvement of the monitoring of groundwater quantity and quality	Improvement of the monitoring of groundwater quantity and quality
Future trends and prospects	Expected pressure on the water resources due to economic growth and climate change	Expected pressure on the water resources due to economic growth and climate change

Standardised TBA Description

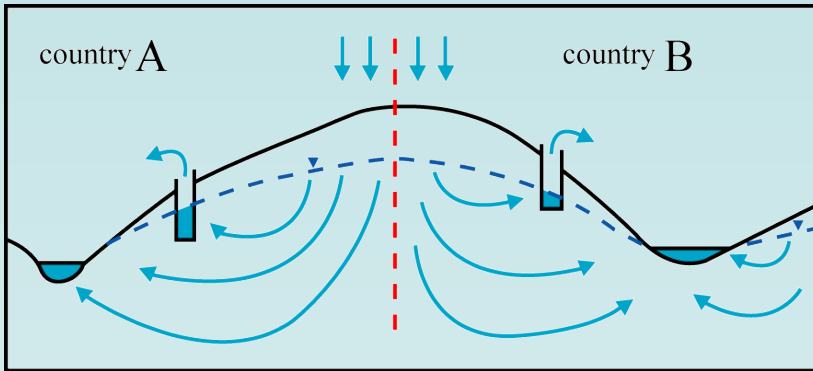
5.16. ARGENTINA – BRASIL – PARAGUAY - URUGUAY

SISTEMA ACUIFERO TRANSFRONTERIZO GUARANI - SAG ARGENTINA-BRASIL-PARAGUAY-URUGUAY
<p>El Sistema Acuífero Transfronterizo Guarani está localizado en el subsuelo de la Cuenca Hidrográfica del Plata y se extiende desde la cuenca sedimentada del Paraná hasta la Cuenca del Chaco-Paraná. Con una extensión aproximada a los 1,2 millones de km² esta subyacente a cuatro países: Argentina, Brasil, Paraguay y Uruguay. El clima se caracteriza como húmedo o subhúmedo con precipitaciones entre 1200 a 1500 mm. Cerca de 20 millones de habitantes se encuentran en esta área. El agua es utilizada principalmente para abastecimiento humano, lazer e industria.</p> <p>El acuífero Guarani está conformado por capas arenosas que se encuentran depositadas en la cuenca sedimentaria del Paraná desde el Mesozoico (periodos triásico, jurásico y cretáceo inferior) entre 200 y 132 millones de años, que constituyen las formaciones geológicas Piramboia y Botucatu en Brasil (las primeras formaciones se encuentran con el nombre Buena Vista en Uruguay y las segundas con el nombre Misiones en Paraguay, Tacuarembó en Uruguay y en Argentina).</p> <p>Las áreas de afloramiento ocurren en dos fajas situadas al oeste y al este del área de ocurrencia y corresponden al 10% de la extensión total del acuífero, mientras el restante 90% del acuífero es confinado. El potencial explotable estimado es de 40 km³/año. Los caudales de pozos varían entre 60 a 200 m³/h en las áreas adyacentes a los afloramientos y de 200 a 400 m³/h en las áreas de mayor confinamiento. Su espesor medio es de 250 m. Las aguas son bicarbonatadas calcáicas y magnésicas en las áreas próximas al afloramiento y son sodicas en las áreas más profundas. El pH es alcalino y los valores de residuos secos varían de 200 a 600 mg/h. La temperatura varía de 25 a 63°C.</p> <p>Hay vacíos de conocimiento ligado a dos aspectos en particular a la delimitación de las áreas de descarga y la ocurrencia de anomalías hidroquímicas como exceso de flúor en algunos pozos. Importancia regional por la magnitud de la reserva.</p> <p>El sistema acuífero reviste mucha importancia a nivel regional y para cada país como elemento básico para el desarrollo socio-económico.</p> <p>El área de recarga del acuífero, que tiene una importante función en el mantenimiento del equilibrio hidrológico, es el área más vulnerable y necesita específicas medidas de protección.</p> <p>Los cuatro países están trabajando juntos en un proyecto empezado en el año 2002, sobre la gestión sostenible y protección del acuífero con cooperación del GEF/Banco Mundial/OEA.</p> <p>Referencias</p> <ul style="list-style-type: none"> • Mapa Hidrogeológico do Aquífero Guarani, 1999, Campos, H.C. • Mapa Hidrogeológico da América do Sul (papel, 1996, Escala 1:5.000.000, UNESCO, CPRM, DNPM) <p>Autores: Argentina: Ofelia Tujchneider, con la colaboración de Marta Paris, Mario Hernández. Brasil: Julio Thadeu Kettelhut, Colaboradores: Uriel Duarte-ABAS, Geroncio Rocha-DAEE/SP, Mara Akie Iritani, IG/SP, Adriana Ferreira, Fabricio Cardoso, Hélio Oliveira, Claudia Lima- SRH/MMA. Paraguay: Celso Velásquez con la colaboración de Wilfrido Castro, Ana María Castillo, Uruguay: Juan Ledesma con la colaboración de DINAMIGE OSE.</p>

