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Impacts of Climate Change and Human Activities on Groundwater Resources



Holger Treidel, UNESCO-IHP



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Second Learning Workshop for GEF MENARID Project Managers

“Opportunities for Managed Aquifer Recharge”, Amman, 11-13 December 2012



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Outline

- Global Change / Climate Change
- Impacts of Climate Change on (ground)water resources
- UNESCO's GRAPHIC project
- Role of groundwater for adaptation to the impacts of climate change



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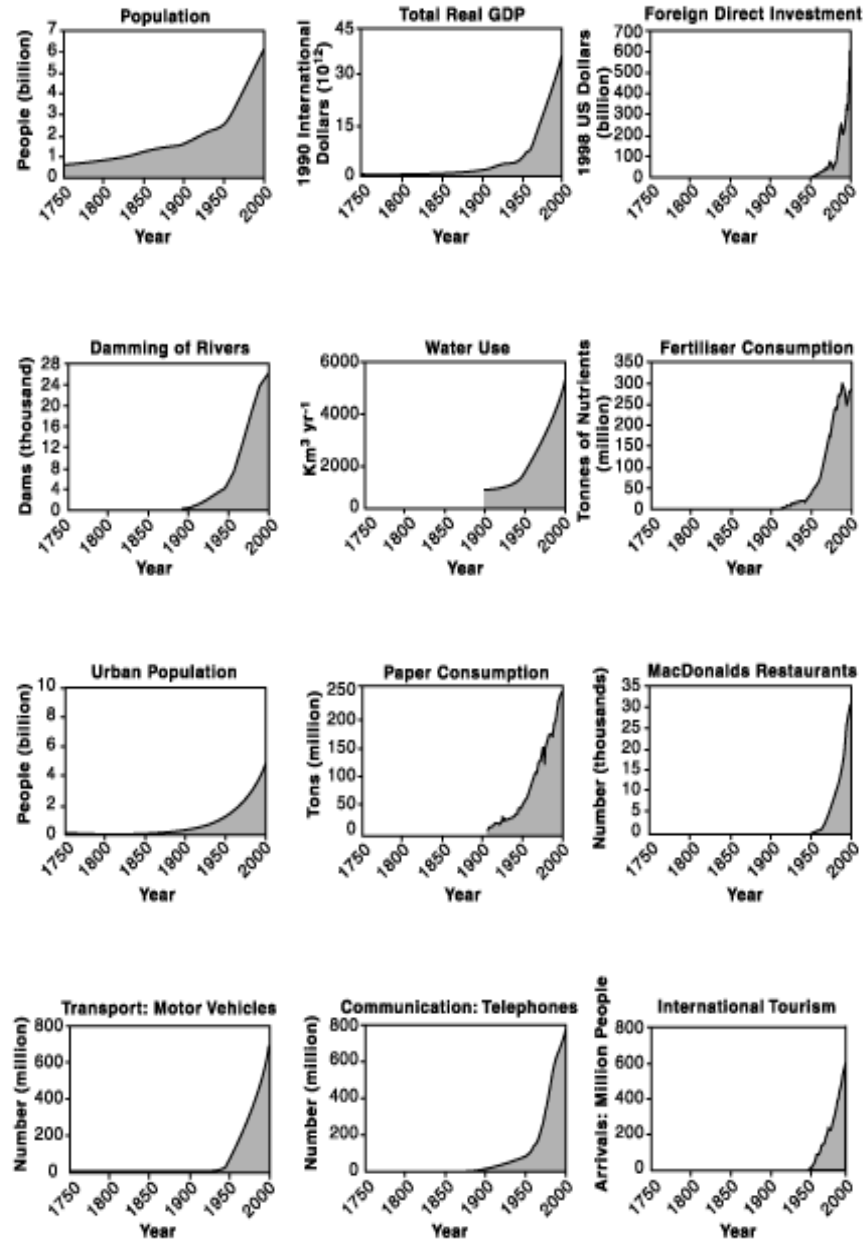
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Global

- Demography: Population growth, migration, urbanization, age structure
- Geo-political change
- Economy: Trade and development
- Technological change
- Climate change



