A world map showing groundwater resources, with different colors representing various hydrogeological conditions. The map is overlaid with a grid of latitude and longitude lines. The text is centered over the map.

Global Groundwater Maps

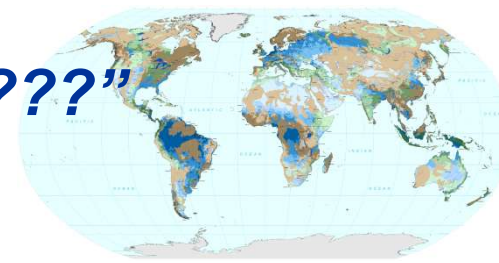
The World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP)

Andrea Richts, Sandra Groth & Uta Philipp

Federal Institute for Geosciences and Natural Resources (BGR)

Motivation

“WHY this MAP ???”



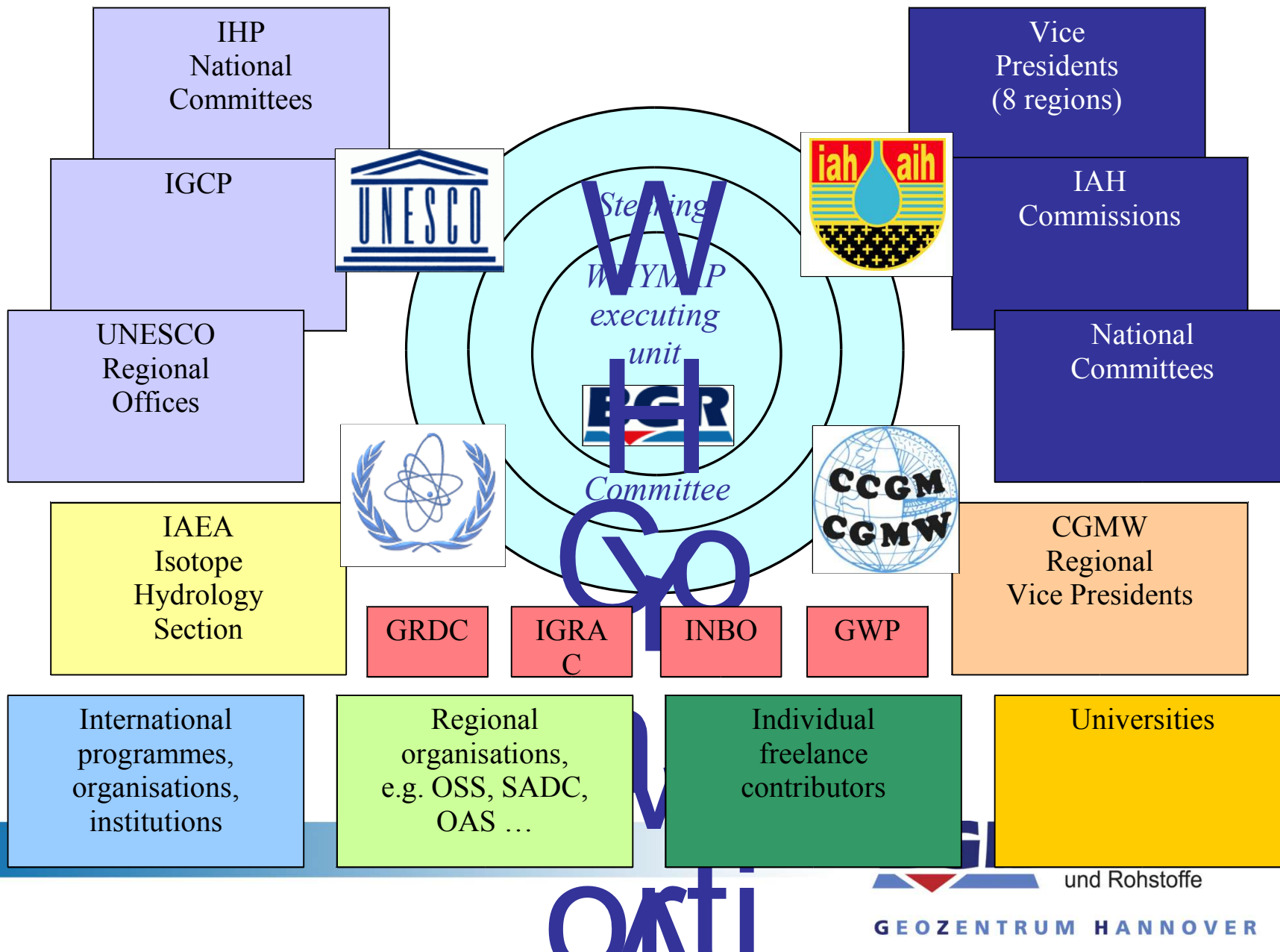
- rising political and public awareness of groundwater in discussions on global water issues
- communicate groundwater related information in an appropriate way to experts as well as non-experts
- educational purposes
- contribute to the world-wide efforts to better study and manage aquifer resources (knowledge still weak in many places)
- groundwater as a possible solution of increasing water shortage problems (“water crisis”)