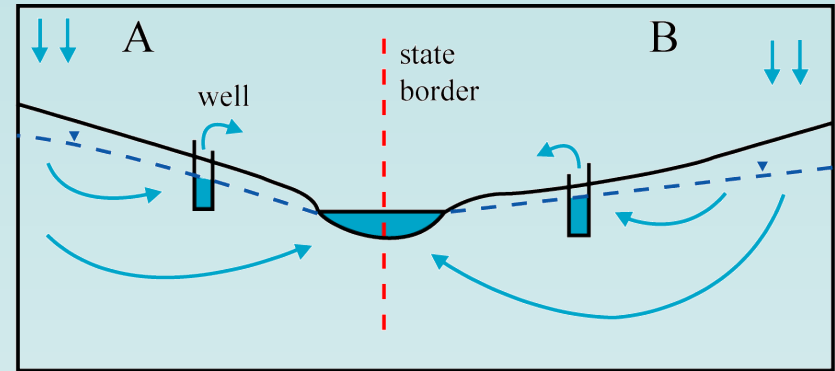
(TBA Activities Americas)

- ◀ Physiography, Demography & Water Use
- ◀ Geological Setting of Aquifer
- ◀ Water Quantity & Quality
- ◀ Importance and need for TBA
- ◀ TBA cooperation
- ◀ References
- ◀ Authors

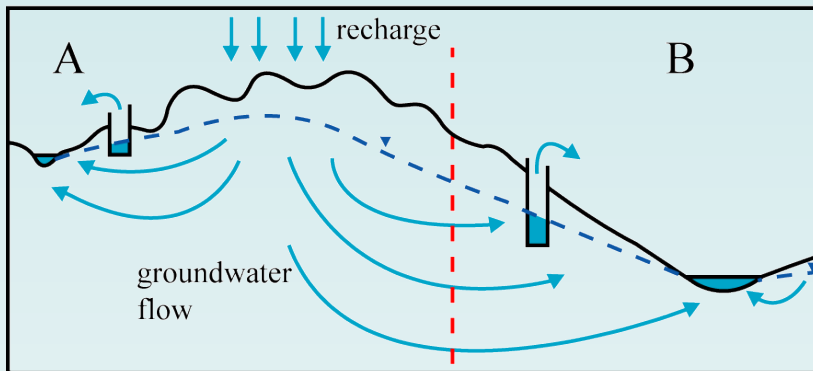
Classification, Diagnostics and Zoning



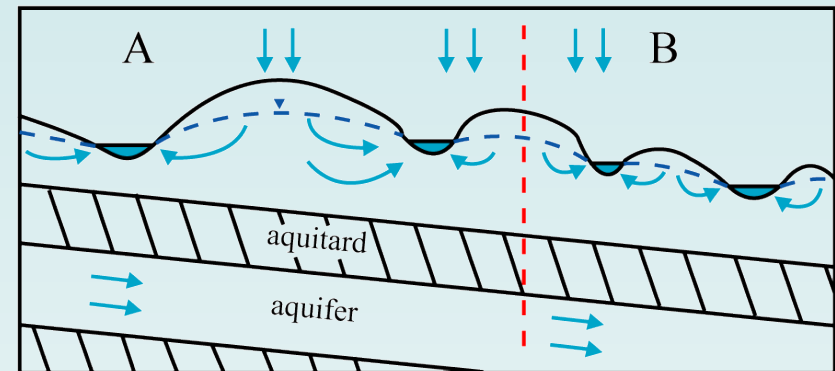
(1) state border follows surface water catchment and groundwater divide, little transboundary groundwater flow.



(3) state border follows major river or lake, alluvial aquifer connected to river, little transboundary flow.



(2) Surface water and groundwater divides separate from state border, recharge in one country, discharge in adjacent.



(4) Large deep aquifer, recharged far from border, not connected to local surface water and groundwater.

