Climate Change calls for better consideration of **Groundwater** in **River Basin Management**

because

Rivers and underlying Aquifer systems are coupled systems

and

CC will hit surface water first whilst groundwater will serve as a buffer first, but will be hit later by CC

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Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)
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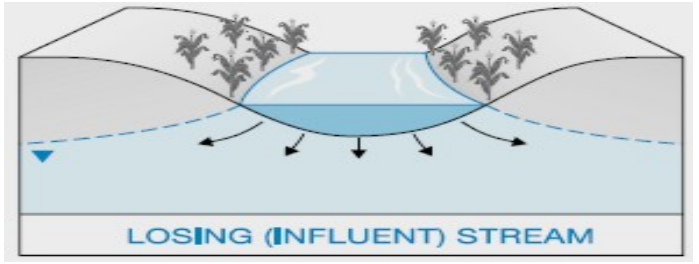
+

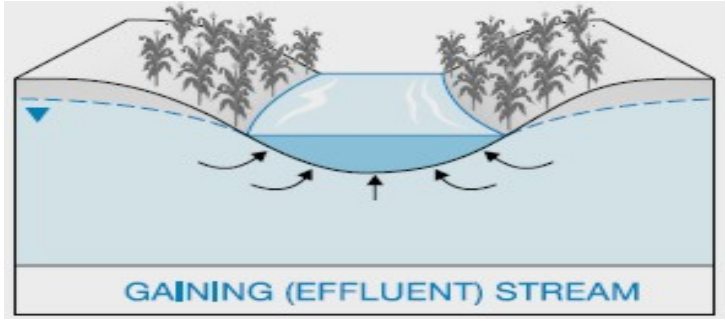
President

The International
Groundwater Organisation

Rivers and underlying aquifer systems are coupled systems

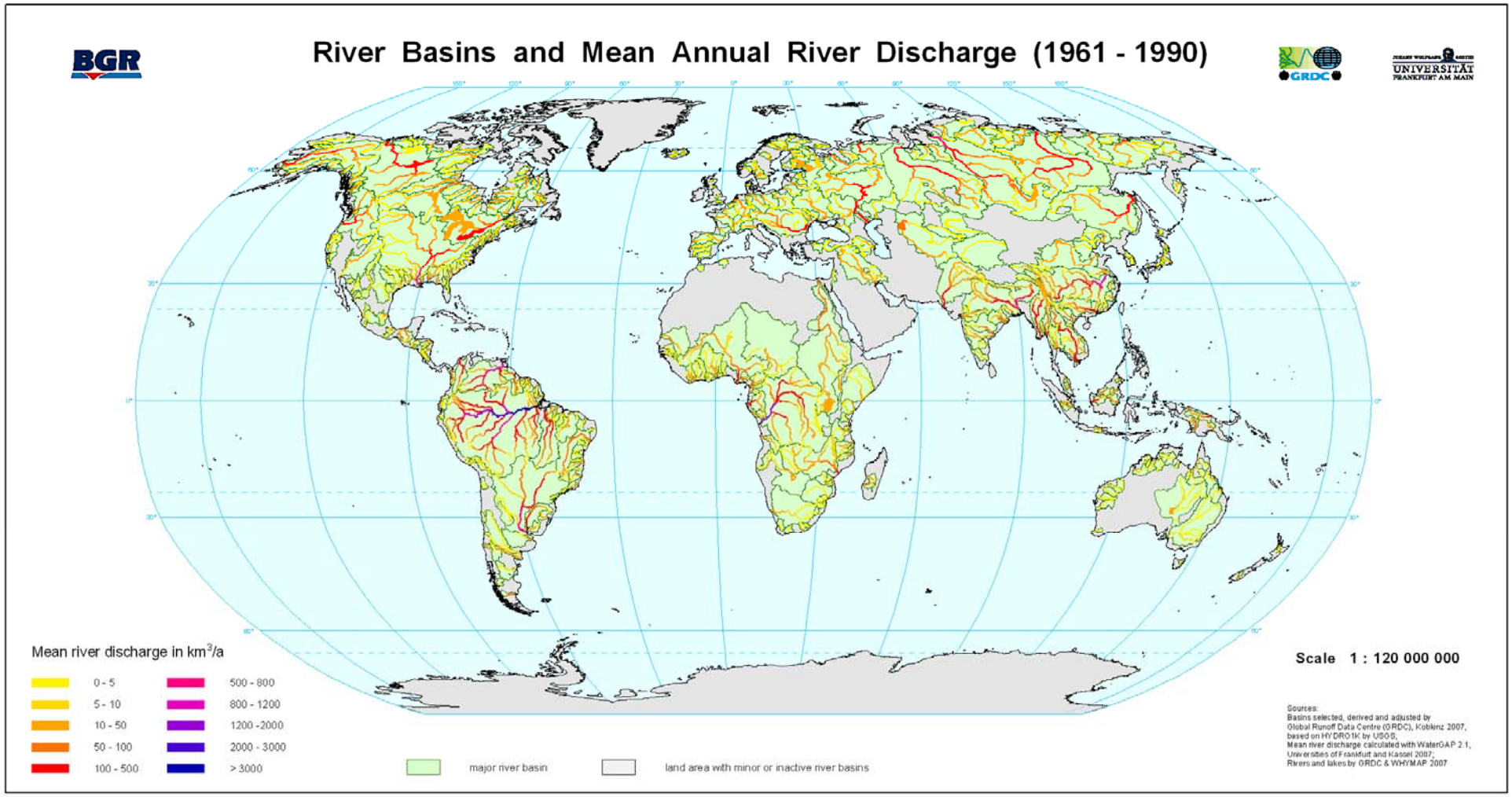


- river water may infiltrate into the ground and recharge underlying aquifers
- discharge from aquifers sustains surface flow and groundwater dependent ecosystems (dry periods)