U.S. Bureau of the Census



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Managers
November 2012



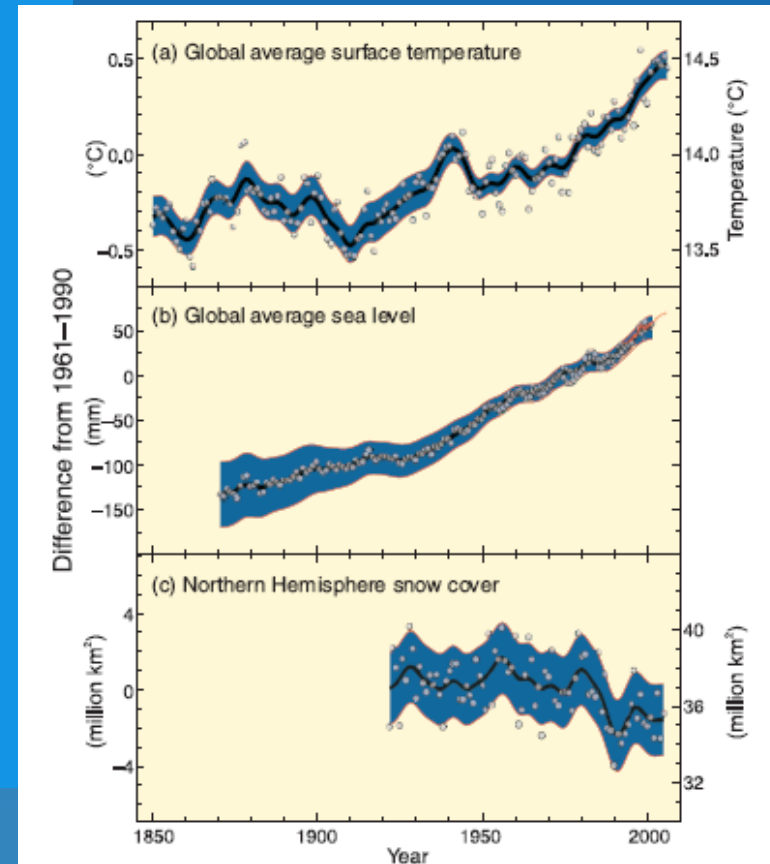
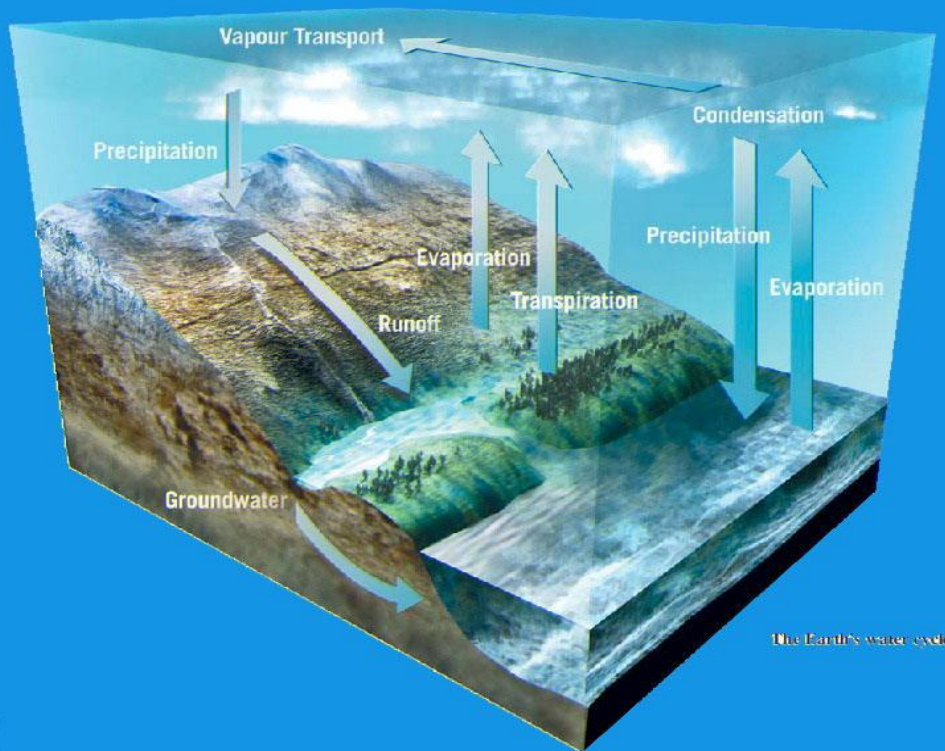
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Climate Change