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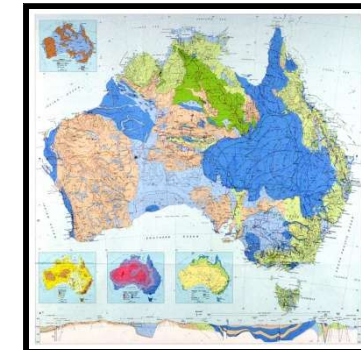
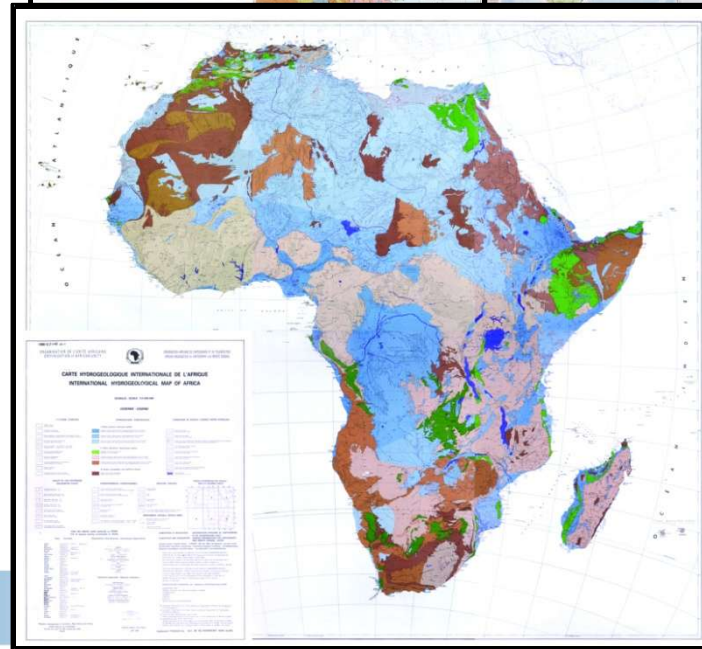
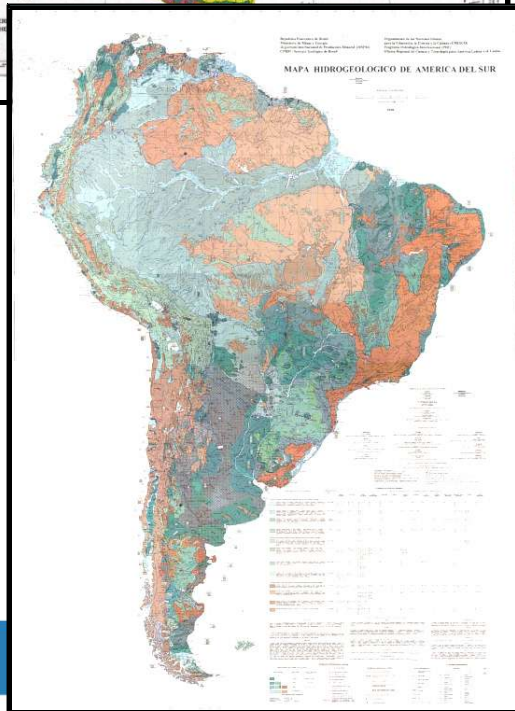
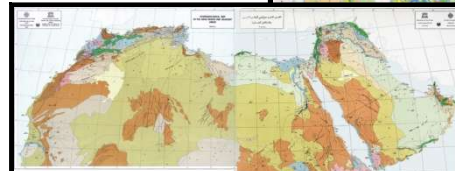
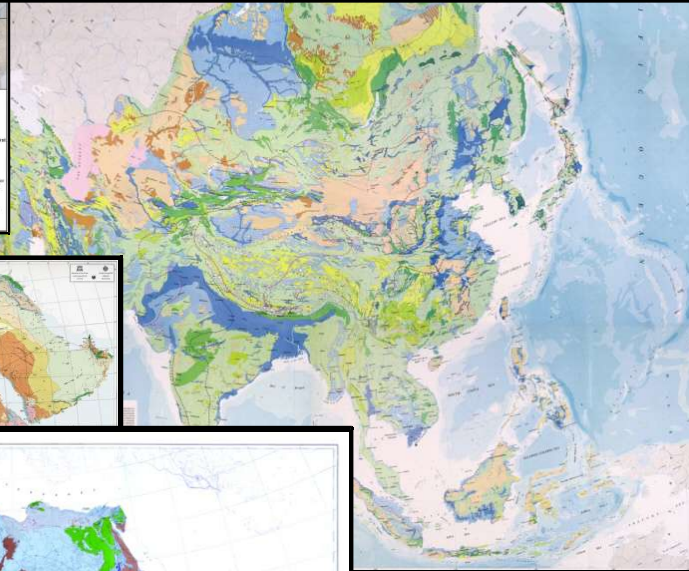
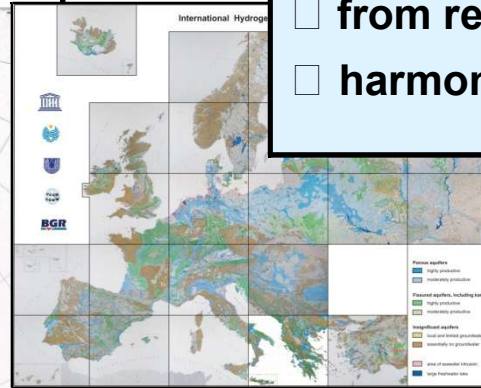
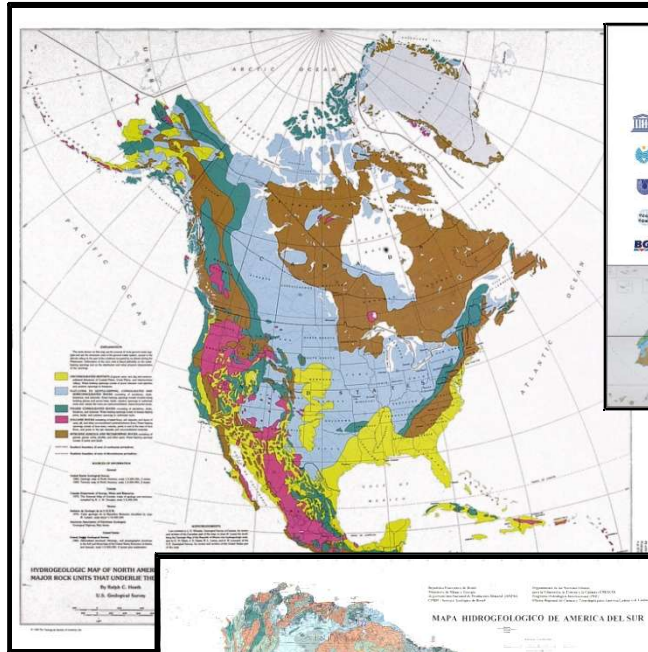
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The WHYMAP Network



key ideas

- from regional and continental to global
- harmonised view of groundwater resources

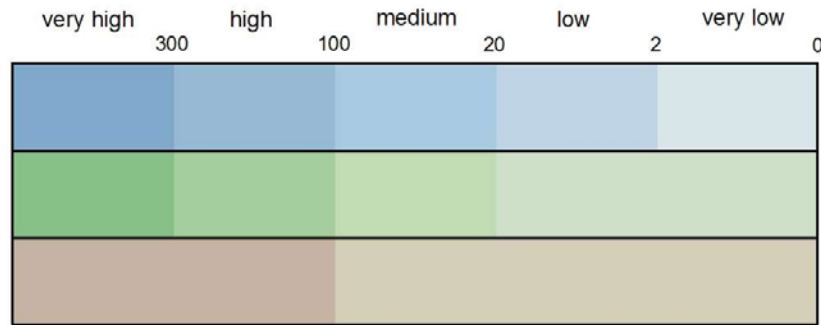


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Map legend

Groundwater Resources of the World 1 : 25 000 000

Groundwater resources and recharge (mm/year)



in major groundwater basins

in areas with complex hydrogeological structure

in areas with local and shallow aquifers

Special groundwater features



area of saline groundwater (> 5 g/l total dissolved solids (TDS))



natural groundwater discharge area in arid regions



area of heavy groundwater abstraction with over-exploitation



area of groundwater mining



selected wetland, mostly groundwater related

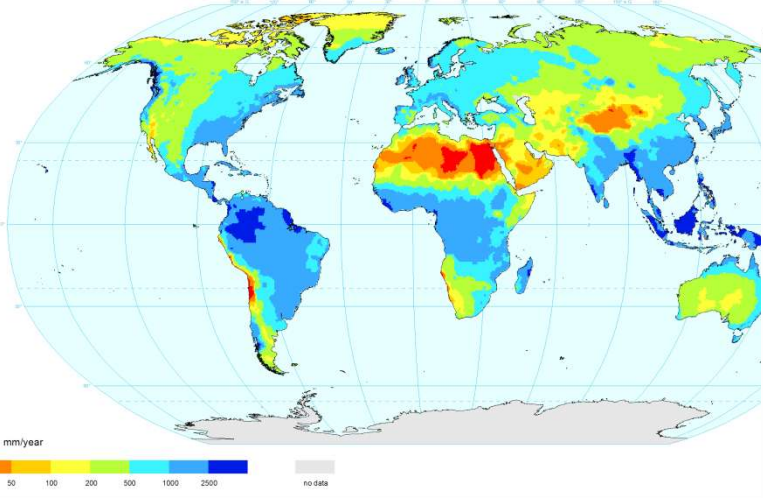


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und Rohstoffe

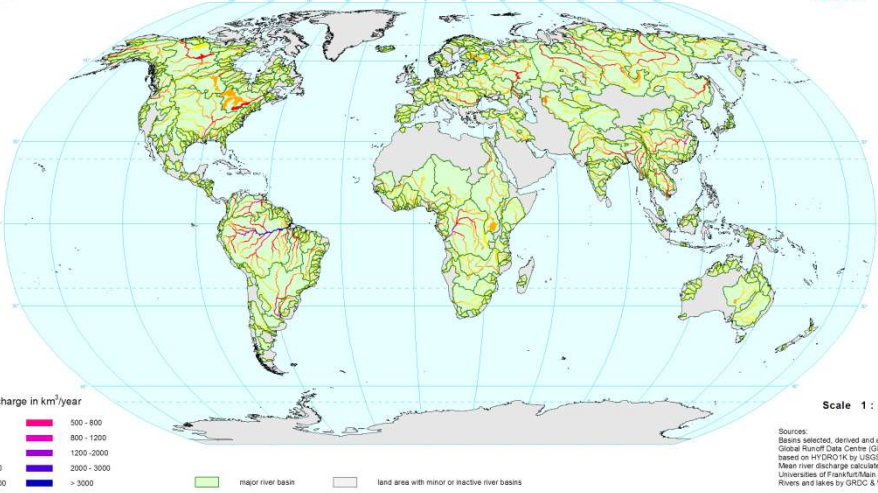
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Insert maps with additional groundwater related information