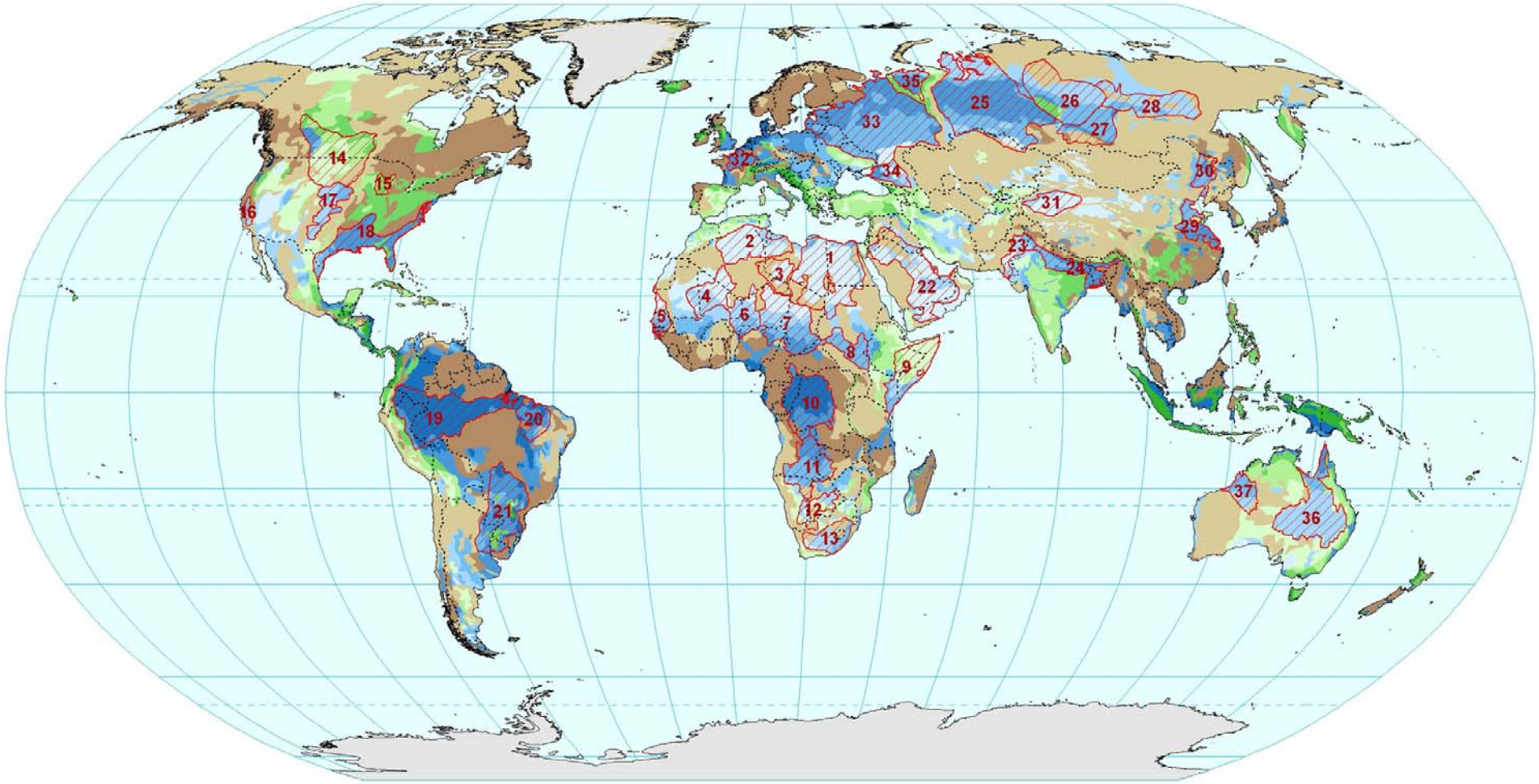
- no connection between river and aquifers (deep water table, largely decoupled systems or no aquifer underneath)

New Map of the Global Runoff Data Centre, Koblenz/Germany (2008)



