igrac

International Groundwater Resources Assessment Centre

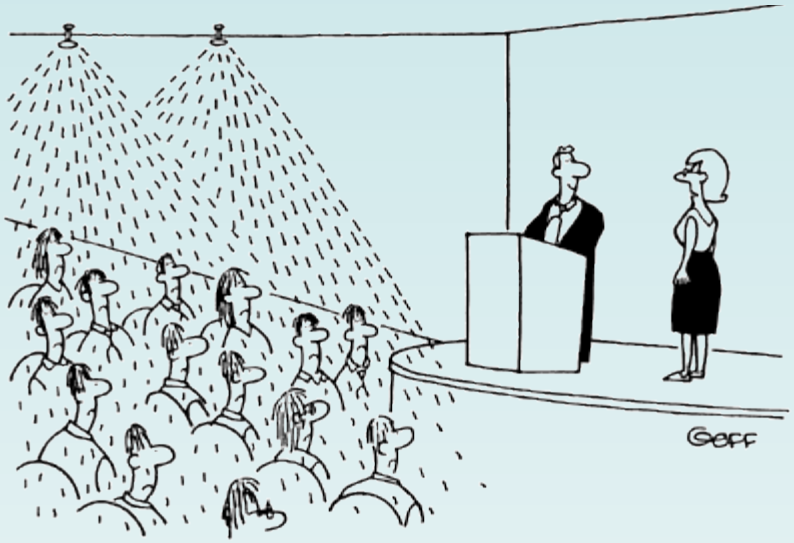
Towards a Methodology for Assessment of Internationally Shared Aquifers

Dr Neno Kukuric

Thessaloniki, 2008

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."

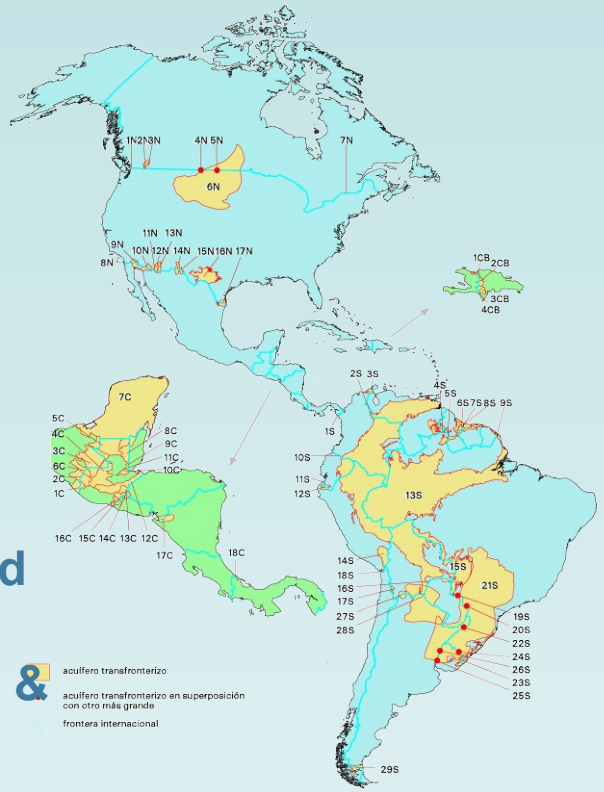
What is IGRAC?

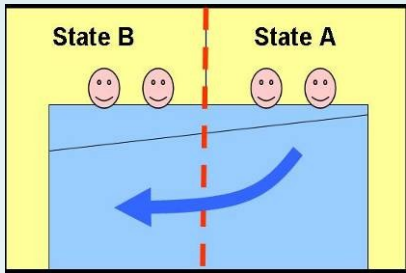
- A non-profit centre that **facilitates and promotes global sharing of information and knowledge** required for sustainable groundwater resources development and management.
- An initiative of **UNESCO** and **WMO** from 1999,
- Launched at WWF3 in Kyoto in **Spring 2003,**
- Receives financial support 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..).