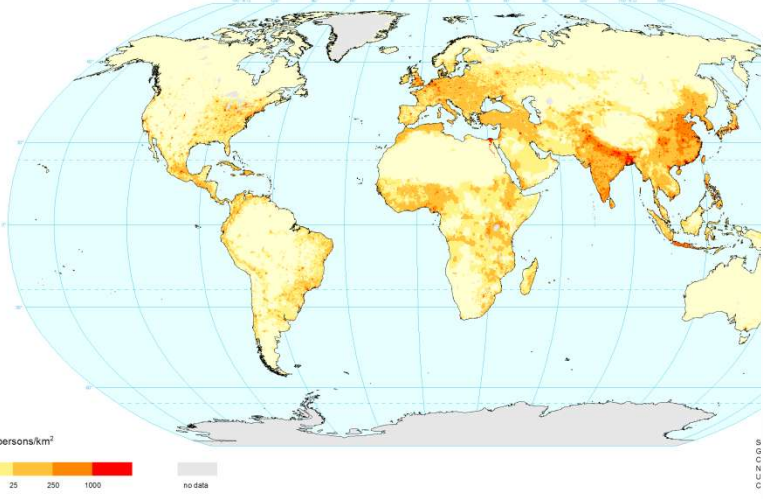
Mean Annual Precipitation (1961 - 1990)



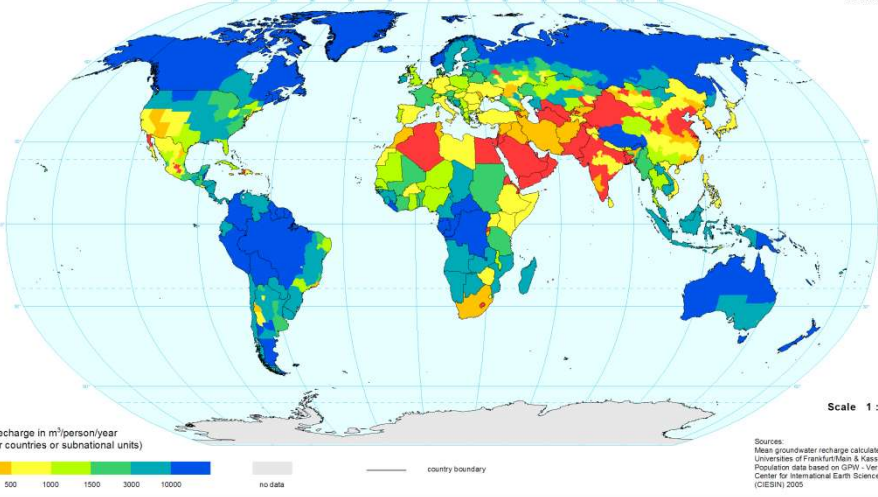
River Basins and Mean Annual River Discharge (1961 - 1990)



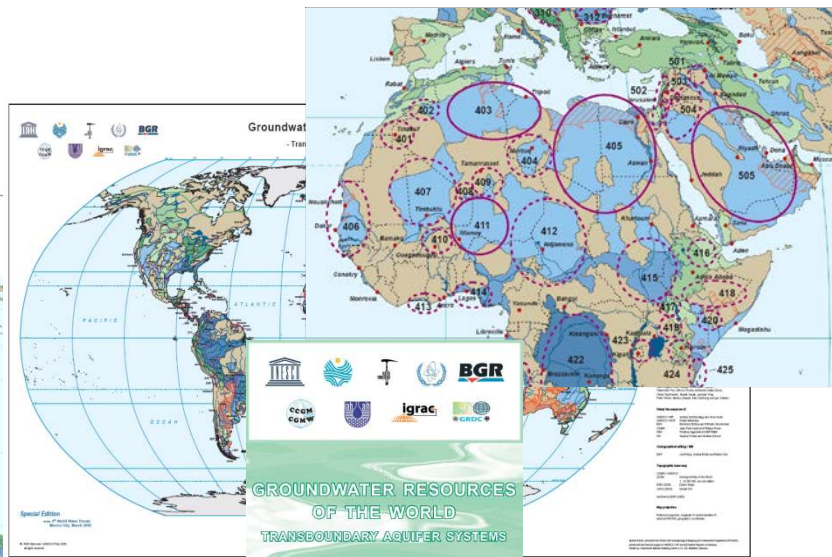
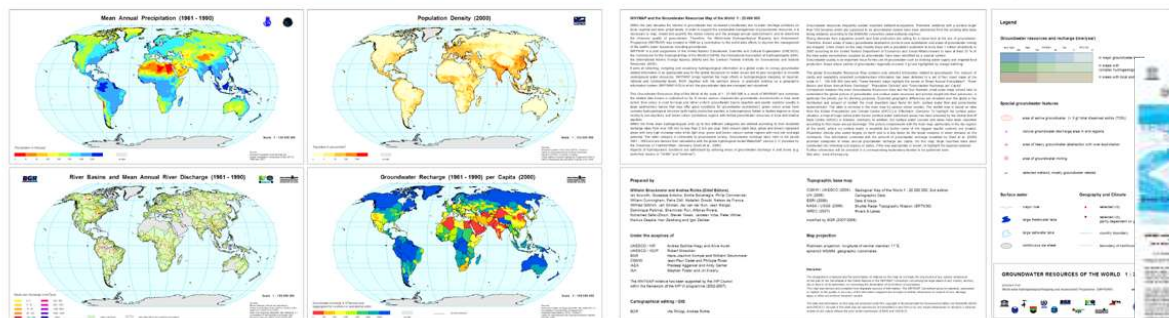
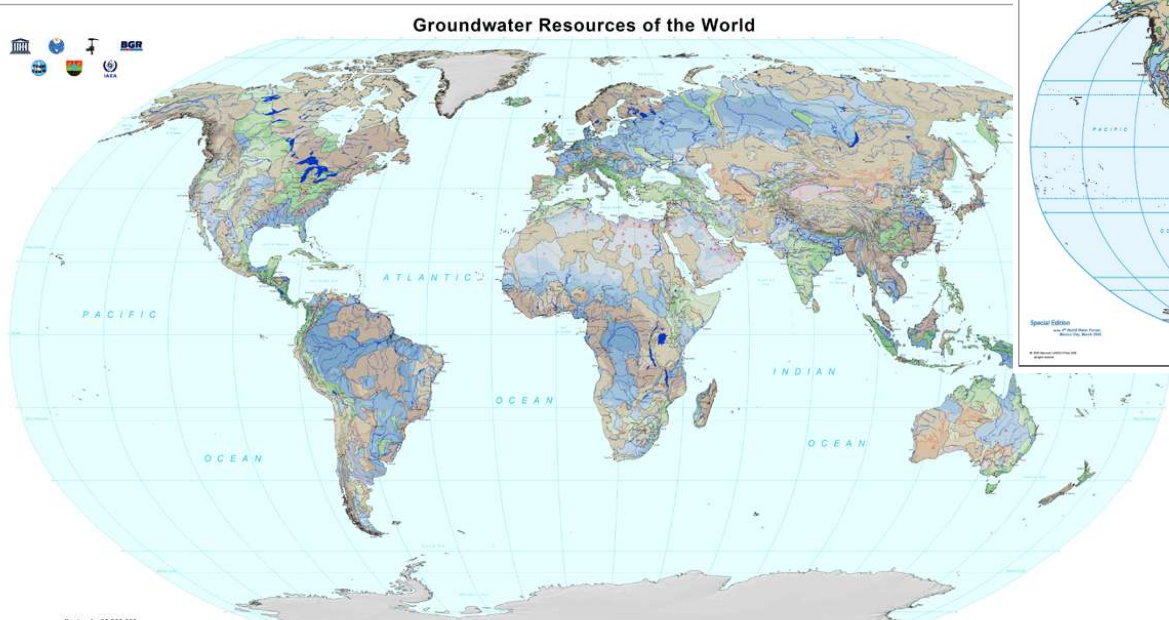
Population Density (2000)



Groundwater Recharge (1961 - 1990) per Capita (2000)