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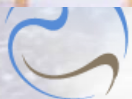
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CC Impacts on the global water cycle

Intensification of the hydrological cycle

- Alteration of rainfall distribution, regionally and temporally
- increased number of extreme weather events (floods, droughts, storms...)



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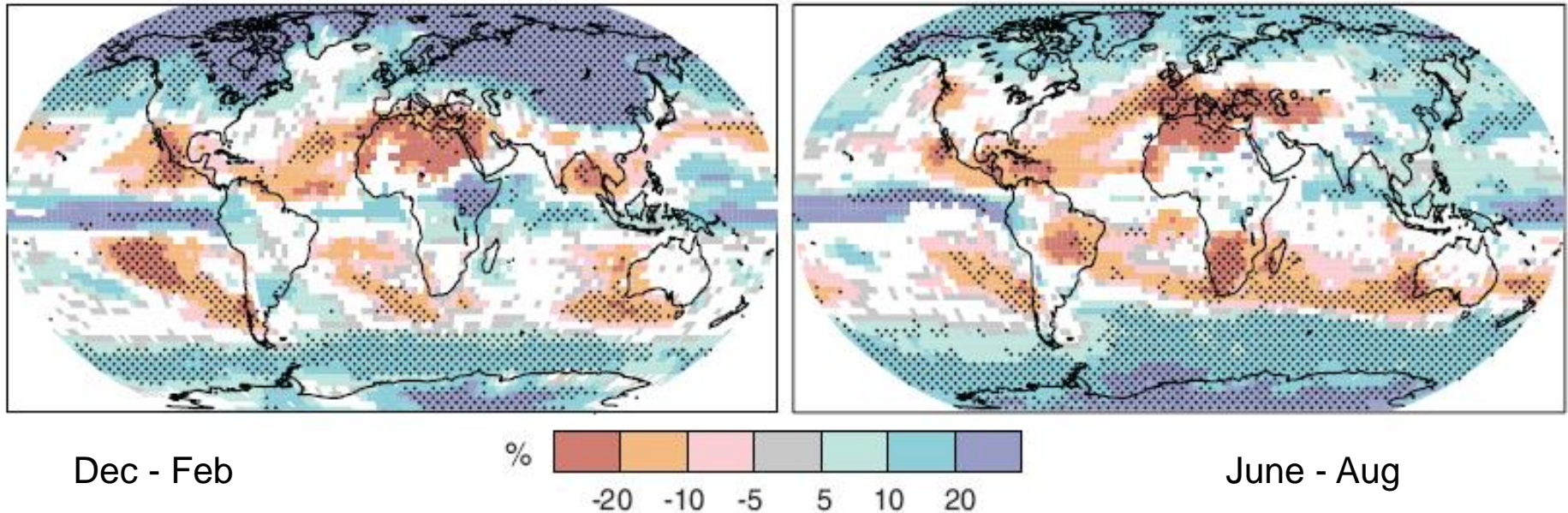


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Projected patterns of precipitation changes

Multi-model projected patterns of precipitation changes



Relative changes in precipitation (in percent) for the period 2080-2099, relative to 1980-1999.