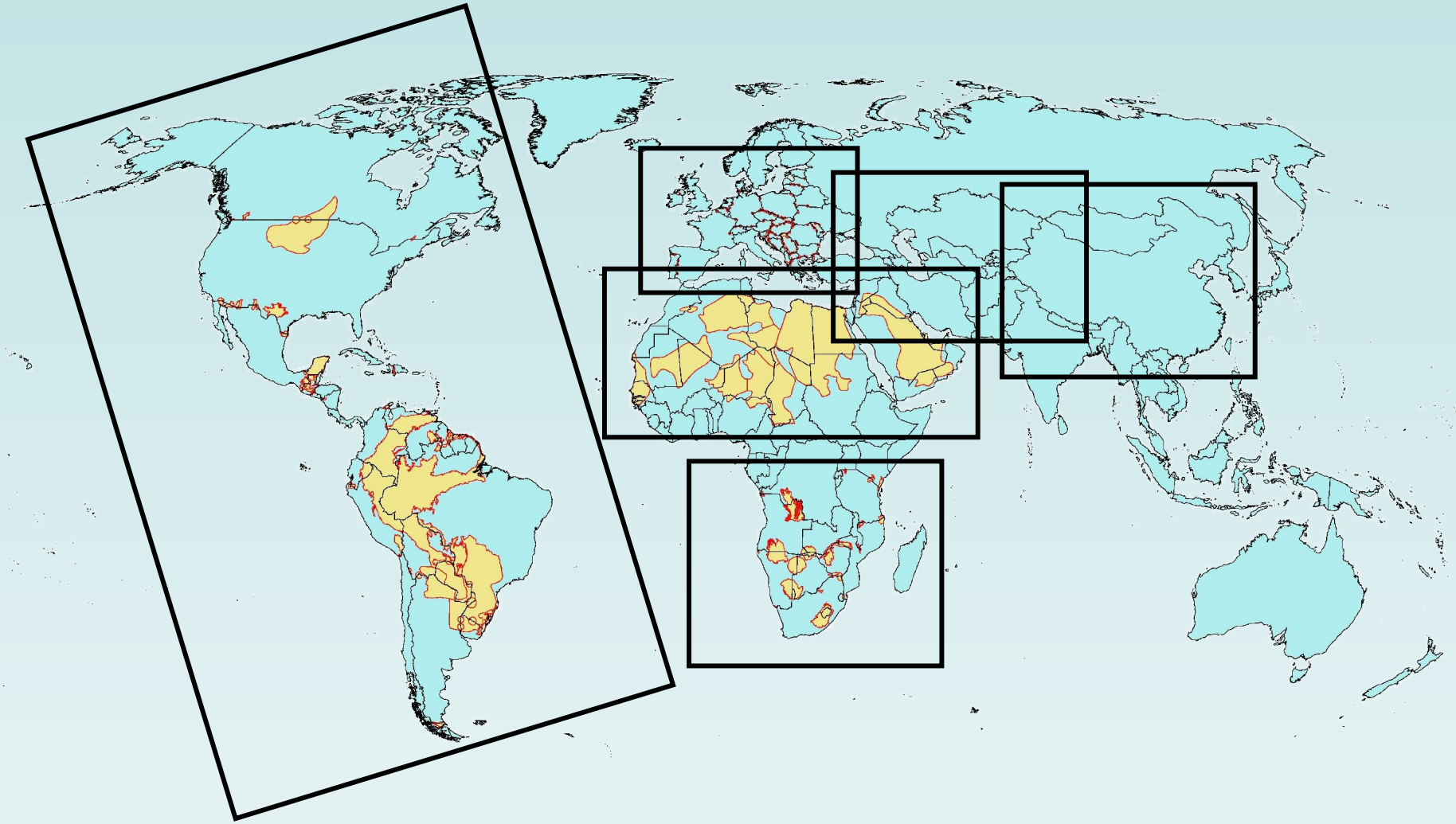


ISARM Programme

- 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

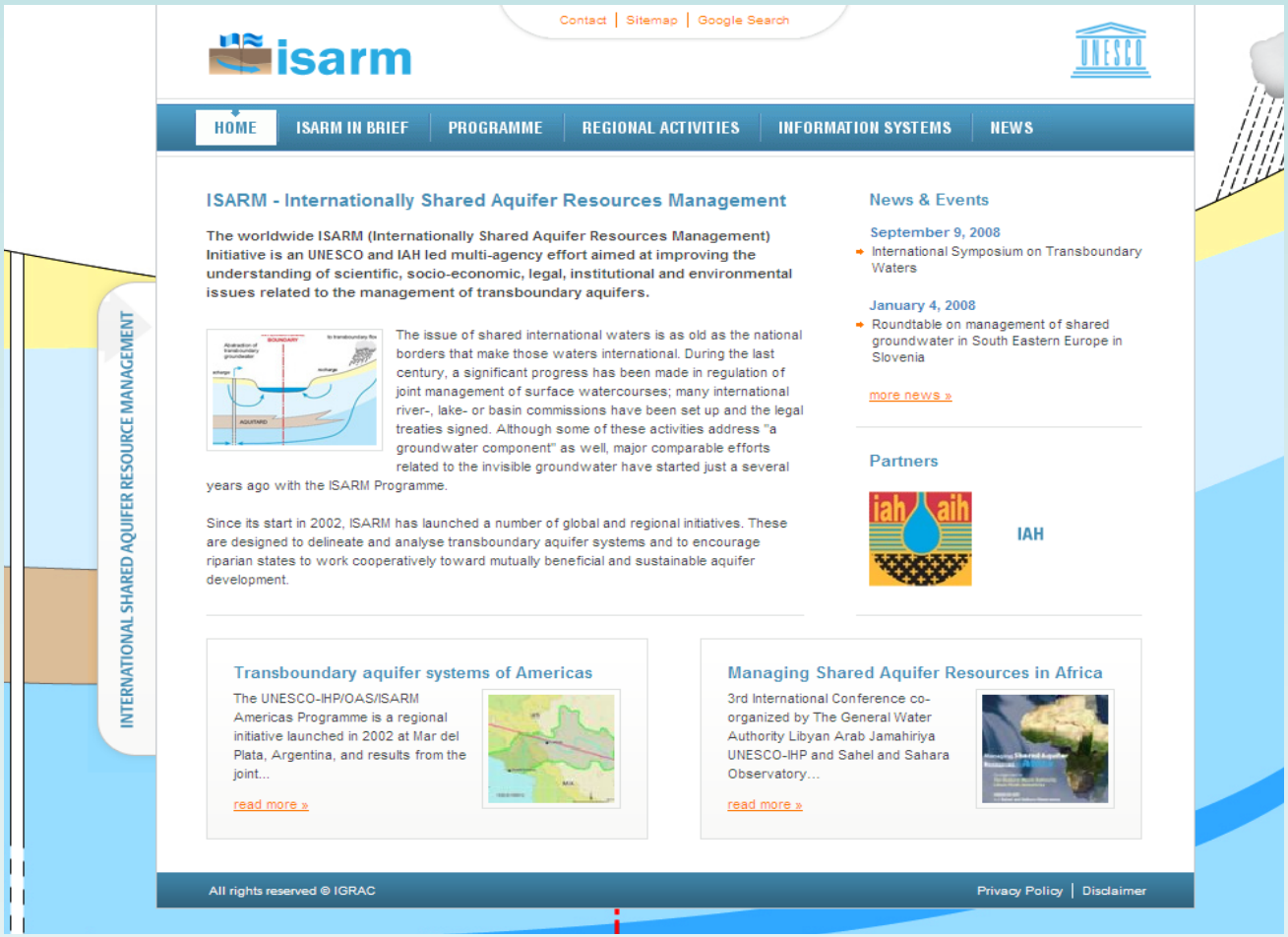


Hydrogeological assessment of transboundary aquifers

Snapshot of regional ISARM activities

- 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.