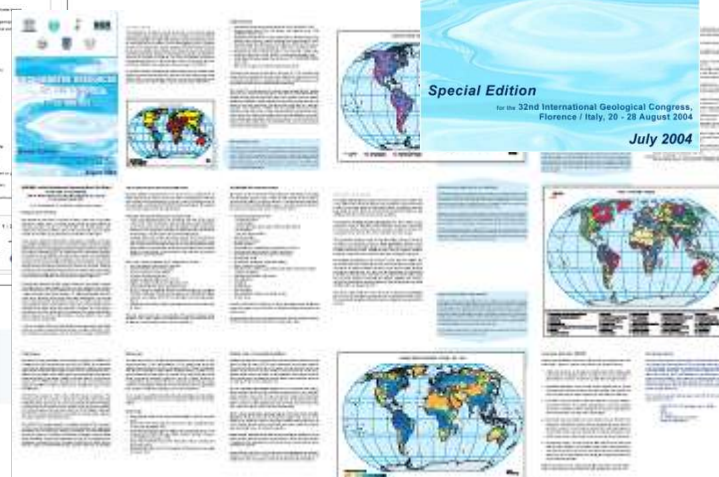


The global groundwater resources maps 1/25 M and 1/50M

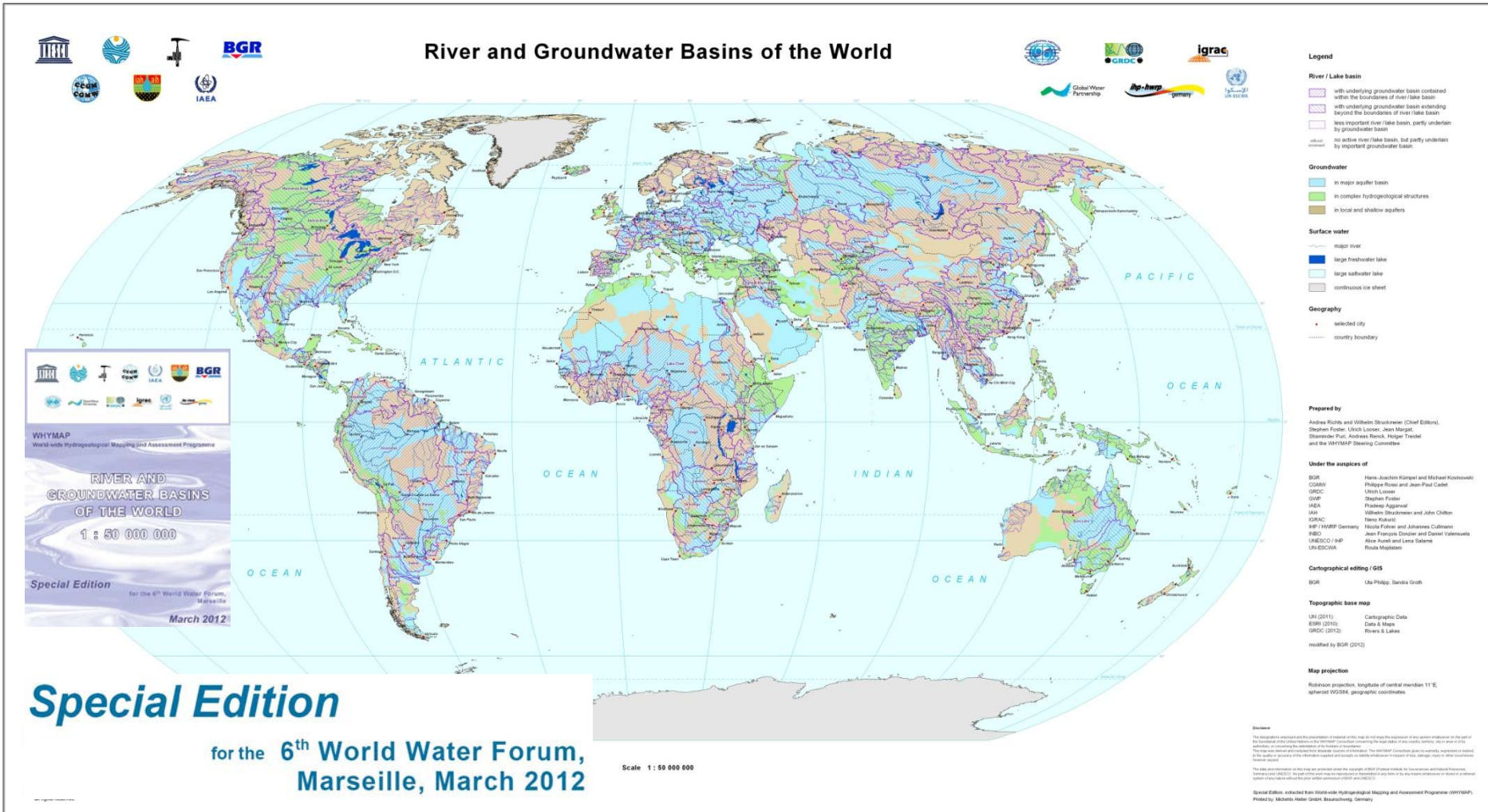


GROUNDWATER RESOURCES OF THE WORLD
TRANSBOUNDARY AQUIFER SYSTEMS
 1 : 50 000 000
 Special Edition
 for the 4th World Water Forum, Mexico City
 March 2006

GROUNDWATER RESOURCES OF THE WORLD
 1 : 50 000 000
 Special Edition
 for the 32nd International Geological Congress, Florence / Italy, 20 - 28 August 2004
 July 2004

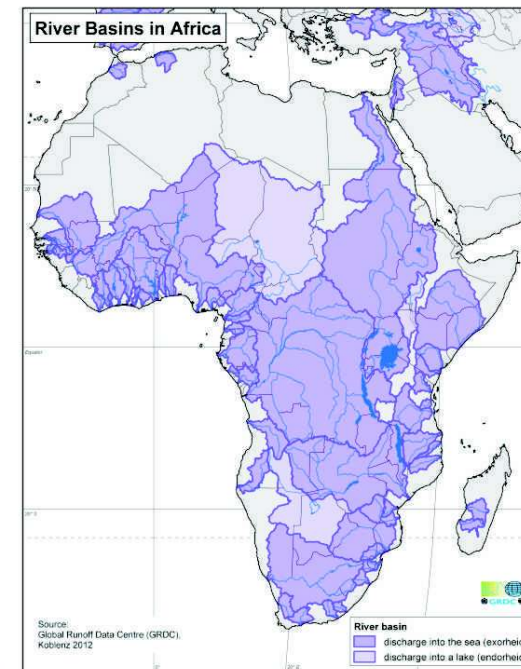
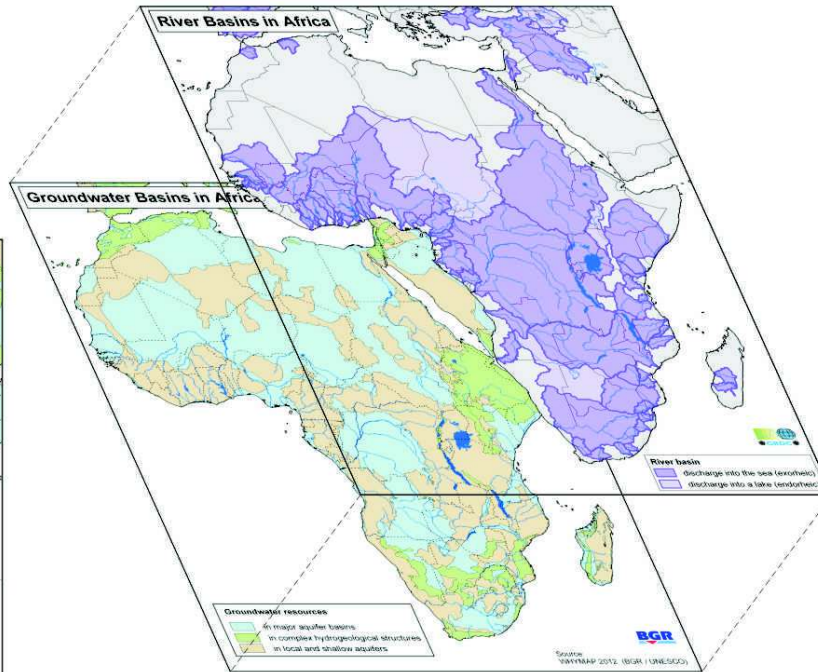
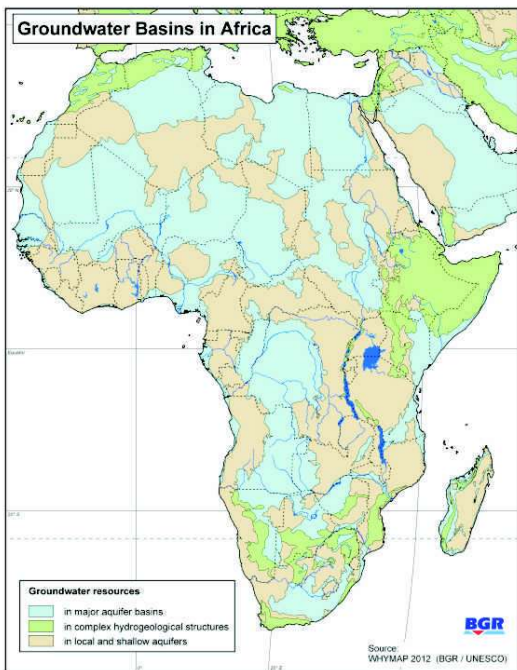