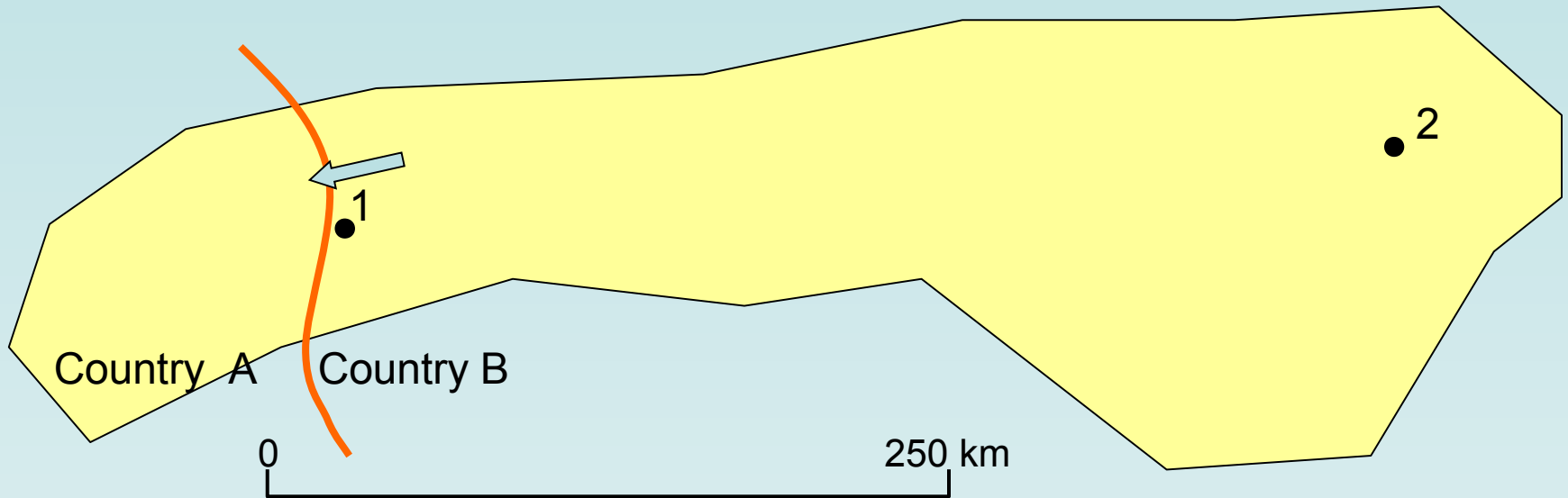
Classification, Diagnostics and Zoning

- **Input for classification:**
 - aquifer size and hydraulic properties,
 - vulnerability,
 - current functions,
 - observed or perceived stresses,
 - Possible groundwater interferences, etc.

- **Input for diagnostics:**
 - inventory of major perceived issues and problems;
 - overview of possible actions
 - Priority and feasibility study, stakeholders and institutional analysis.