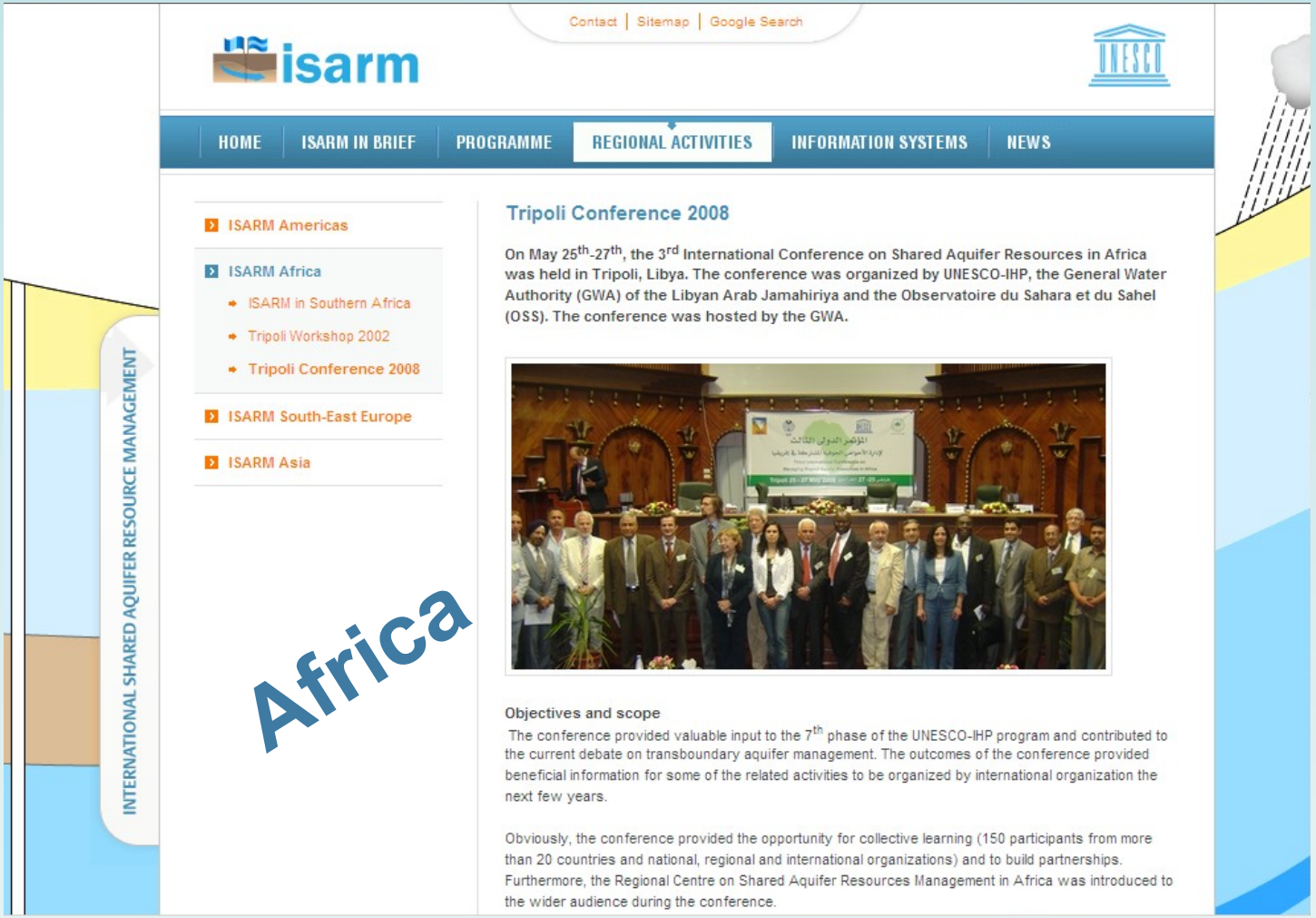
ISARM Portal



www.isarm.net

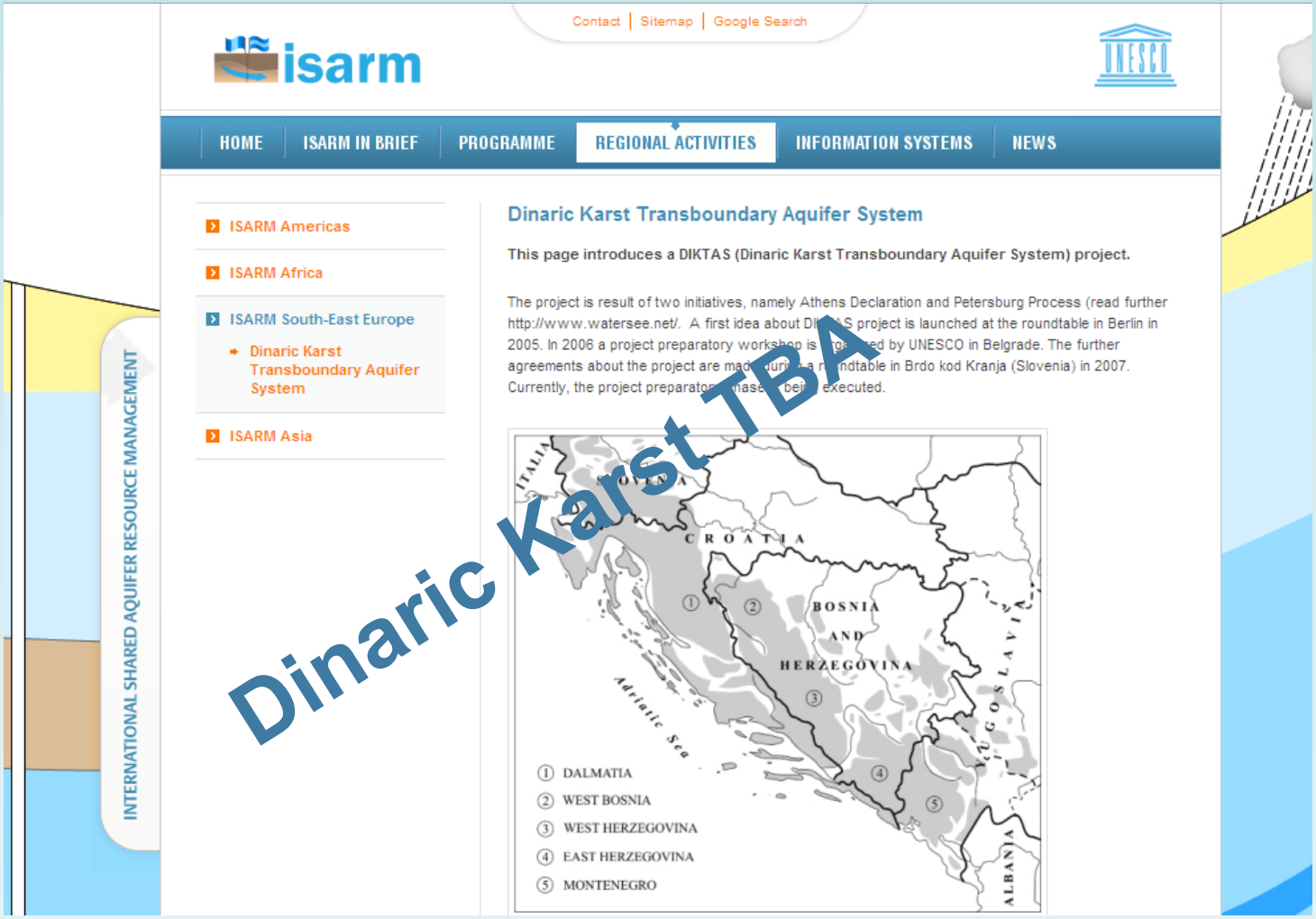
Regional ISARM activities

Regional ISARM activities



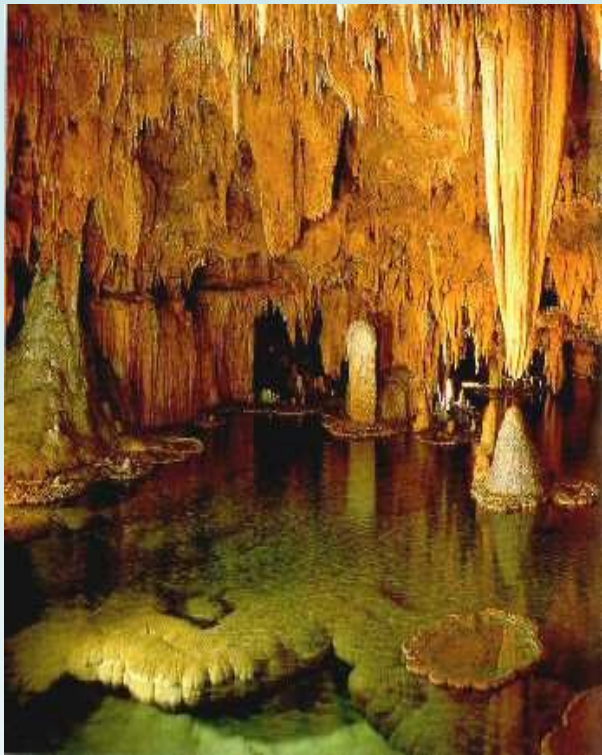
Regional ISARM activities

DIKTAS Project



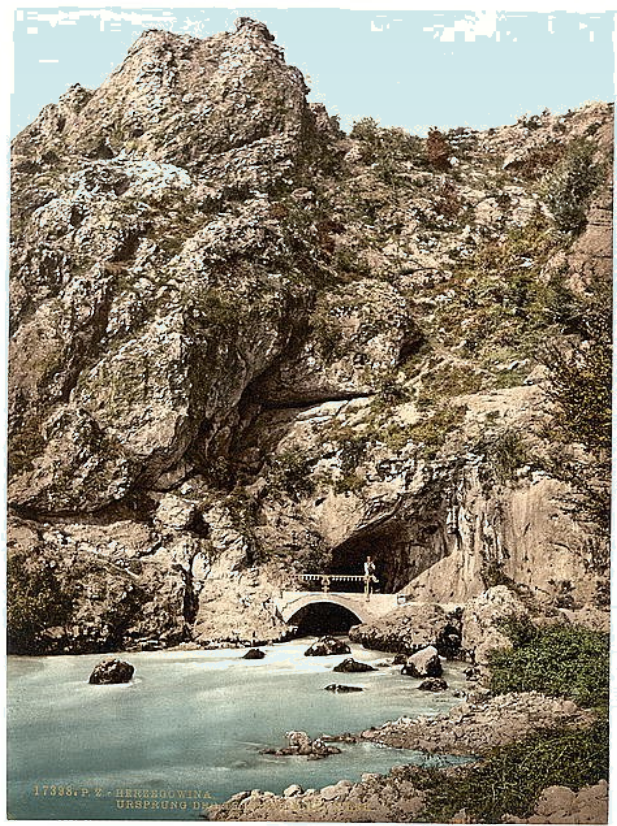
What is DIKTAS?

- **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,

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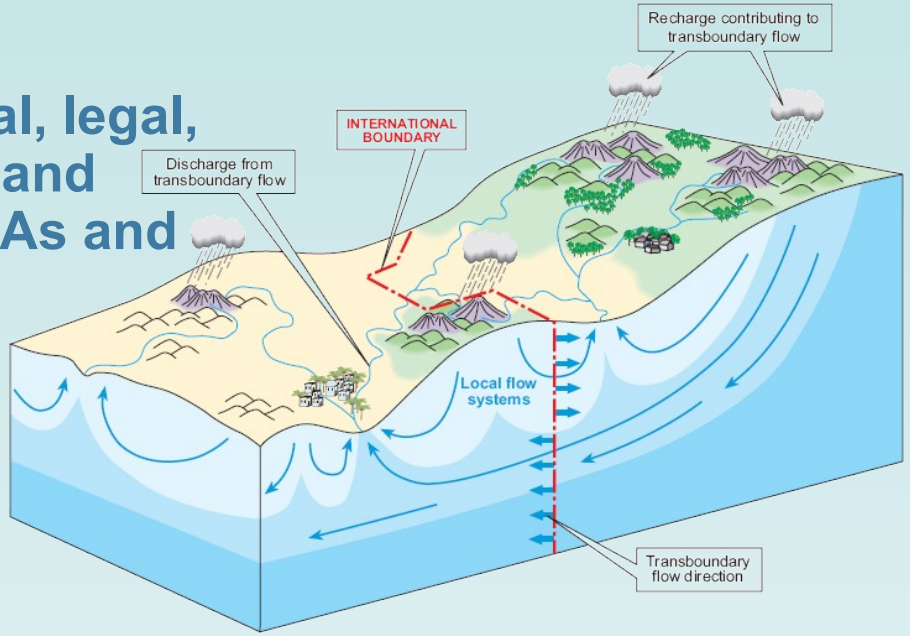
- Concluding notes