Global Map of River and Groundwater Basins



Surface Water vs. Groundwater


- comparing river/lake basins and aquifer systems



- boundaries and sizes often differ radically
- management units

- both have to be addressed in IWRM

Global Map of River and Groundwater Basins - explanatory notes -



WHYMAP
World-wide Hydrogeological Mapping and Assessment Programme

RIVER AND GROUNDWATER BASINS OF THE WORLD

1 : 50 000 000

Special Edition for the 6th World Water Forum, Marseille

By Andrea Rivoli, William Strickland and Shantani Pudar with contributions of Louis Loussier, Jean Margat, Dariusz Papi, Francis Sureau, Vanessa Sassen, and Gerd Wessels

Rationale for Map
Global population growth, need urbanisation, increasing industrialisation, agriculture intensification and tourism are putting water resources under increasing stress... This edition is a further expansion of the previous edition... It is intended as a management tool for water resources planning and decision-making.

In one country, and these trends are likely to continue in the future, the need for water is increasing rapidly. This is due to the fact that with increasing population there is an increasing demand for water. This is the case in all countries, but particularly in the developing countries. The need for water is increasing rapidly in the cities, where the population is increasing rapidly. This is due to the fact that with increasing population there is an increasing demand for water. This is the case in all countries, but particularly in the developing countries. The need for water is increasing rapidly in the cities, where the population is increasing rapidly.

Water Resources Mapping
Water resources mapping is the systematic collection of data on the natural and human-induced water resources of a basin. This data is then used to assess the water resources of a basin. This is done by collecting data on the natural water resources of a basin, such as rivers, lakes, and groundwater. This data is then used to assess the water resources of a basin. This is done by collecting data on the natural water resources of a basin, such as rivers, lakes, and groundwater.

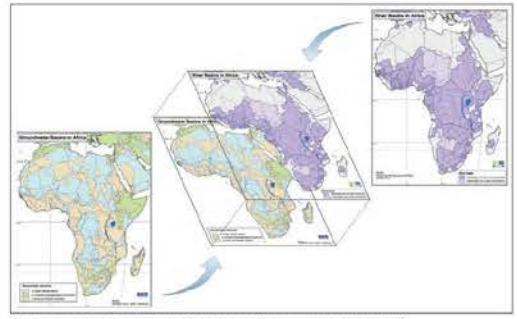


Figure 1. Pseudocolor map of river and groundwater basins in Africa based on maps of the basin (upper left) and groundwater basins (lower right)

Approach to Comparative Mapping of Basins at Global Scale
The present map delineates and approximates river-basin basins on the land surface, and the hydrogeological basins of underlying aquifers. This requires representing a three-dimensional reality on two-dimensional paper in an easily readable way which is both comprehensive and consistent.

Key Messages
Groundwater should play an equal part in the management of water resources, especially in the context of the growing water scarcity and agricultural irrigation and industrial production, and as part of the water supply management. Groundwater is usually regarded as part of the water supply management. However, groundwater systems have to be different from the surface water output controls as aquifers in subsurface basins.

Global population growth, need urbanisation, increasing industrialisation, agriculture intensification and tourism are putting water resources under increasing stress... This edition is a further expansion of the previous edition... It is intended as a management tool for water resources planning and decision-making.

March 2012

Figure 1. Integration of groundwater and surface water (2000/2008/2010/2012)

On the broader scale, the lower trends of major aquifers are predominantly of groundwater discharging, not recharge, but as such, they are not a net source of water. This means that the water resources of the world are not increasing, and the water resources of the world are not increasing, and the water resources of the world are not increasing.

Table 1. The basic forms of management, surface water and groundwater systems in global water management planning system

Type of Basin	Surface Water	Groundwater	Surface Water	Groundwater	Surface Water	Groundwater	Surface Water	Groundwater
Superficially irrigated (dry)	river	well	canal	well	canal	well	canal	well
Weather	rainfall	rainfall	rainfall	rainfall	rainfall	rainfall	rainfall	rainfall
Surface Water	pond	canal	canal	canal	canal	canal	canal	canal
Groundwater	shallow	shallow	shallow	shallow	shallow	shallow	shallow	shallow
Other Water Management	emergency plan	emergency plan	emergency plan	emergency plan	emergency plan	emergency plan	emergency plan	emergency plan

Integrating groundwater into broader water resources management has to be a multi-disciplinary effort, involving hydrogeologists, hydrologists, and other water resources specialists. An approach to managing hydrogeological diversity with river basins would require a multi-disciplinary effort, involving hydrogeologists, hydrologists, and other water resources specialists.

Figure 2. The possible scope of groundwater quality and management of aquifer utilization (this has been defined by the basin, 2008)

On the broader scale, the lower trends of major aquifers are predominantly of groundwater discharging, not recharge, but as such, they are not a net source of water. This means that the water resources of the world are not increasing, and the water resources of the world are not increasing.

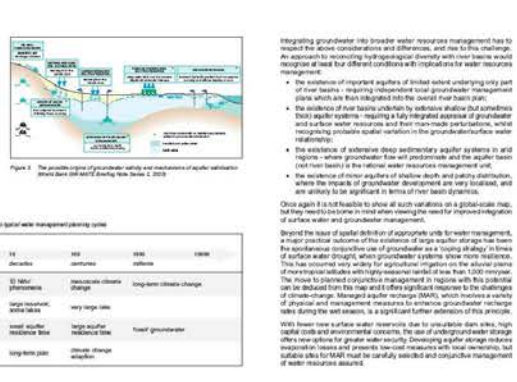


Figure 2. The possible scope of groundwater quality and management of aquifer utilization (this has been defined by the basin, 2008)

References
BGR & UNESCO (2005) Groundwater Resources of the World. Transboundary Aquifer Systems, 2005/002. Berlin, Germany: BGR & UNESCO.

BGR & UNESCO (2008) Groundwater Resources of the World, 2008/002. Berlin, Germany: BGR & UNESCO.

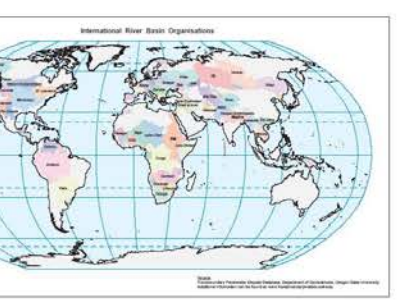
FAO & UNESCO (2005) Groundwater Resources of the World, 2005/002. Berlin, Germany: FAO & UNESCO.

FAO & UNESCO (2008) Groundwater Resources of the World, 2008/002. Berlin, Germany: FAO & UNESCO.

FAO & UNESCO (2010) Groundwater Resources of the World, 2010/002. Berlin, Germany: FAO & UNESCO.

GLOBAL WATER PARTNERSHIP (GWP)
GWP is an international network whose main aim is to support the sustainable development and management of water resources of all states. GWP was created in 1996 by BGR (Integrated Water Resources Management) as the project to which water resources, sustainability and efficiency, and thus water security, could be achieved.

WHYMAP
WHYMAP endeavours to promote the local or cross-border management of water, land and related resources for increasing economic and social welfare, while ensuring the sustainability of the water resources systems. The WHYMAP process helps to manage and develop water resources in a sustainable and balanced way by taking account of social, economic and environmental interests, understanding the water access sectors and the water supply and distribution systems, and the water resources systems. It emphasizes the need for involvement in national policy and law-making and the establishment of legal frameworks, policies, procedures, and institutional and regulatory arrangements. A range of tasks, including social and educational activities, economic instruments, and information and monitoring systems, support this process.