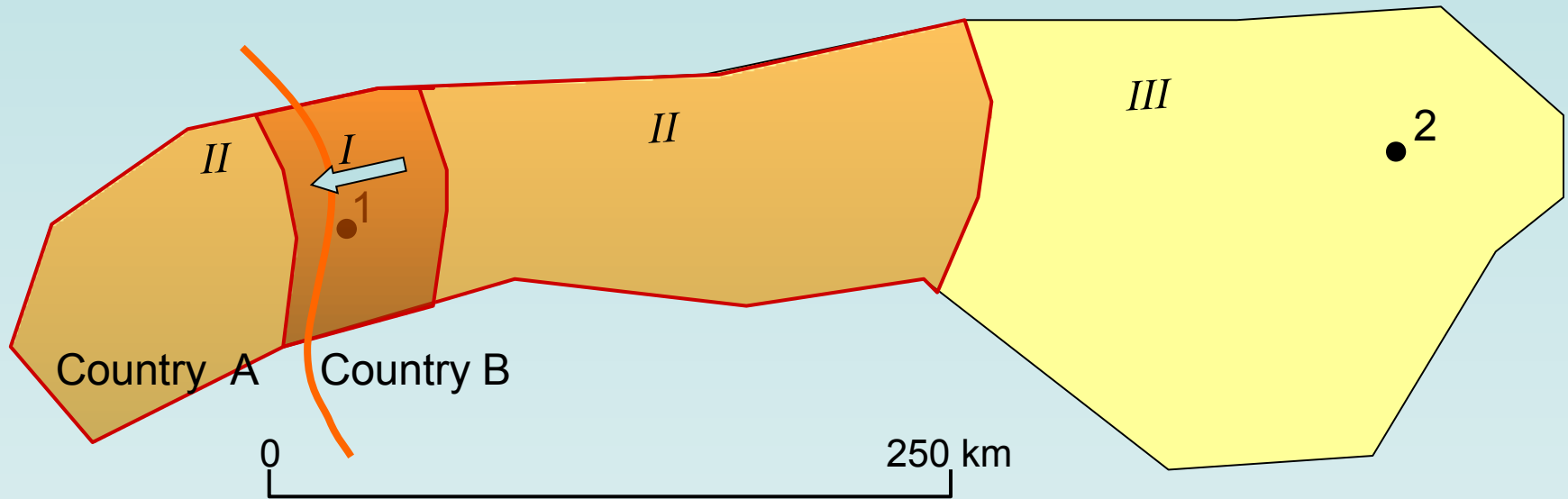


Classification, Diagnostics and Zoning



- Activities at location 2 in country B will be much less risky for the aquifer in country A than activities at location 1
- Effects resulting from causes at larger distance will be smaller and come with more retardation
- General flow direction does matter
- Zoning: e.g. based on isochrones of propagation of the effects (may contribute to a realistic picture of the transboundary risks).

Classification, Diagnostics and Zoning

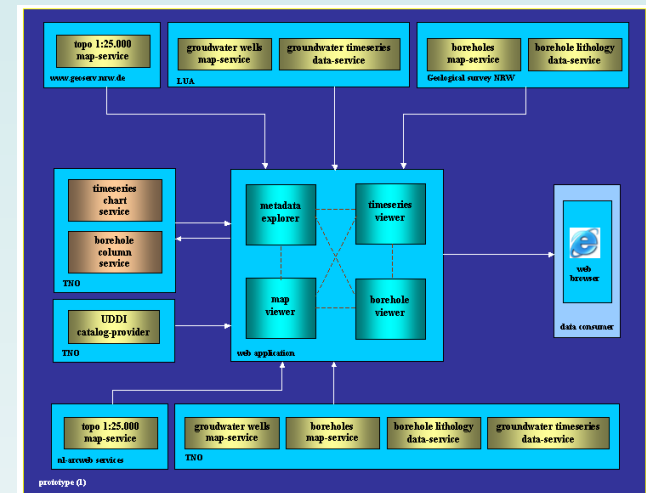


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Harmonisation & Info management