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

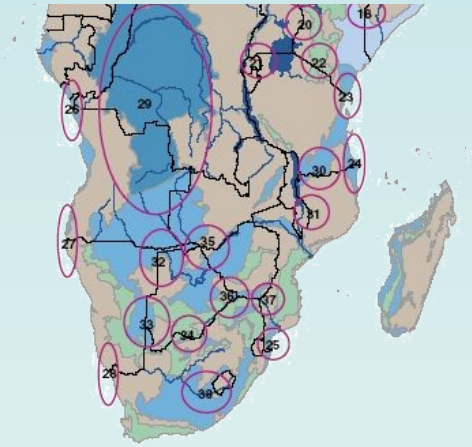
TBA assessment steps

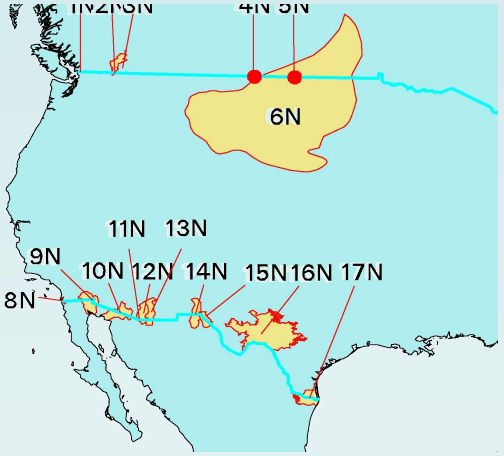
- Delineation and description
- Classification, diagnostic analysis and zoning
- Data harmonisation and information management

- **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

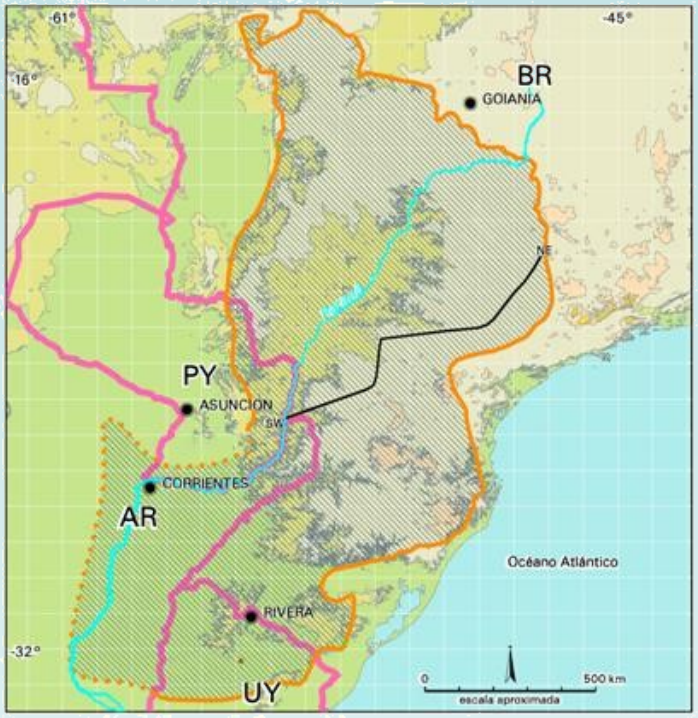
- chiefly about collecting, combining and interpreting the field information
- "**inventory**" or "**characterisation**" (stage and scale dependent)