IPCC, 2007



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Impacts of climate change on water resources



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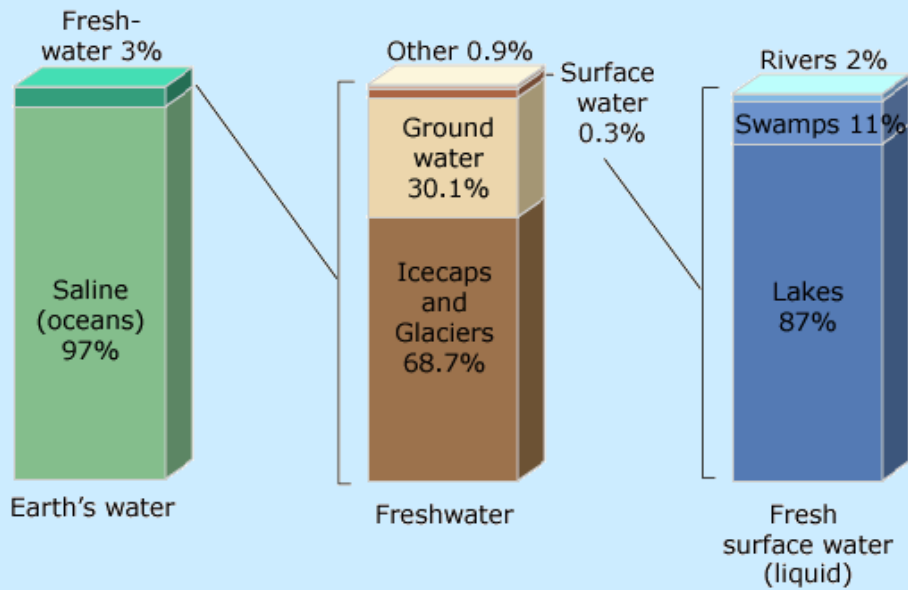
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**primary source of drinking water
for nearly half of the world's
population**



**43% of the global consumptive
use in irrigation**

**70% of global groundwater
abstraction is used in irrigation**



for some...

**groundwater is their only source
of water**



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Groundwater resources are under pressure...

- Excessive exploitation
- Pollution, deterioration of groundwater quality
- and Climate Change



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“there has been very little research on the impact of climate change on groundwater...”

p. 185, Chapter 3 (Freshwater), IPCC AR4 (Kundzewicz et al., 2007)



Makgadikgadi Salt Pan – an evaporated lake in Botswana



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Impacts on groundwater?

➤ ... quantity

- How is groundwater recharge affected?
- Impacts on groundwater dependant ecosystems?

➤ ... quality

- What impacts will climate change have on the quality of groundwater resources?

→ Depends on climate (precipitation and temperature regimes), local geology and soil, topography, vegetation, surface-water hydrology, coastal flooding, and land-use activities



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Direct impacts – indirect impacts

- Direct impacts: natural processes
 - Groundwater recharge, discharge, interactions between groundwater and seawater
- Indirect impacts: Human response
 - Changes in abstraction patterns
 - Land use changes



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UNESCO-IHP GRAPHIC: *Groundwater Resources Assessment under the Pressures of Humanity and Climate Change*

- Global network of scientists and institutions, aimed at
 - Better understanding how climate change and human activities affect the future availability and quality of groundwater resources
 - Informing water managers and decision makers
 - Raising awareness on how groundwater can contribute to Climate Change adaptation



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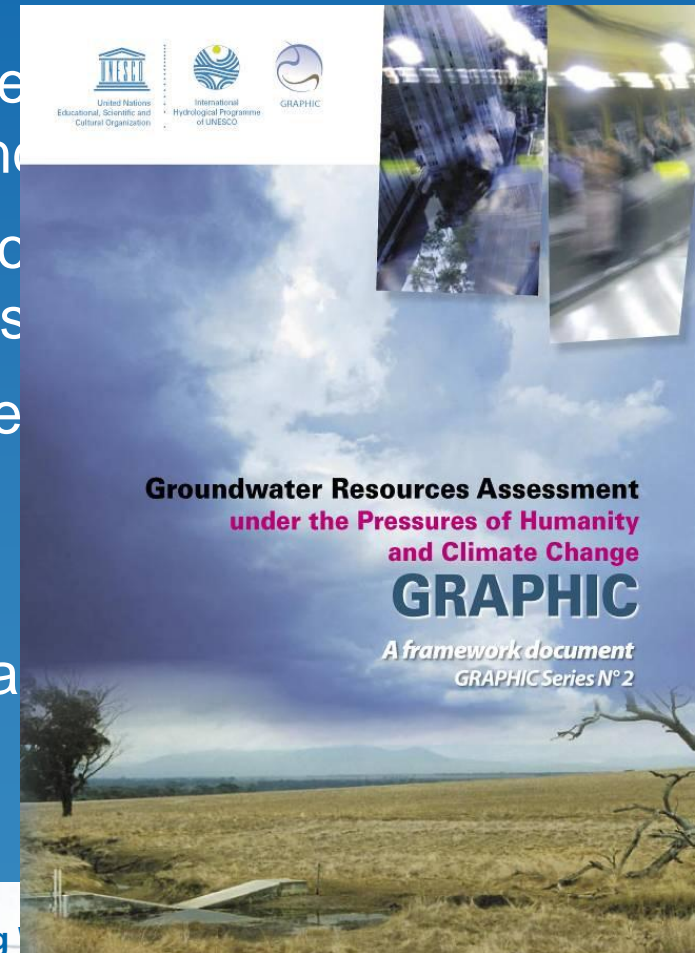