INTERNATIONAL NETWORK OF BASIN ORGANIZATIONS (INBO)
Basin organizations in the general term used for all types of institutions that manage drainage basins. said can be anything from large formal agencies to small informal committees. They vary in purpose according to their members and/or management of water resources, but they may have functions of water resources investigation, monitoring and regulation, water resources development and management, and planning of agricultural management measures. Some 47% of the total global continental land area including Antarctica and Greenland is covered by river and lake basins that are under basin management agreements, and two thirds of which are very large international or national basins, with the remaining area that not yet covered many because of their very small size.

River Basins and Mean Annual Discharge

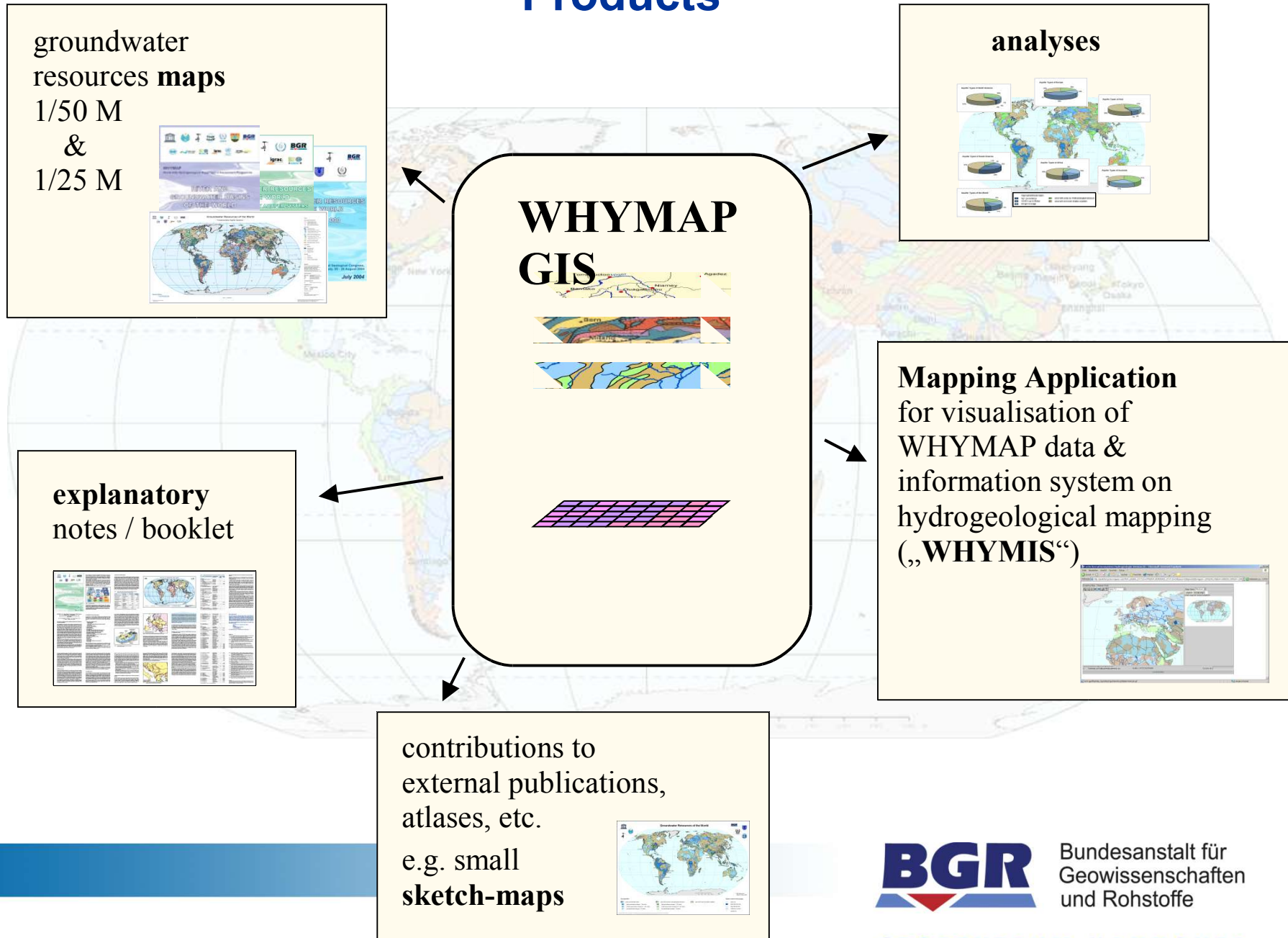
WHYMAP PROGRAMME
WHYMAP (World-wide Hydrogeological Mapping and Assessment Programme) is a project of the BGR (Bundesanstalt für Geowissenschaften und Rohstoffe), CCGR (Commission for the Geographical Map of the World), and International Association of Hydrogeologists, IAEA International Atomic Energy Agency and BGR (Federal Institute for Geosciences and Natural Resources, Germany), was established in 1999 as a contribution to management of the world's water resources, especially groundwater.

WHYMAP collects, organizes and collates groundwater-related hydrogeological information, in continental and global scales, to feed global databases of water basins by using existing water resources data. To achieve this it synthesizes the very large amount of hydrogeological mapping data from regional and national scale, and is producing a global hydrogeological information system (WHYMAP-GIS) in which groundwater data are managed and evaluated. The following major products have been defined from WHYMAP:

- 2003: First global groundwater resources map at the scale of 1:500 000 000 published in the 4th World Water Development Report.
- 2004: First global groundwater resources map at the scale of 1:50 000 000 published in the 32nd IAGLR Geological Congress.
- 2006: World map showing hydrogeological basins for the 4th World Water Forum in Mexico City.
- 2007: First global groundwater resources map of the World at the scale of 1:25 000 000 published as a contribution to the International Year of Planet Earth.

Additionally an international map is available, which combines WHYMAP data with information systems on national, regional and continental hydrogeological maps (WHYMAP-GIS). All products and services are accessible via the programme web site: www.whymap.org.

Products



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und Rohstoffe

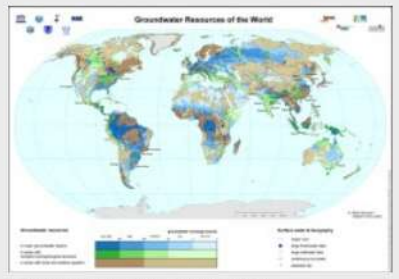
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<http://www.whymap.org>



- About WHYMAP
- Products
- Statistics
- Map applications/services
- Downloads

Whymap
World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP)



Groundwater resources of the world
Source: BGR & UNESCO

Groundwater is the largest accessible and often still untapped freshwater reservoir on earth. Its world-wide resources are assessed at 10.5 million km³. The increasing number of regional water shortages and water crises can only be met with a rational and sustainable use of this resource. Such sustainable use requires understanding and knowledge as well as careful planning and management. Yet, information on this hidden resource is still weak in many places.

In order to provide data and information about the major groundwater resources of the world and thus make a contribution to their reasonable management and protection the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) was launched in 2000.