….. within the WHYMAP project of BGR, UNESCO, IAH, IAEA, CGMW and others …

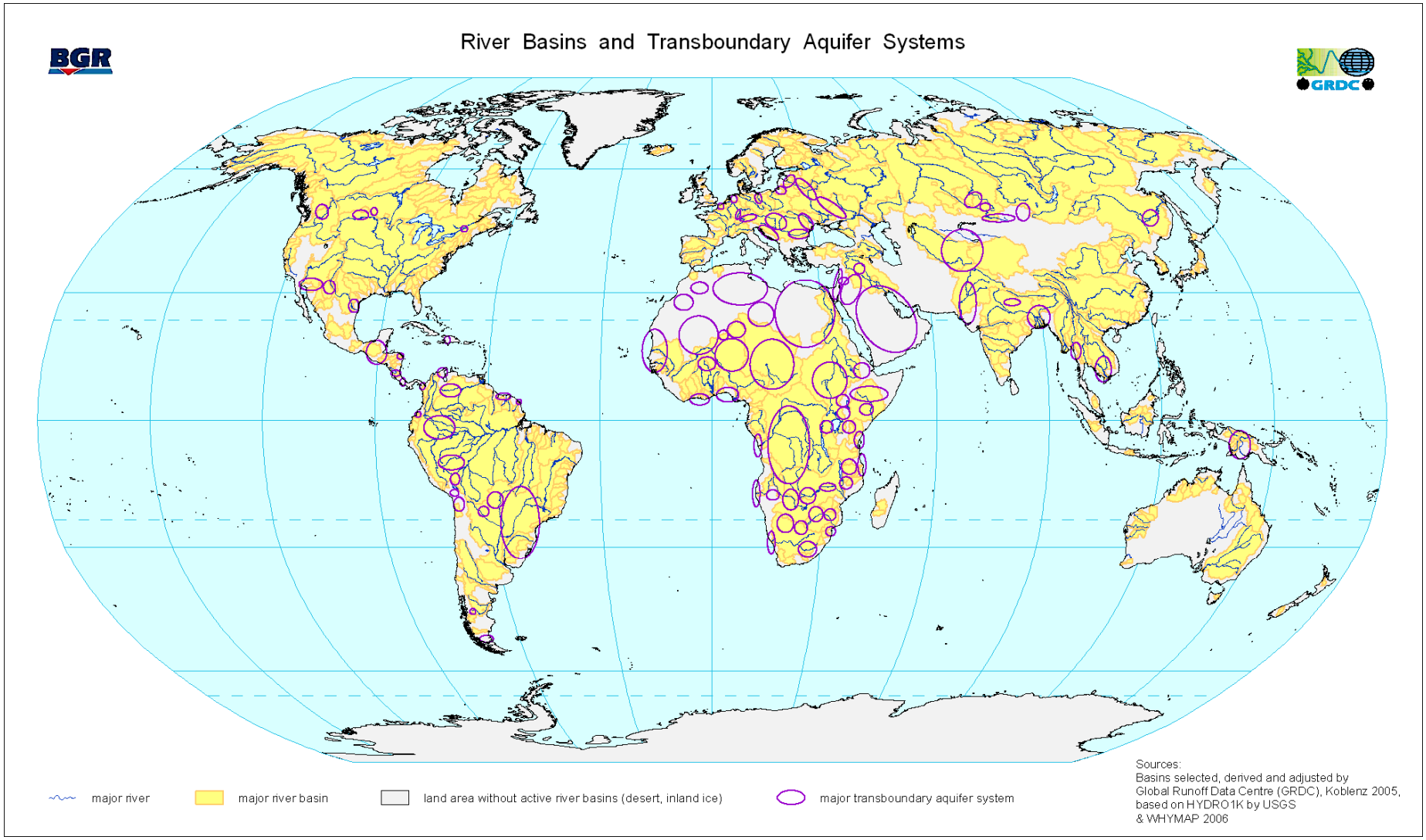
Worldwide Hydrogeological Mapping and Assessment Programme (WHYMAP)



www.whymap.org

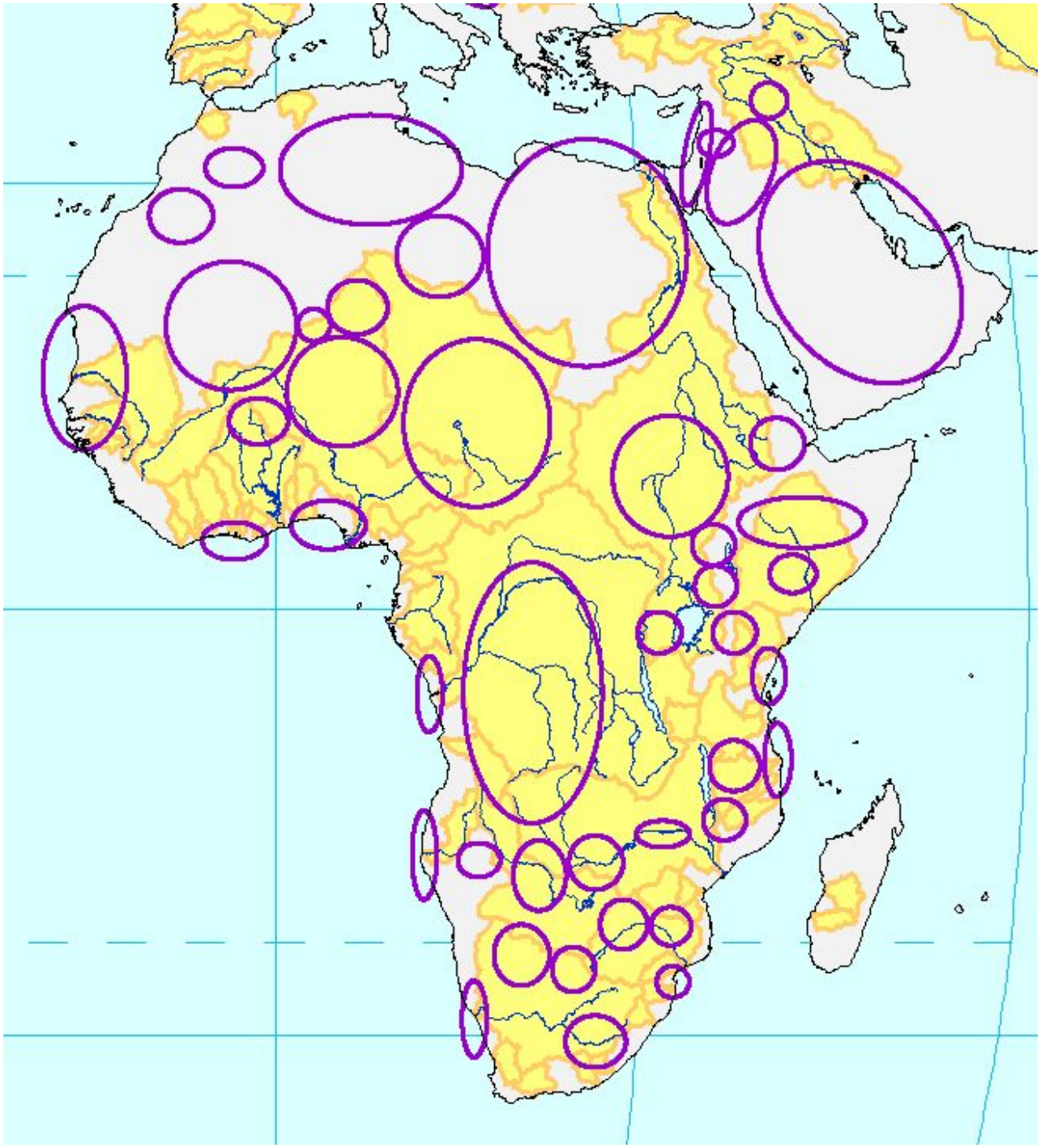
A comparison of the GRDC map and the WHYMAP groundwater resources map reveals