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GRAPHIC – what do we do?

- ✓ Conduct case studies, covering a wide range of scientific methods, and geographical areas
- ✓ Derive policy-relevant recommendations from findings and communicate them to decision makers
- ✓ Organize meetings, sessions at conferences and training courses
- ✓ Publications
- ✓ Raise awareness among decision makers

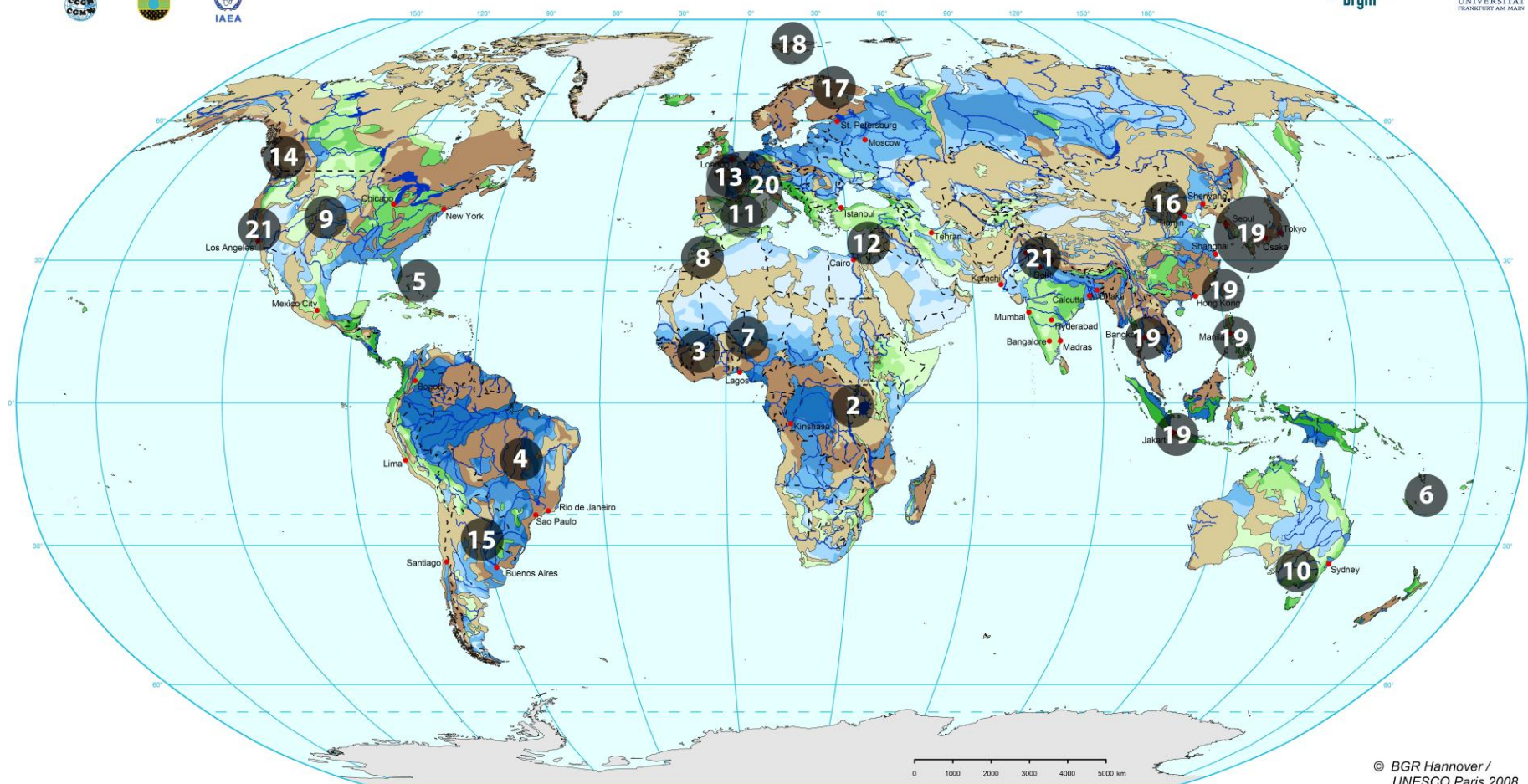


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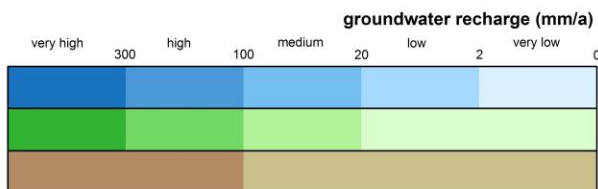
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Groundwater Resources of the World