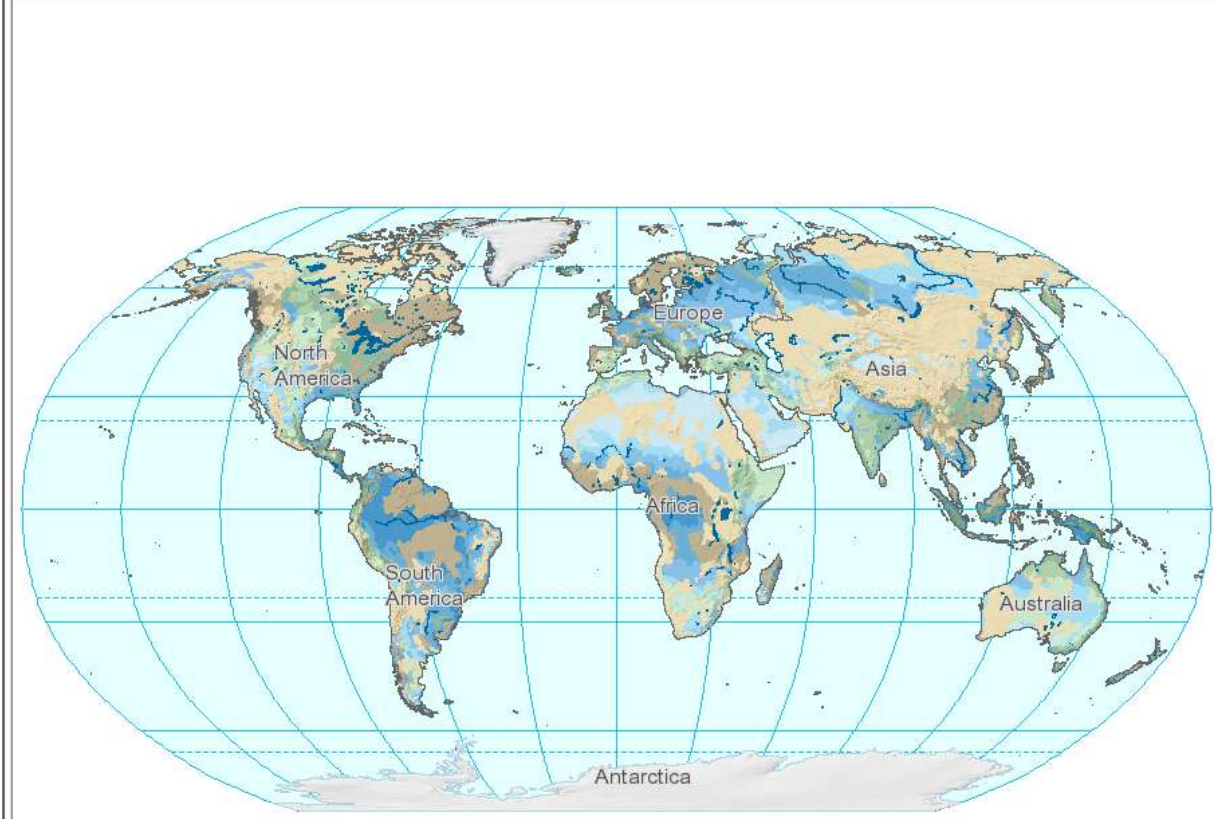
The programme compiles data on groundwater from national, regional and global sources, and visualises them in maps, web map applications and services. The generated products provide information on quantity, quality and vulnerability of the groundwater resources on earth and help communicating groundwater related issues to water experts as well as decision makers and the general public.

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WHYMAP Web Map Application

WHYMAP - World-wide Hydrogeological Mapping and Assessment Programme

WHYMIS Jump to ... Pan



Map size: medium

- Legend Key Map
- Groundwater**
- Groundwater resources and recharge
 - MAJOR GROUNDWATER BASIN
 - very high recharge (> 300 mm/year)
 - high recharge (100 - 300 mm/year)
 - medium recharge (20 - 100 mm/year)
 - low recharge (2 - 20 mm/year)
 - very low recharge (< 2 mm/year)
 - COMPLEX HYDROGEOLOGICAL STRUCTURE
 - very high recharge (> 300 mm/year)
 - high recharge (100 - 300 mm/year)
 - medium recharge (20 - 100 mm/year)
 - low - very low recharge (< 20 mm/year)
 - LOCAL AND SHALLOW AQUIFERS
 - very high - high recharge (> 100 mm/year)
 - medium - very low recharge (< 100 mm/year)
 - area of low rainfall (< 200 mm/year)
 - area of saline groundwater (> 5 g/l TDS)
 - Transboundary Aquifer System
- Surface Water**
- major river
 - large freshwater lake
 - large saltwater lake
 - major catchment basin
 - continuous ice sheet
- Geography and Climate**
- selected city
 - country boundary
 - continent boundary
 - boundary of continuous permafrost
 - grid
- Raster Image**
- world relief



Scale 1:168315100

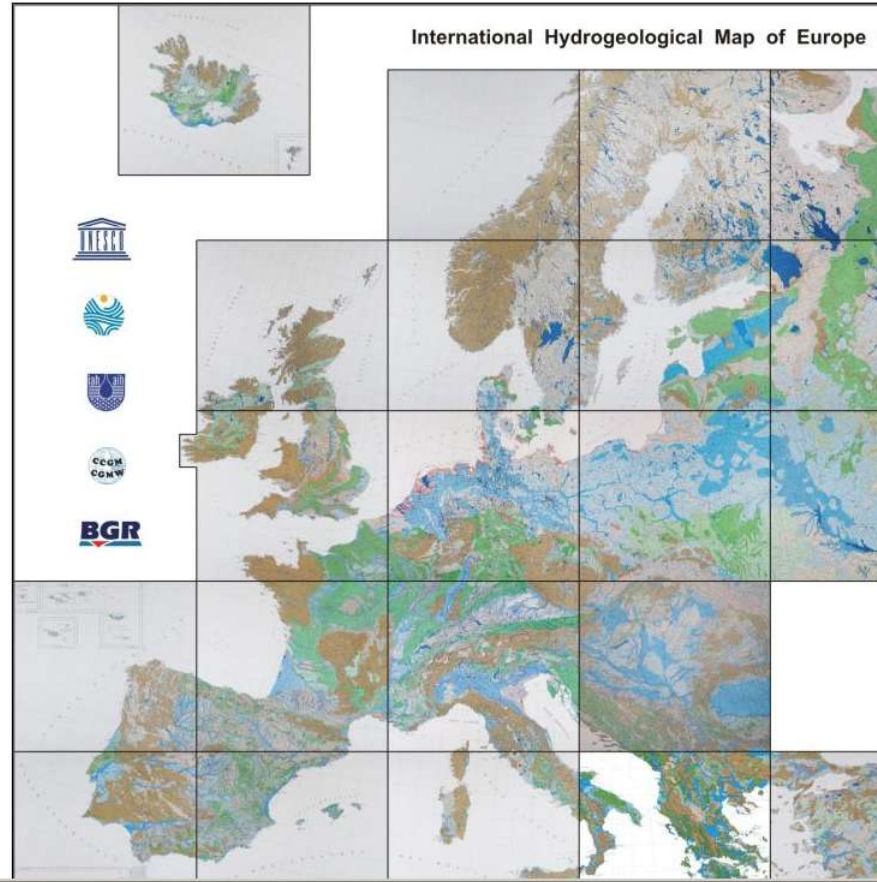
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WHYMIS – Map Information System

WHYMIS, World-wide Hydrogeological Map Information System

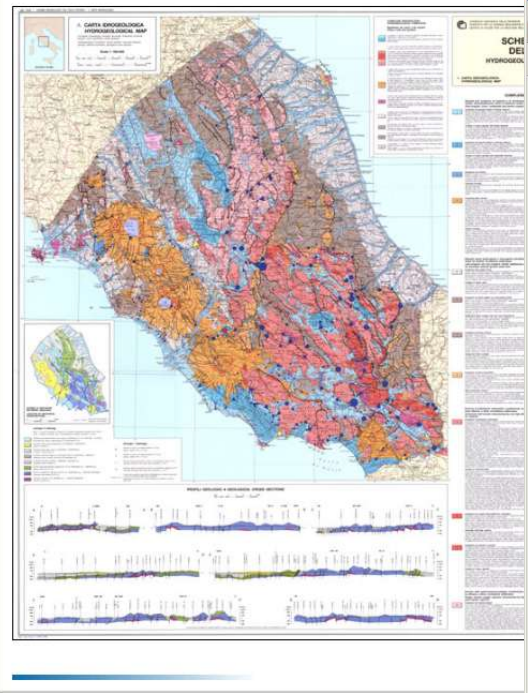
Europe

Title: International Hydrogeological Map of Europe (IHME 1500)
 Scale: 1: 1 500 000
 Year: 1960 - 2005
 Publisher: Federal Institute for Geosciences and Natural Resources (BGR) & United Nations Educational, Scientific and Cultural Organization (UNESCO)
 Internet: <http://www.bgr.bund.de>
 Web Mapping: <http://www.bgr.de/app/ihme1500/>
 Legend: [Legend](#)