- 276 international river and lake basins and 273 shared groundwater basins identified globally


River Basins and Transboundary Aquifer Systems
GRDC
major river
major river basin
land area without active river basins (desert, inland ice)
major transboundary aquifer system
Sources:
Basins selected, derived and adjusted by
Global Runoff Data Centre (GRDC), Koblenz 2005,
based on HYDRO1K by USGS
& WHYMAP 2006

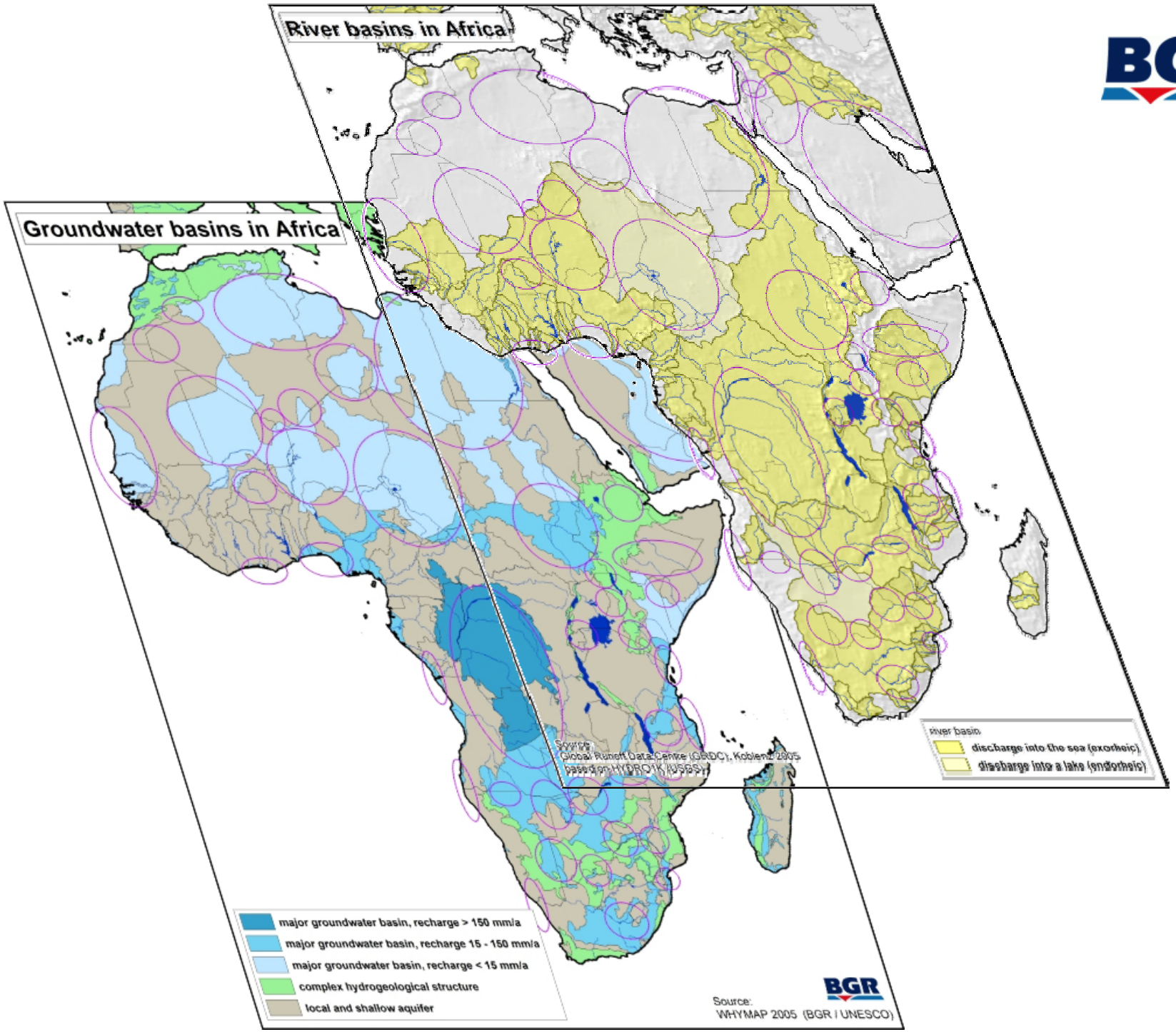
A comparison of the GRDC map and the WHYMAP groundwater resources map reveals

- 276 international river and lake basins and 273 shared groundwater basins identified globally
- river basins and underlying aquifer basins may differ considerably in location and size



A comparison of the GRDC map and the WHYMAP groundwater resources map reveals

- 276 international river and lake basins and 273 shared groundwater basins identified globally
- river basins and underlying aquifer basins may differ considerably in location and size
- rivers may lose water into aquifer systems extending beyond the catchment boundaries (outside the river basin)
- discharge from aquifers having their recharge area in an adjacent river basin may increase the flow in rivers


River basins in Africa
Groundwater basins in Africa
river basin
discharge into the sea (exorheic)
discharge into a lake (endorheic)
major groundwater basin, recharge > 150 mm/a
major groundwater basin, recharge 15 - 150 mm/a
major groundwater basin, recharge < 15 mm/a
complex hydrogeological structure
local and shallow aquifer
Source:
WHYMAP 2005 (BGR / UNESCO)