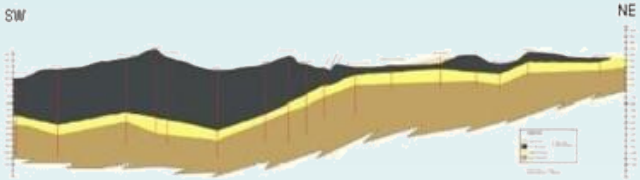


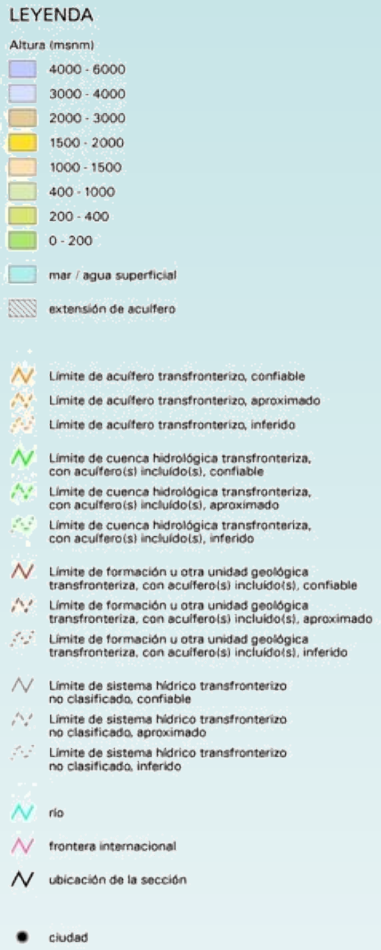


Standardised TBA Delineation

(TBA Activities Americas)

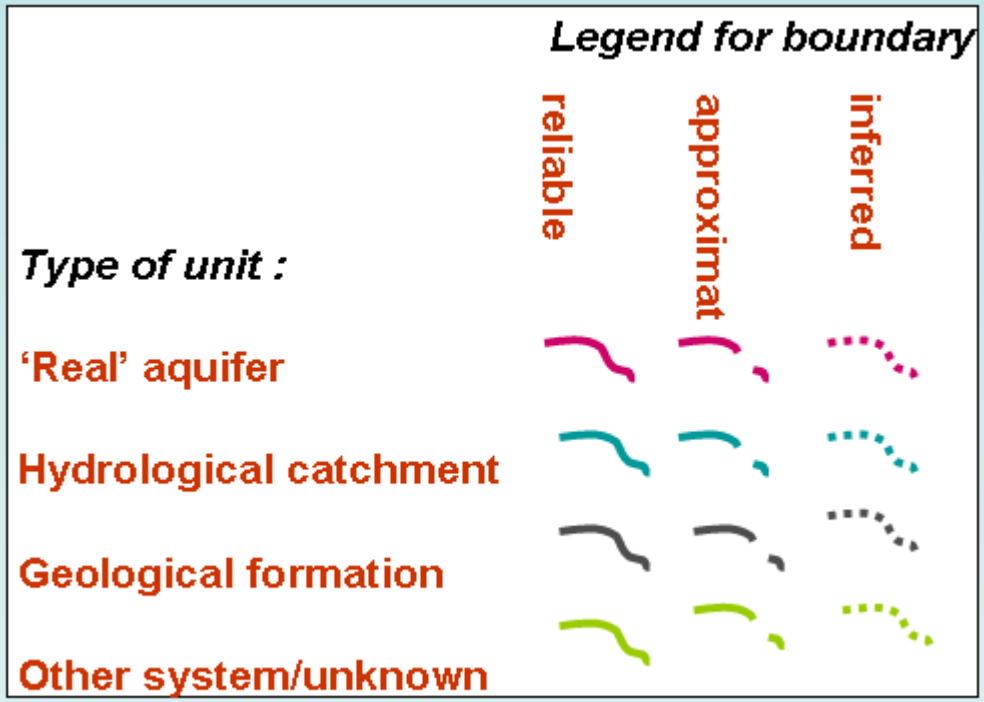






Fuente: Base de Datos Hidrogeológicos Proyecto SAG

Standardised TBA Delineation



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 (km²)		
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 manage ment, 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

El Sistema Acuifero Transfronterizo Guarani esta localizado en el subsuelo de la Cuenca Hidrográfica del Plata y se extiende desde la cuenca sedimentada del Parana hasta la Cuenca del Chaco-Parana. Con una extensión aproximada a los 1,2 millones de km2 esta subyacente a cuatro paises: Argentina, Brasil, Paraguay y Uruguay. El clima se caracteriza como humedo o subhumedo 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.

El acuifero Guarani esta conformado por camadas arenosas que se encuentran depositadas en la cuenca sedimentaria del Parana desde el Mesozoico (periodos triasico, jurasico y cretaceo inferior) entre 200 y 132 millones de anos, que constituyen las formaciones geologicas Pirambóia 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, Tacuarembo en Uruguay y en Argentina).

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 acuifero, mientras el restante 90% del acuifero es confinado. El potencial explotable estimado es de 40 km3/anio. Los caudales de pozos varian 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 calcicas y magnesiacas en las áreas próximas al afloramiento y son sodicas en las áreas mas profundas. El pH es alcalino y los valores de residuos secos varian de 200 a 600 mg/h. La temperatura varia de 25 a 63C.

Hay vacios de conocimiento ligado a dos aspectos en particular a la delimitación de las áreas de descarga y la ocurrencia de anomalias hidroquimicas como exceso de fluor en algunos pozos.
Importancia regional por la magnitud de la reserva.

El sistema acuifero reviste mucha importancia a nivel regional y para cada país como elemento básico para el desarrollo socio-económico.

El área de recarga del acuifero, que tiene una importante función en el mantenimiento del equilibrio hidrologico, es el area mas vulnerable y necesita especificas medidas de proteccion.

Los cuatro paises están trabajando juntos en un proyecto empezado en el año 2002, sobre la gestión sostenible y protección del acuifero con cooperación del GEF/Banco Mundial/OEA.

Referencias

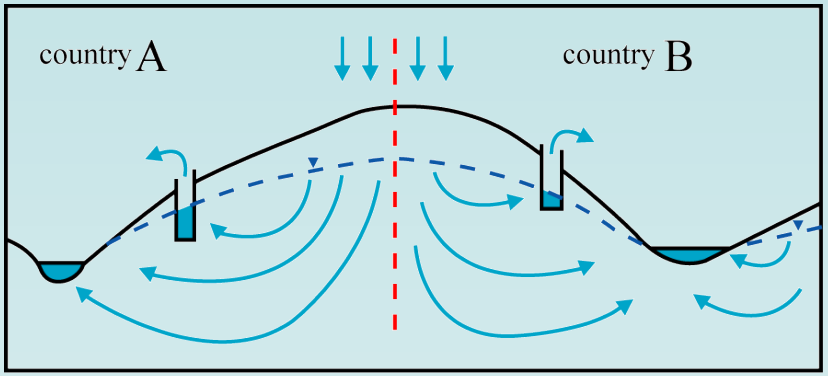
- *Mapa Hidrogeológico do Aquifero Guarani, 1999. Campos, H.C.*
- *Mapa Hidrogeológico da América do Sul (papel, 1996, Escala 1:5.000.000, UNESCO, CPRM, DNPM)*

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 Maria Castillo, Uruguay: Juan Ledesma con la colaboración de DINAMIGE OSE.