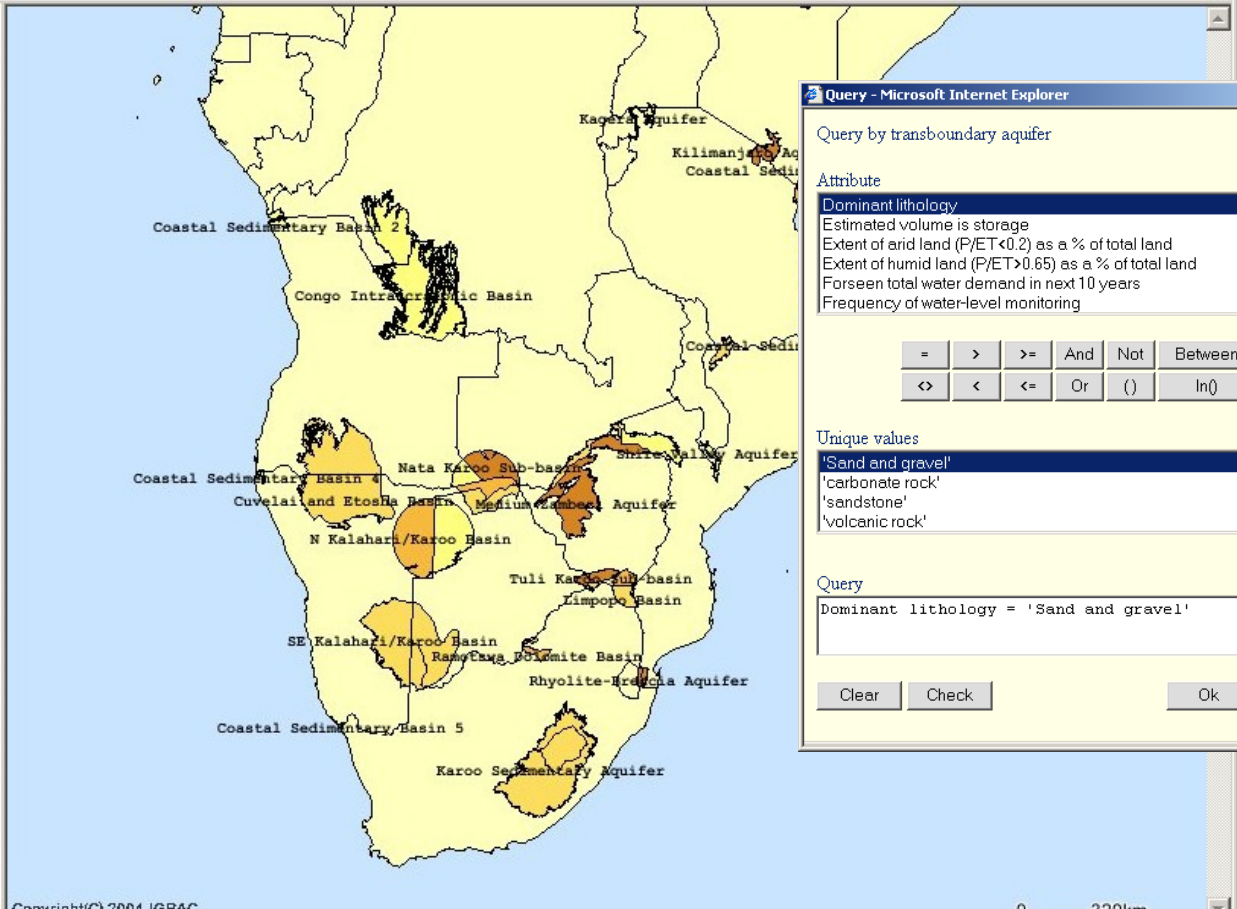
- Current situation
 - Mainly simple GIS- based databases (GEF projects)
 - Developed databases or systems are (according to the available information) neither web-based, nor real-time
 - Databases available via IGRAC and INWEB portals contain meta information on transboundary aquifers.
 - No cases have been reported of harmonisation going beyond items such as reference levels and measurement scales.
 - **WISE** accommodates delineated ‘groundwater bodies’, no observations are available yet

- Ideally, on-line synchronised access to distributed information services (data and information remain at the source!)



Zoom to: Choose transboundary aquifer ... **Only Southern Africa! attribute values not available yet!**

- By transboundary aquifer
- Aquifer Characteristics
- Aquifer type**
(Intergranular/fissured/combined)
 - Reservoir system** (Single layer/multi layered)
 - Dominant lithology** (sand and gravel/sandstone/carbonate rock/carbonate rock and sandstone/volcanic rock/intrusive and metamorphic)
 - Groundwater flow system** (Phreatic/confined/semi-confined)
 - Predominant groundwater flow** (S-N; N-S; E-W; W-E; no predominance)
 - Minimum depth to lower aquifer boundary** (system base) (m)
 - Maximum depth to lower aquifer boundary** (system base) (m)
 - Minimum depth to upper aquifer boundary** (system top) (m)
 - Maximum depth to upper aquifer boundary** (system top) (m)
 - Minimum hydraulic conductivity** (m/s)
 - Maximum hydraulic conductivity** (m/s)



Query - Microsoft Internet Explorer

Query by transboundary aquifer

Attribute

Dominant lithology

- Estimated volume is storage
- Extent of arid land (P/ET < 0.2) as a % of total land
- Extent of humid land (P/ET > 0.65) as a % of total land
- Forseen total water demand in next 10 years
- Frequency of water-level monitoring