GTZ 2008: 18 river or lake basins in Africa received funding from international or / and national donors (2002 to 2007)

II. Donors primarily support large basins

International River Basins of Africa

Note: One donor per bullet
* Financial contribution not available for one or more donors active in this basin
** Sub-basin of Nile Basin

Legend

- up to 250.000 Euro
- 250.000 to 500.000 Euro
- 500.000 to 1.000.000 Euro
- 1.000.000 to 2.000.000 Euro
- more than 2.000.000 Euro
- amount increasing
- amount decreasing
- amount unknown

Table 3: Financial support for river and lake basins

BASIN	2002	2003	2004	2005	2006	2007
Nile*						
Zambezi*						
Senegal						
Niger						
Lake Chad						
Limpopo*						
Lake Malawi						
Lake Victoria						
Okavango*						
Orange-Senqu*						
Volta						
Pungwe						
Incomati*						
Ruvuma						
Gambia						
Mara Basin**						
Congo						
Lake Tanganyika						

Note: One donor per bullet

Table 9: Financial support for groundwater management, per basin organisation (2005)

AQUIFER/BASIN	BASIN ORGANISATIONS			
	LCBC (2006)	BCSP	CNMC	NNJC
Lake Chad Basin	•			
Kalahari Aquifer	Namibian Dep. of Water Affairs ●			
Northwest Sahara Aquifer	OSS (2006) ● ●			
Nubian Sandstone Aquifer	OSS (2006) ●			

Notes: One donor per bullet

No information was provided for th

The acronyms of the basin organisa

Legend

- up to 250.000 Euro
- 250.000 to 500.000 Euro
- 500.000 to 1.000.000 Euro
- 1.000.000 to 2.000.000 Euro
- more than 2.000.000 Euro

VII. Limited support for groundwater management

Table 7: Financial support for groundwater management

AQUIFER/BASIN	2002	2003	2004	2005	2006	2007
Northwest Sahara Aquifer	•	••	••	••	●●	••
Kalahari Aquifer	●	●	●	●	●	●
Volta Basin	•	•	•	•	•	•
Limpopo Basin				•	•	•
Nubian Sandstone Aquifer					•	•
Lake Chad Basin					•	•

Note: One donor per bullet

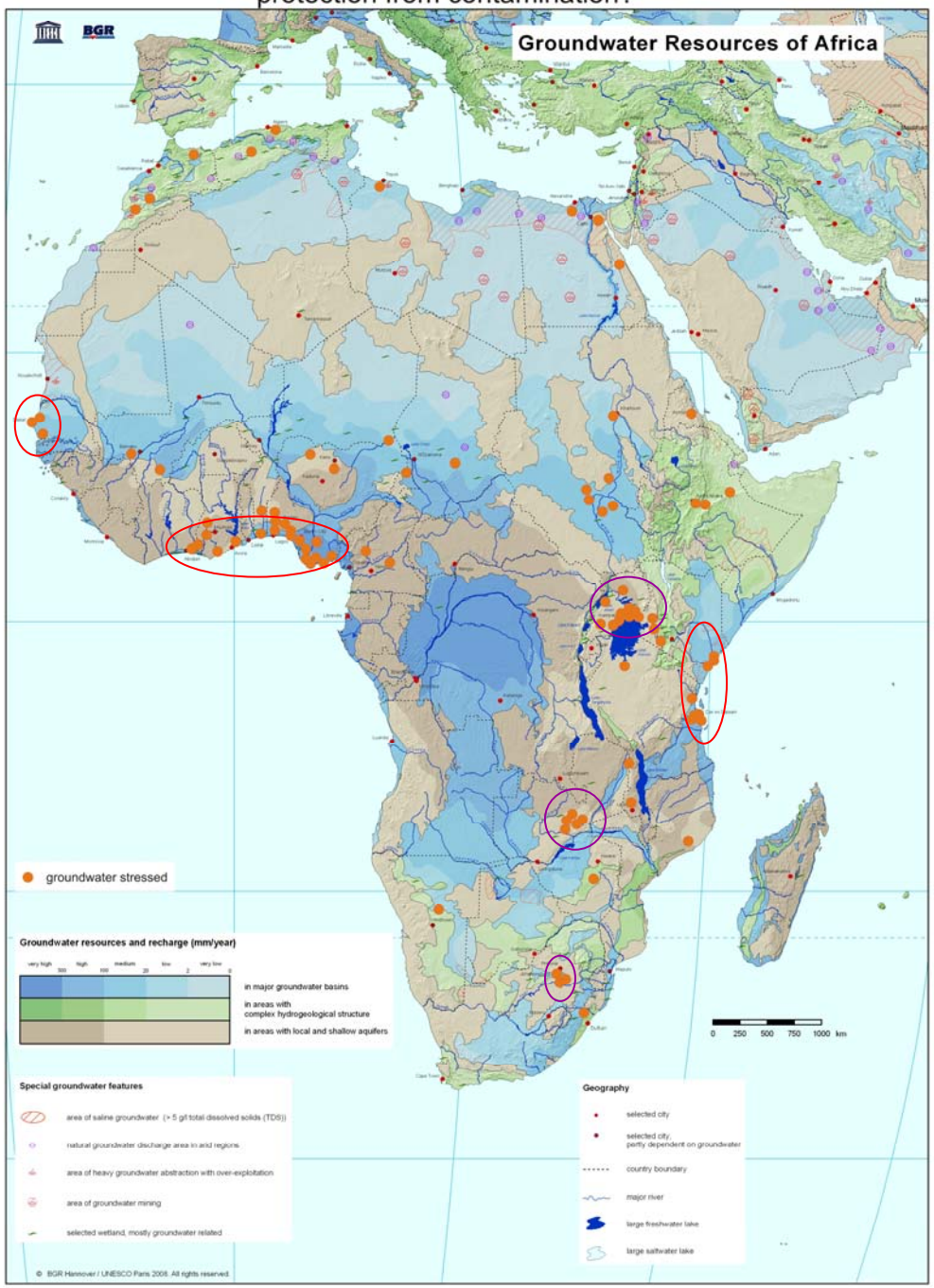
Legend

- up to 250.000 Euro
- 250.000 to 500.000 Euro
- 500.000 to 1.000.000 Euro
- 1.000.000 to 2.000.000 Euro
- more than 2.000.000 Euro

- amount increasing
- amount decreasing
- amount unknown


Groundwater Resources of the World
Thank You

Where is an urgent need for groundwater protection from contamination?