Groundwater resources

in major groundwater basins
in areas with complex hydrogeological structure
in areas with local and shallow aquifers



Surface water & Geography

- major river
- large freshwater lake
- large saltwater lake
- continuous ice sheet
- selected city
- country boundary
- GRAPHIC case study

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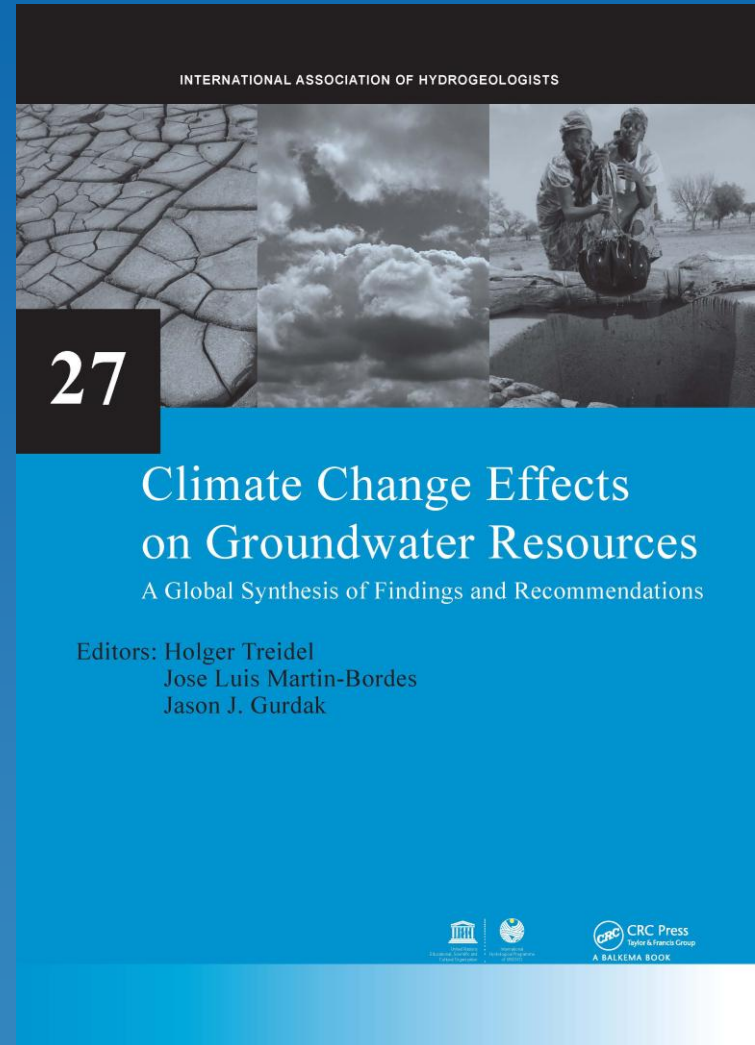
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- IAH International Contributions to Hydrogeology
- Scientific results and policy recommendations derived from case studies