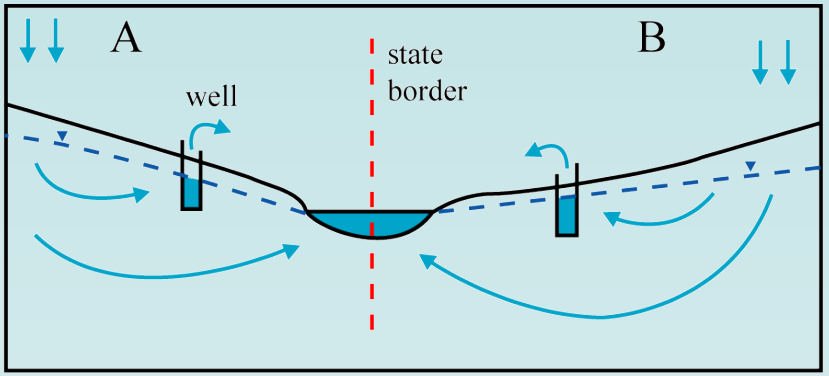
(TBA Activities Americas)

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

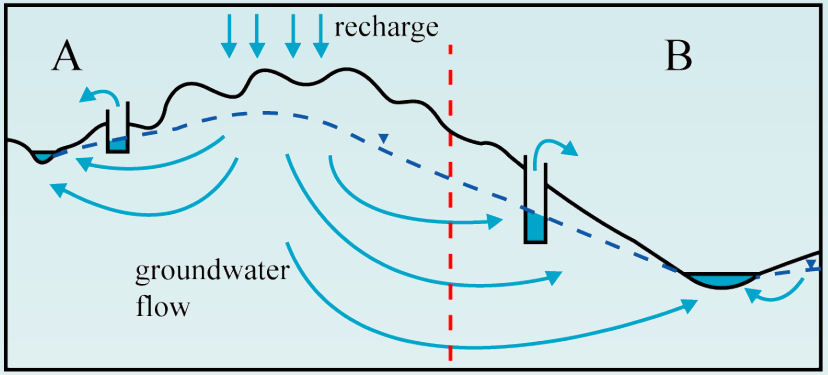
Classification, Diagnostics and Zoning



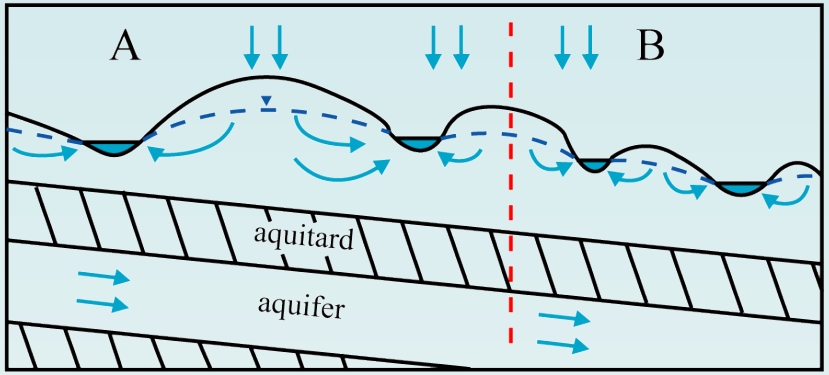
(1) state border follows surface water catchment and groundwater divide, little transboundary groundwater flow.



(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.



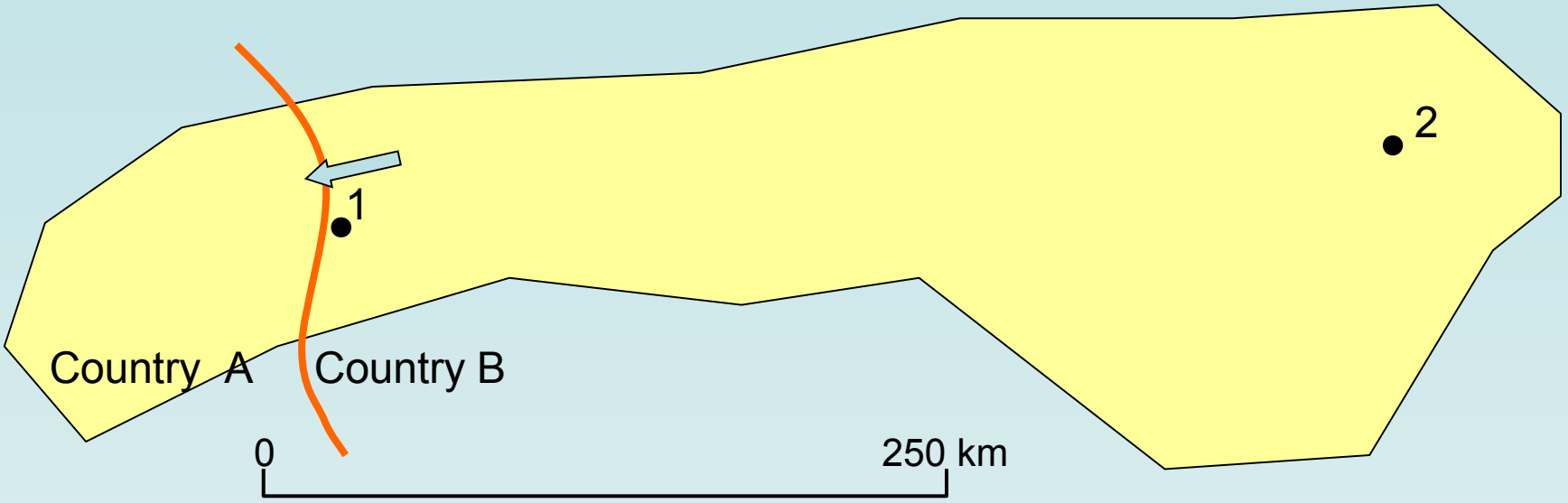
(4) Large deep aquifer, recharged far from border, not connected to local surface water and groundwater.