Hot spots of groundwater contamination:

- ***coastal aquifers***

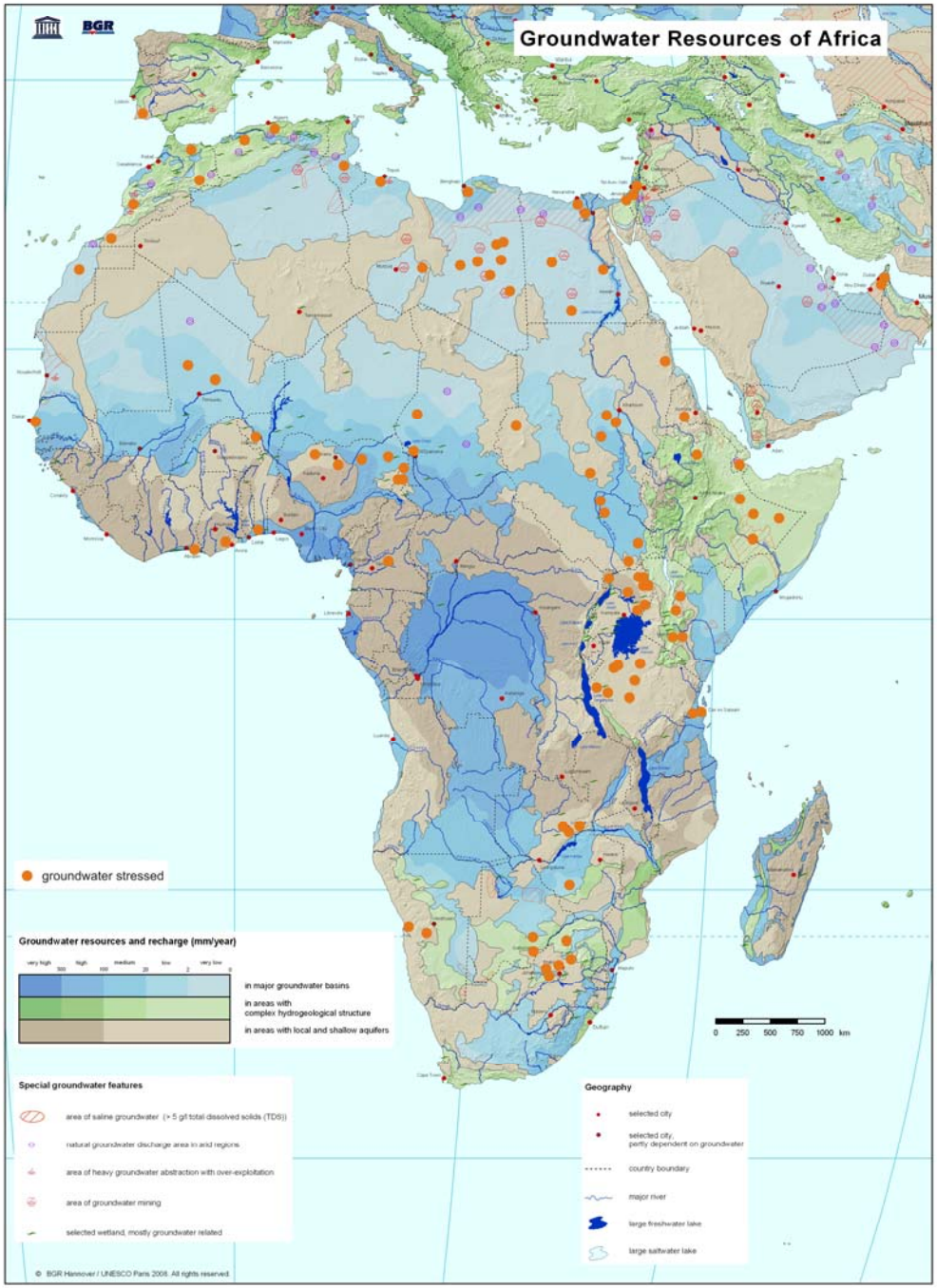
(e.g. West Africa, East Africa)

- ***inland clusters close to cities***

(e.g. Johannesburg, Lusaka, Entebbe-Kampala)