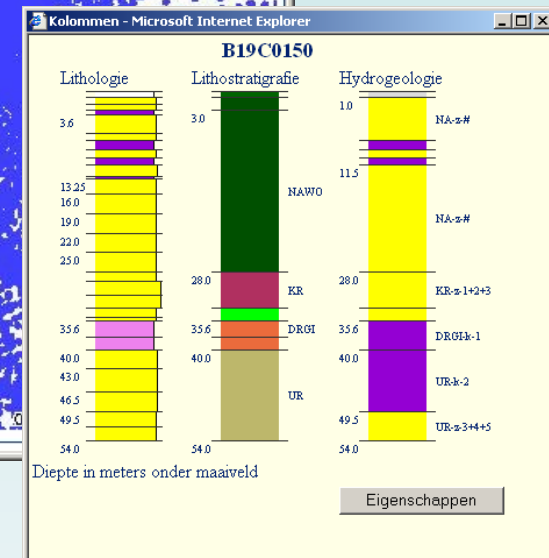
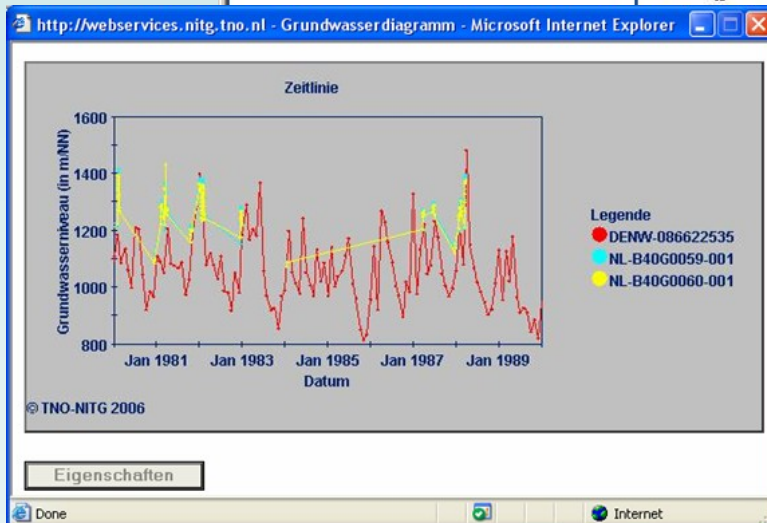
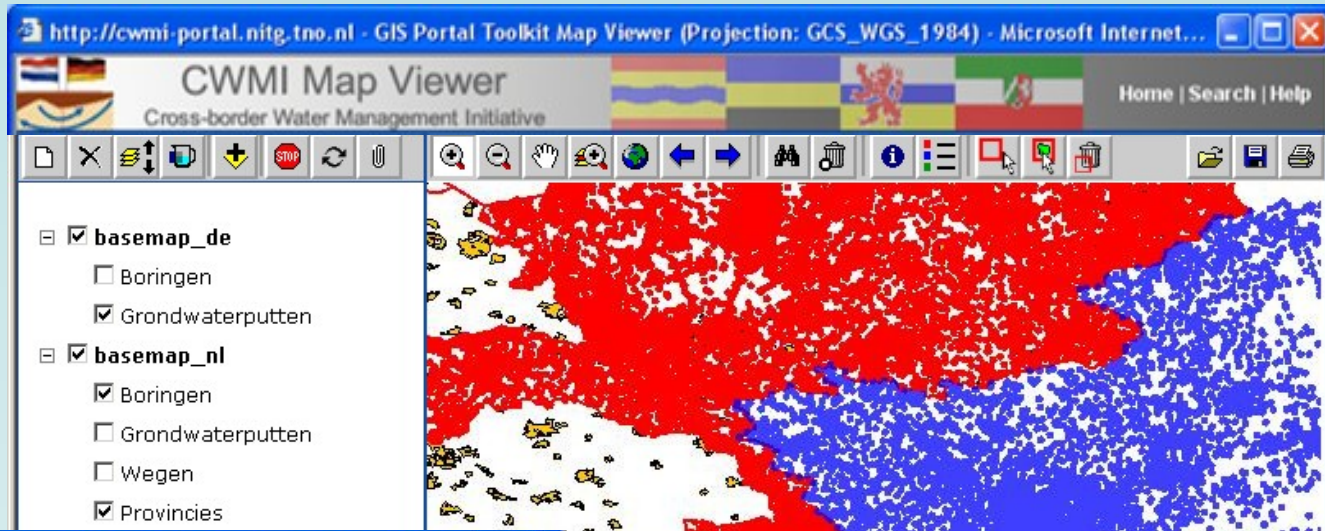
Unique values

- 'Sand and gravel'
- 'carbonate rock'
- 'sandstone'
- 'volcanic rock'

Query

Dominant lithology = 'Sand and gravel'

Harmonisation & Info management



Concluding notes

- **Challenges of TBA assessment**
 - (invisible groundwater, usually slow changes, various approaches to aquifer assessment, lack of information, political will...)
- **Need for a generally accepted TBA assessment methodology**
 - Enhancing the assessment
 - Improving information consistency
 - Providing clear info for decision makers (on issues at stake, promising TBA management strategies and zones for TBA management actions)
- **Importance of ISARM umbrella and cooperation with similar programmes and international projects**
- **Thank you for your attention!**



United Nations Educational,
Scientific and Cultural Organization



World Meteorological
Organization



Government of
The Netherlands



Deltares