Classification, Diagnostics and Zoning

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

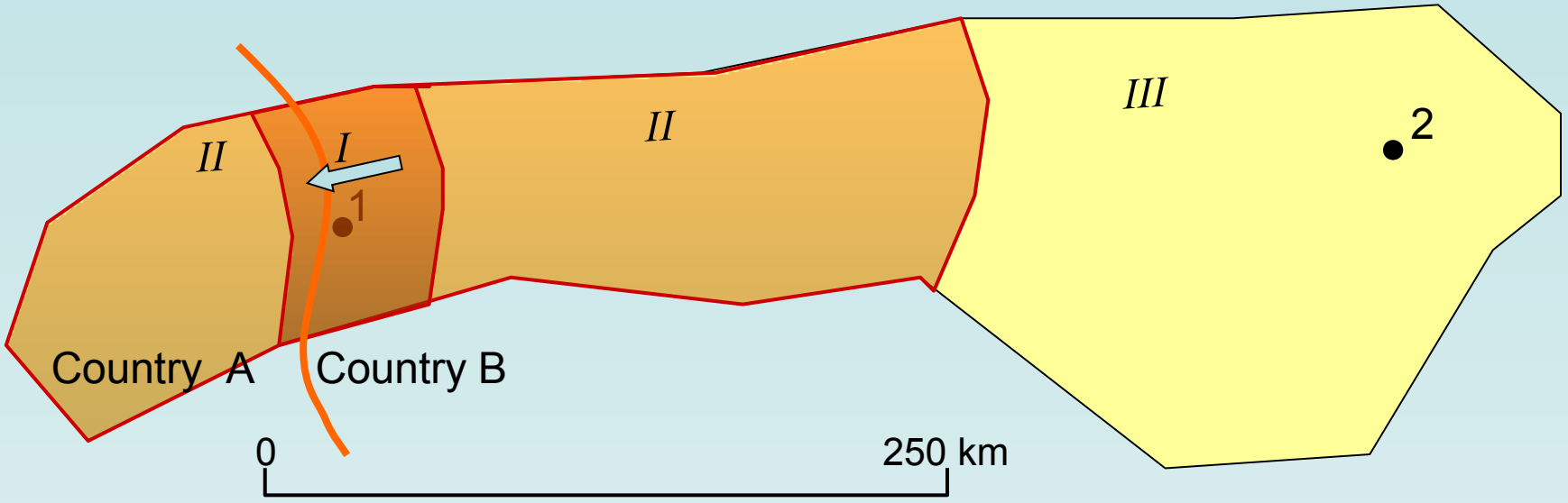
- Input for **diagnostics**:
  - inventory of major perceived issues and problems;
  - overview of possible actions
  - Priority and feasibility study, stakeholders and institutional analysis.

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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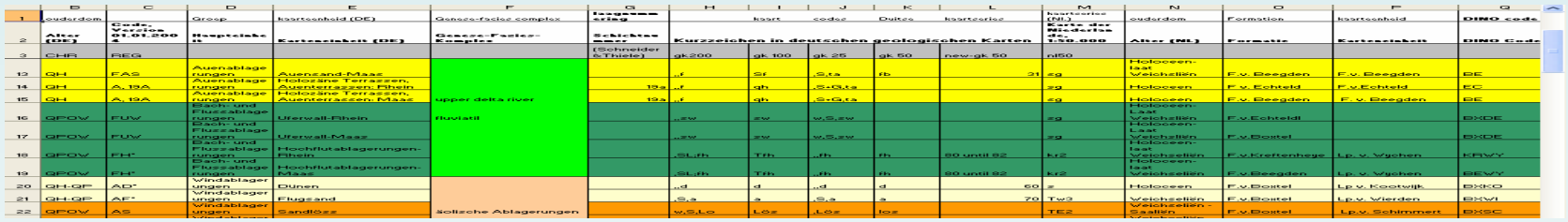
Harmonisation & Info management

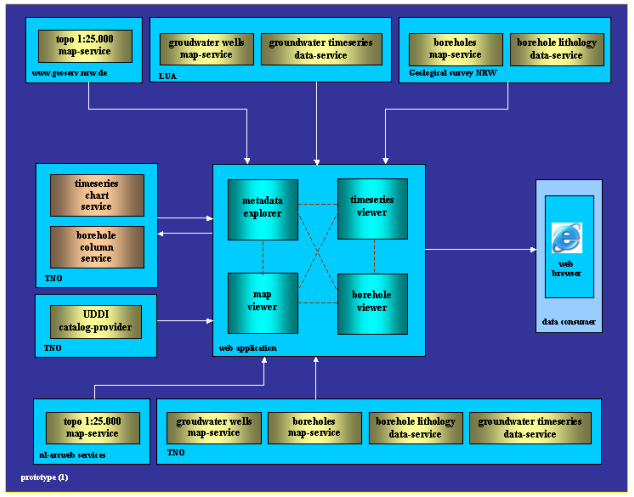
- Rationale
  - Assessment: **availability** and **quality** of data
  - Internationally – also data **harmonisation** & info management
- Technical activity
  - **Basically** harmonisation of formats, classifications, terminologies, reference systems, levels, software and hardware specific, etc.
  - Heavily **influenced** by political, organisational, legal, cultural and economical situation and agenda
- Objectives
  - Depend on **scope** and **scale**: visualisation, textual/spatial/temporal data, web-based, common processing, real-time