- ***many single spots in the Sahel and North Africa***

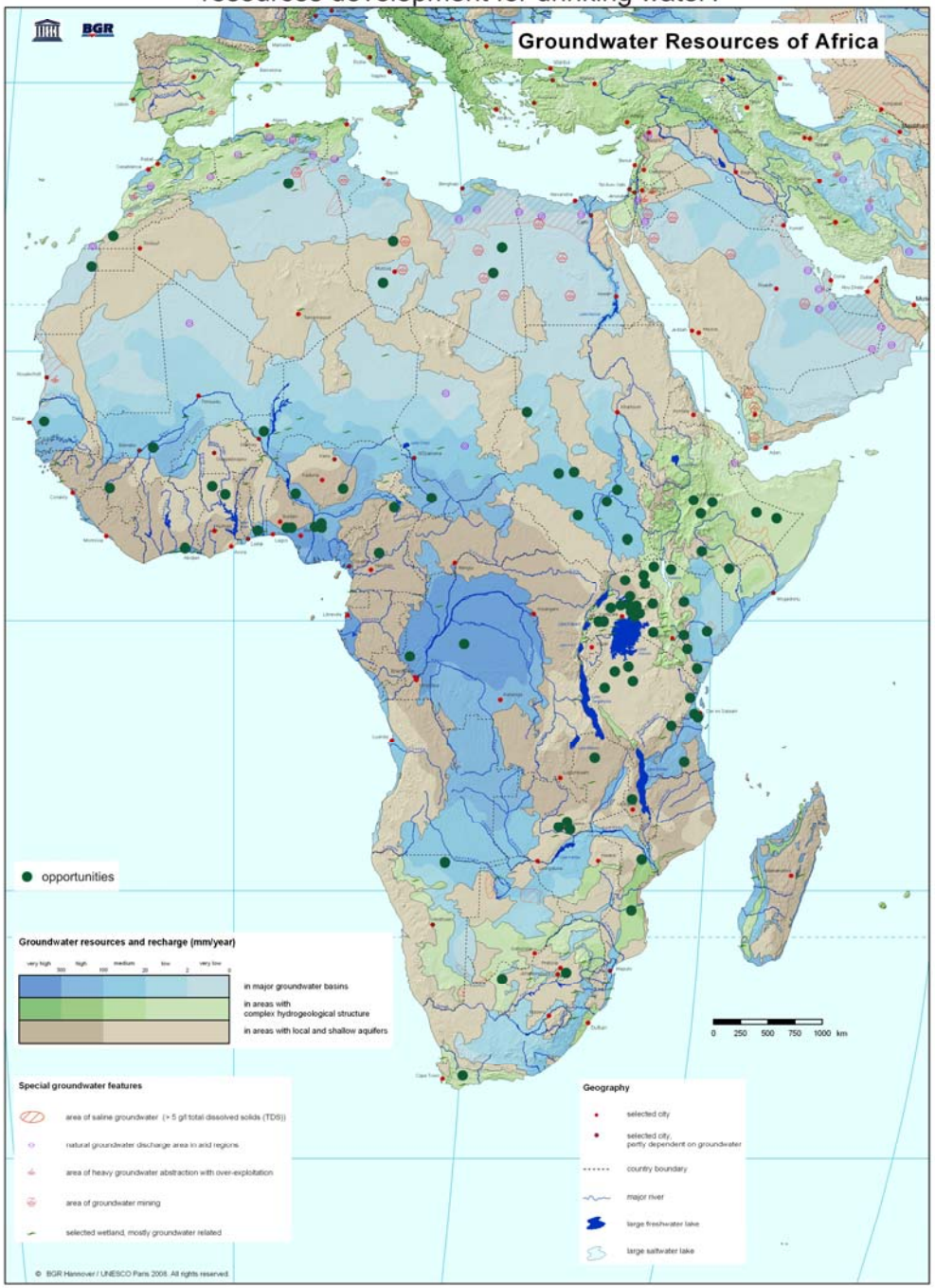
Where are groundwater resources heavily stressed?



Heavily stressed groundwater resources:

- ***many spots in North Africa and the Sahel (= non-renewable)***
- ***numerous spots in East Africa, from Sudan to RSA***

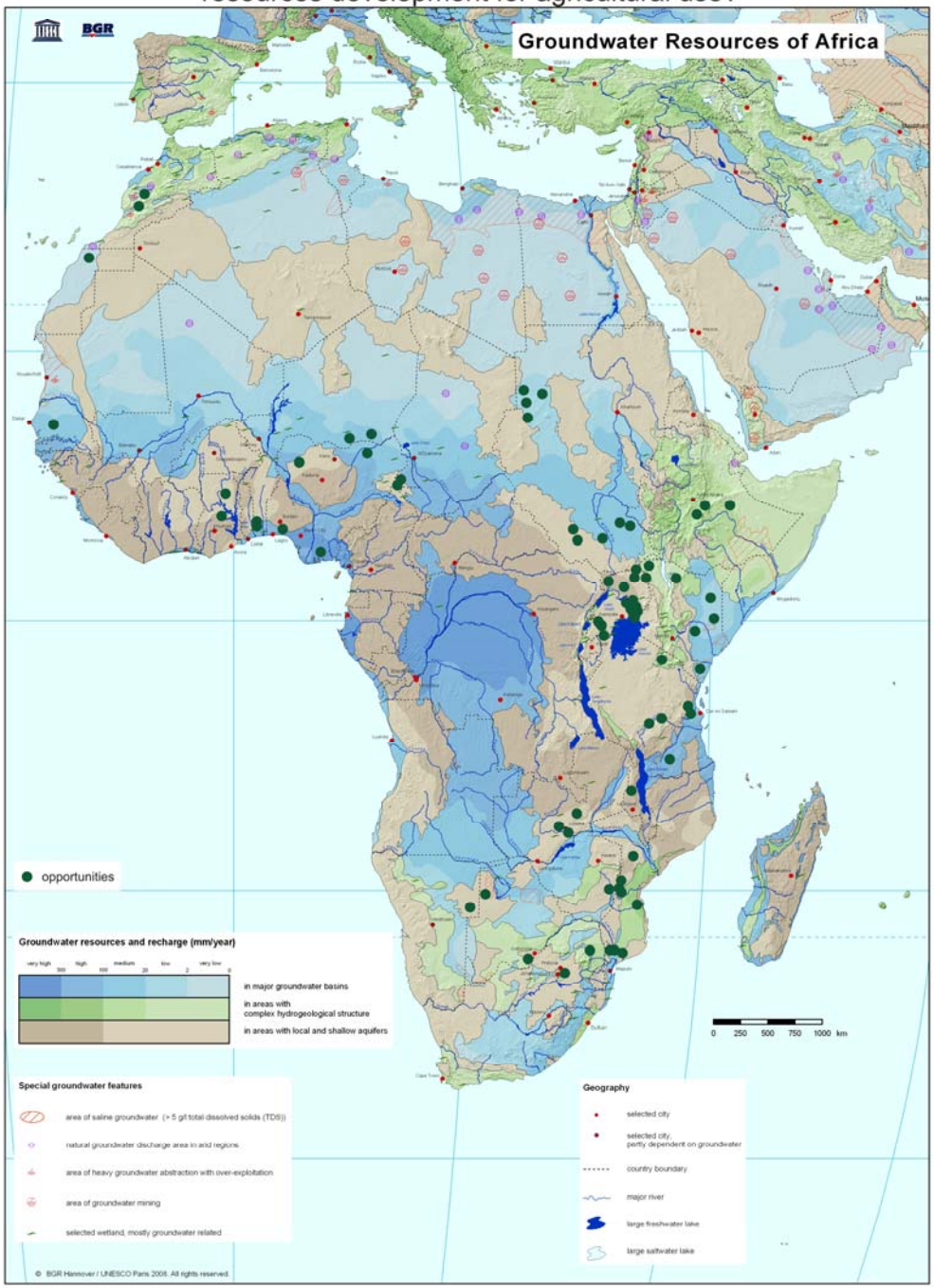
Where are opportunities for more groundwater resources development for drinking water?