Italy

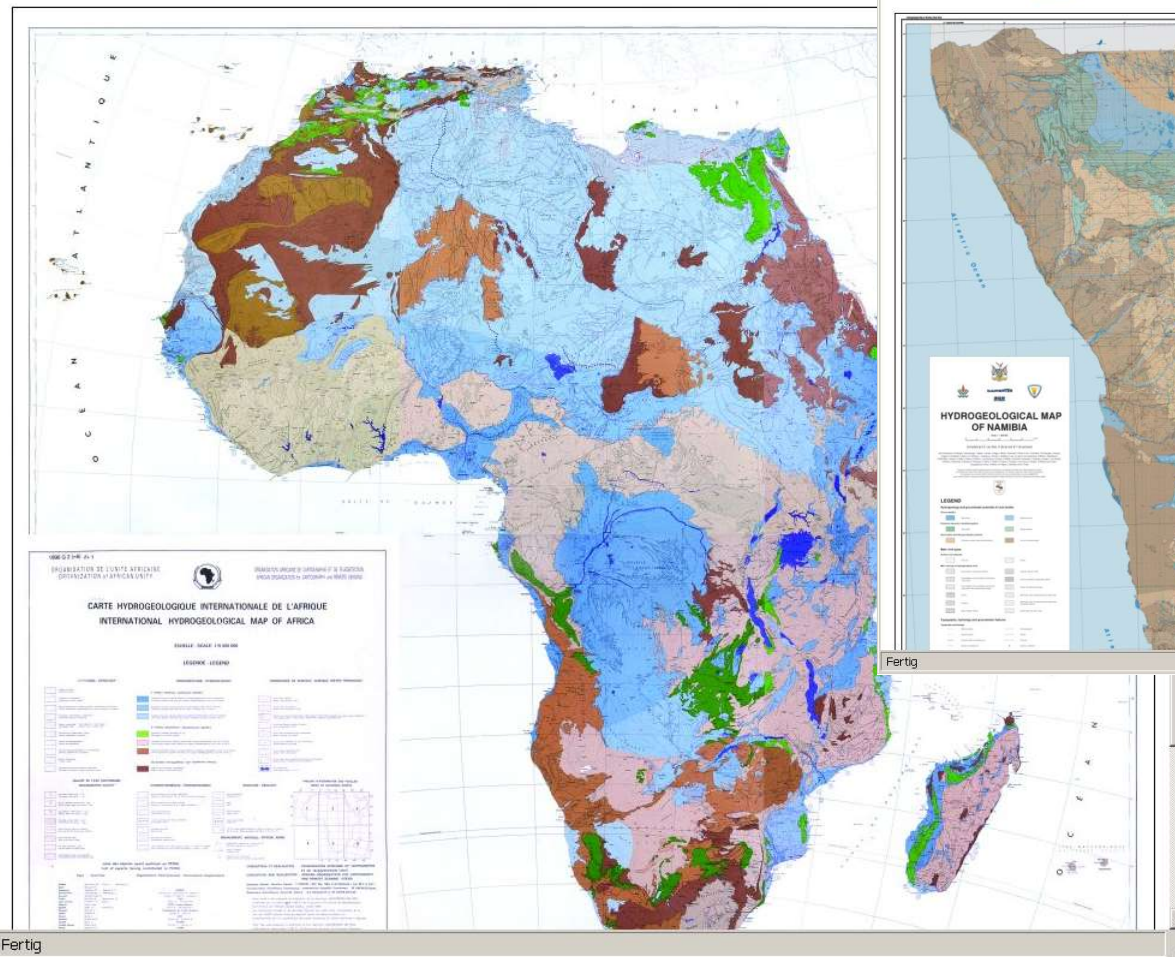
Title: Hydrogeological Scheme of Central Italy - Hydrogeological Map / Shema Idrogeologico dell'Italia Centrale - Carta Idrogeologica
 Scale: 1: 500 000
 Year: 1987
 Editor: Boni, C., Bono, P. & Capelli, G.
 Publisher: Centro di Studio per la Geologia dell'Italia Centrale, Roma
 Int. Number: ISSN 0375-9857
 Legend: [Legend](#)



WHYMIS, World-wide Hydrogeological Map Information System

Africa

Title: International Hydrogeological Map of Africa
 Scale: 1 : 5 000 000
 Year: 1992
 Editor: Safar Zitoun, M. & Nouiouat, A.C.
 Publisher: Organisation Africaine de Cartographie et de Télédétection (OACT)
 Legend: [Legend](#)



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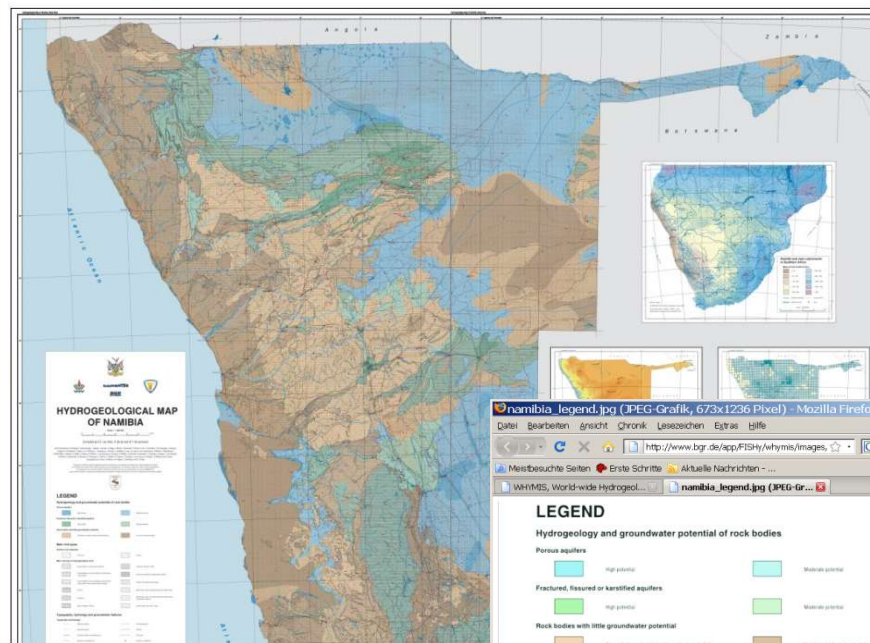
WHYMIS – Map Information System

WHYMIS, World-wide Hydrogeological Map Information System

Namibia

Map no. 1

Title: Hydrogeological Map of Namibia
 Scale: 1 : 1 000 000
 Year: 2001
 Editor: Wyk, A.E. van, Strub, H. & Struckmeier, W.F.
 Publisher: Geological Survey Namibia, Department of Water Affairs, Windhoek & Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover
 Int. Number: ISBN 0-86976-571-X
 Legend: [Legend](#)



Fertig

namibia_legend.jpg (JPEG-Grafik, 673x1236 Pixel) - Mozilla Firefox

http://www.bgr.de/app/FISHy/whymis/images/...

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LEGEND

Hydrogeology and groundwater potential of rock bodies

Porous aquifers	High potential	Medium potential
Fractured, fissured or karstified aquifers	High potential	Medium potential
Rock bodies with little groundwater potential	Slightly low potential, moderate potential	Very low potential

Main rock types

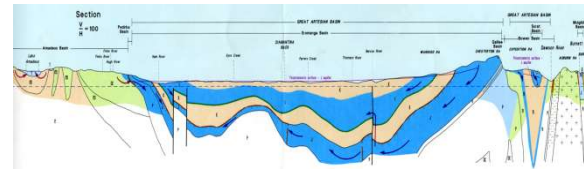
Surface cover deposits	Clay loam	Clay loam
Main rock type of hydrogeological units	Sand and gravel, little fracture (shallow)	Limestone, dolomite, marl
	Unconsolidated to semi-consolidated sand and gravel, sandy gravels	No porous sandstone, conglomerate, granite
	Unconsolidated to semi-consolidated sand and gravel, sandy gravels, with fractured bedrock contact	Volcanic rocks (basalt and gabbro)
	Gabbro	Metamorphic rocks, including quartzite and orthogneiss
	Sandstone	Metamorphic rocks, including quartzite and orthogneiss, with gabbro intrusions
	Shale, medium to coarse	Granite, gabbro, orthogneiss, dykes



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Outlook: next steps of WHYMAP

- correction and improvement of the existing maps
- compilation of new thematic layers (e.g. karst, submarine gw-discharge, climate change/population growth, etc.)
- towards the third dimension:
include hydrogeological sections
- preparation of new map products
- WHYMAP information system “WHYMIS”: complete / establish a network and information base for “map makers” of gw maps



more information available at

www.whymap.org



contact:

whymap@bgr.de

Andrea Richts
Federal Institute for Geosciences and Natural Resources
(BGR)

THANK YOU!