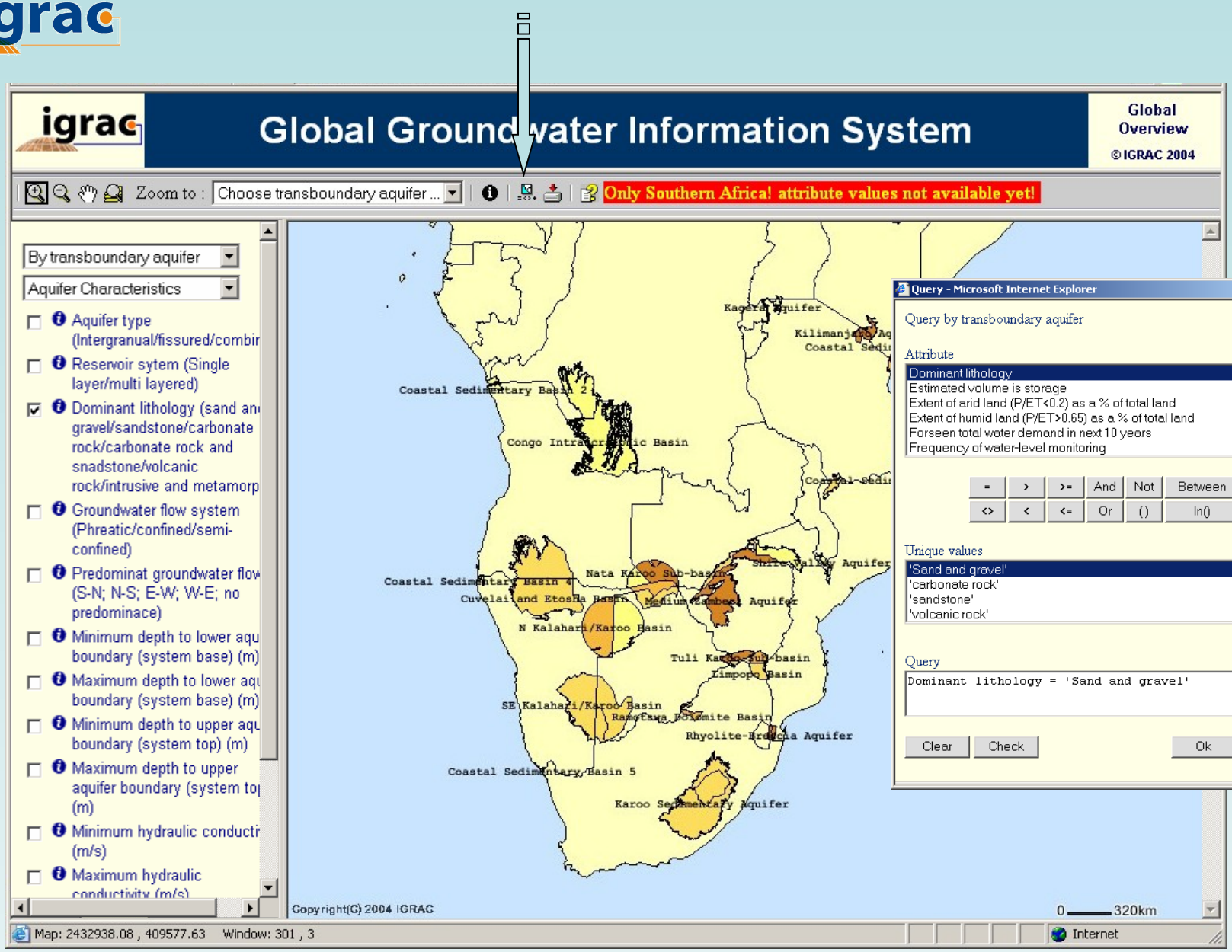


Harmonisation & Info management

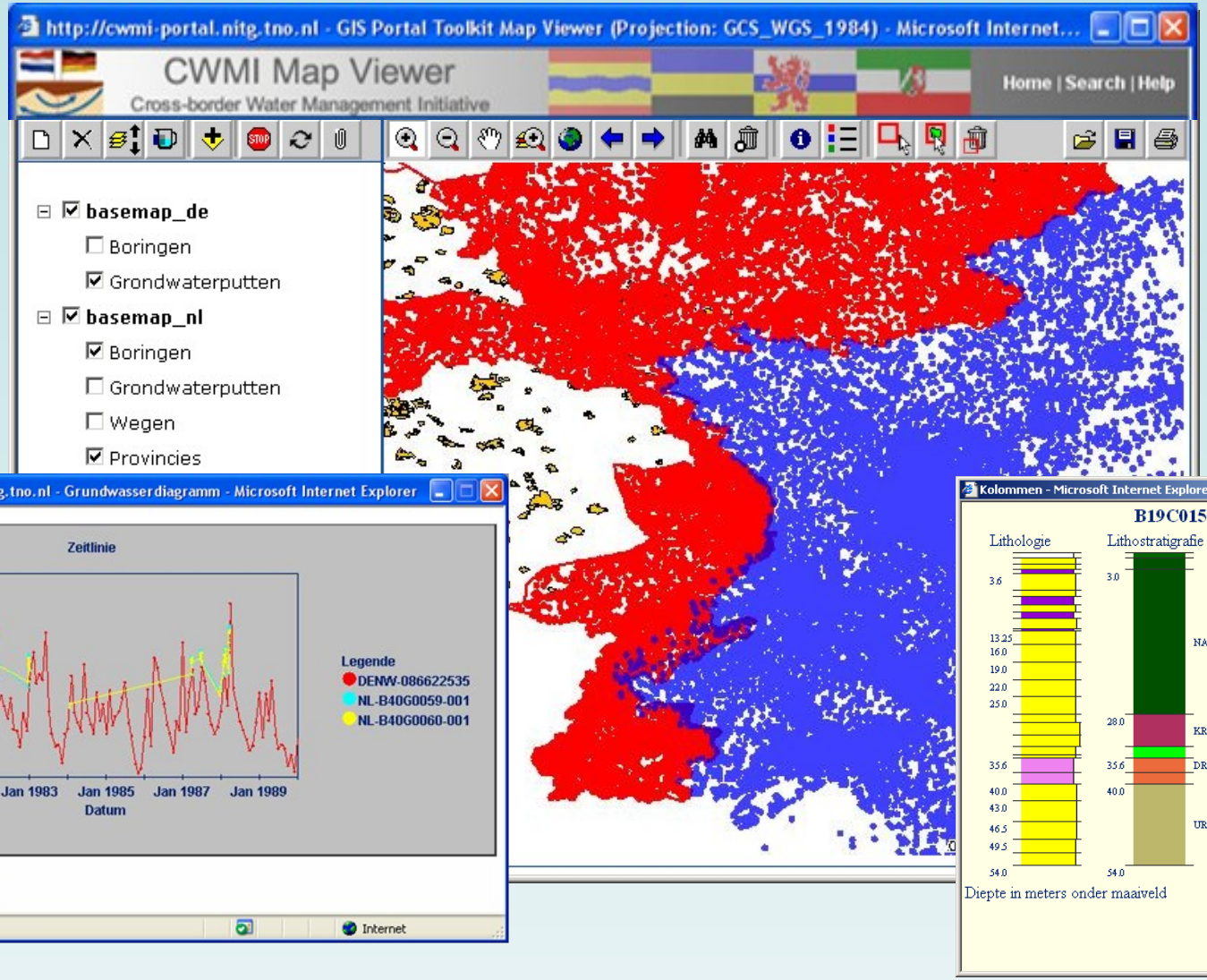
- Current situation
  - Mainly **simple GIS- based** databases (GEF projects)
  - Developed databases or systems are (according to the available information) **neither web-based, nor real-time**
  - Databases available via IGRAC and INWEB portals contain **meta information** on transboundary aquifers.
  - 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!




Global Groundwater Information System
Global Overview
© IGRAC 2004
Zoom to :
Choose transboundary aquifer ...
Only Southern Africa! attribute values not available yet!
By transboundary aquifer
Aquifer Characteristics
Aquifer type (Intergranual/fissured/combir
Reservoir sytem (Single layer/multi layered)
Dominant lithology (sand an gravel/sandstone/carbonate rock/carbonate rock and snadstone/volcanic rock/intrusive and metamorp
Groundwater flow system (Phreatic/confined/semi-confined)
Predominat groundwater flow (S-N; N-S; E-W; W-E; no predominace)
Minimum depth to lower aqu boundary (system base) (m)
Maximum depth to lower aqu boundary (system base) (m)
Minimum depth to upper aqu boundary (system top) (m)
Maximum depth to upper aquifer boundary (system to (m)
Minimum hydraulic conducti (m/s)
Maximum hydraulic conductivity (m/s)
Coastal Sedimentary Basin 2
Congo Intracratonic Basin
Coastal Sedimentary Basin 4
Nata Karoo Sub-basin
Cuvelai and Etosha Basin
Medium Zambezi Aquifer
N Kalahari/Karoo Basin
Tuli Karoo Sub-basin
Limpopo Basin
SE Kalahari/Karoo Basin
Rhyolite-Andesite Aquifer
Coastal Sedimentary Basin 5
Karoo Sedimentary Aquifer
Copyright(C) 2004 IGRAC
0 320km
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
= > >= And Not Between
<> < <= Or () In()
Unique values
'Sand and gravel'
'carbonate rock'
'sandstone'
'volcanic rock'
Retrieve
Query
Dominant lithology = 'Sand and gravel'
Clear Check Ok Close
Map: 2432938.08 , 409577.63 Window: 301 , 3
Internet

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