Opportunities for drinking water from groundwater resources:

- ***many spots scattered over large parts of Africa***

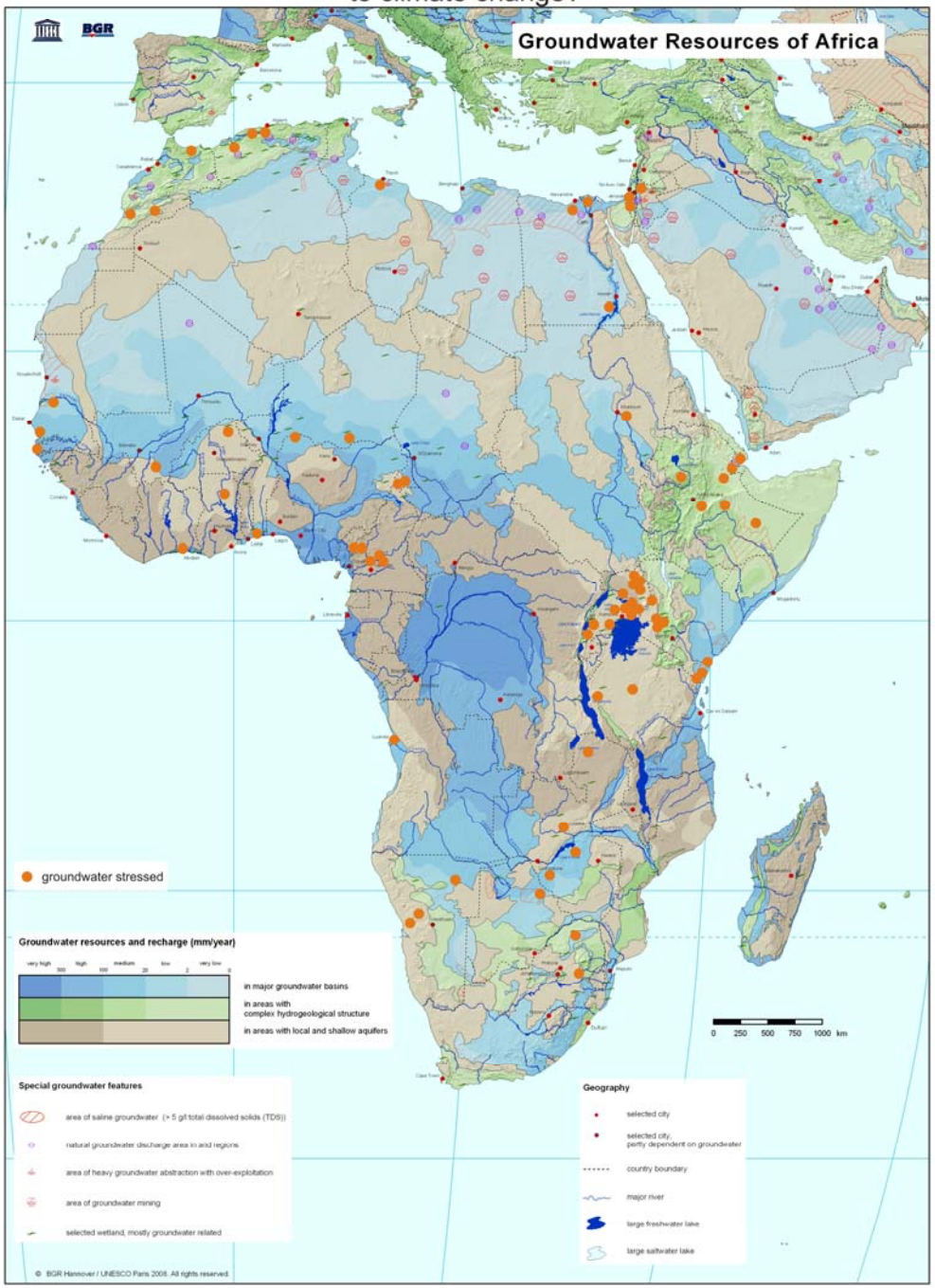
Where are opportunities for more groundwater resources development for agricultural use?



Opportunities for irrigation water from groundwater resources:

- ***clusters of spots concentrated in East Africa, some Sahelian countries and on the West coast of Africa***

Which aquifers are most vulnerable to climate change?



Aquifers vulnerable to climate change:

- ***less dots than in the other maps***
- ***aquifers in***

-North Africa (Maghreb)

-the Sahel region (= non-renewable)

- ***East Africa and Southern Africa***