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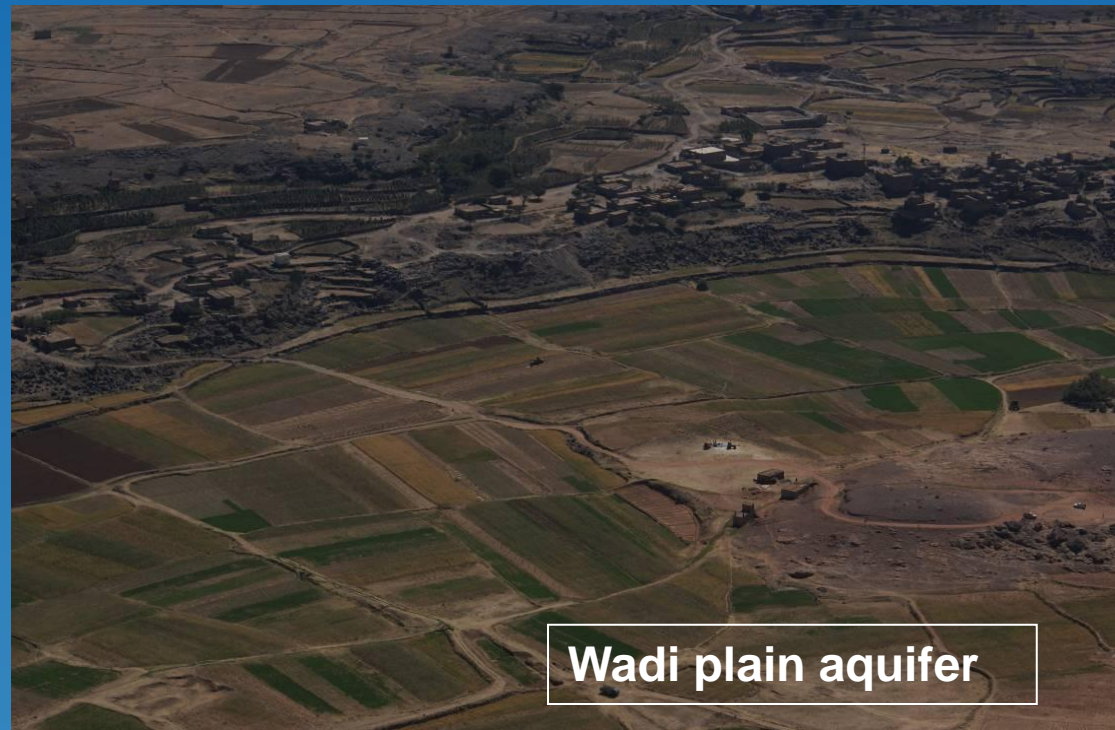


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Climate Change Impacts on alluvial aquifers in arid regions

- Low annual rainfall, irregular precipitation events
- Discharge by natural drainage channels (wadis)
- Intermittent flow
- Usually underlain by alluvial aquifers



Wadi plain aquifer



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Predicted change by end of 21st century

Temp: +3°C

Total precipitation: likely to decrease

Recharge

- → small decrease in rainfall may lead to large change in groundwater recharge (threshold effect)

Abstraction patterns & land use

- Increased water demand
- pET of crops to increase by 75mm/a
- → irrigated lands will require 10% more water



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Alluvial aquifers in arid zones

- Isolated alluvial aquifers with low storage may be affected in the near future, threatening livelihoods
- Alluvial aquifers with high storage, or presence of regional aquifers that are more resilient: no threat at the short to medium term, but on the long term
- Most aquifers are threatened by overexploitation, this will be accelerated by CC
- Economic considerations: growing cost for using groundwater
- In coastal alluvial aquifers decreased recharge (along with overexploitation) can lead to seawater intrusion



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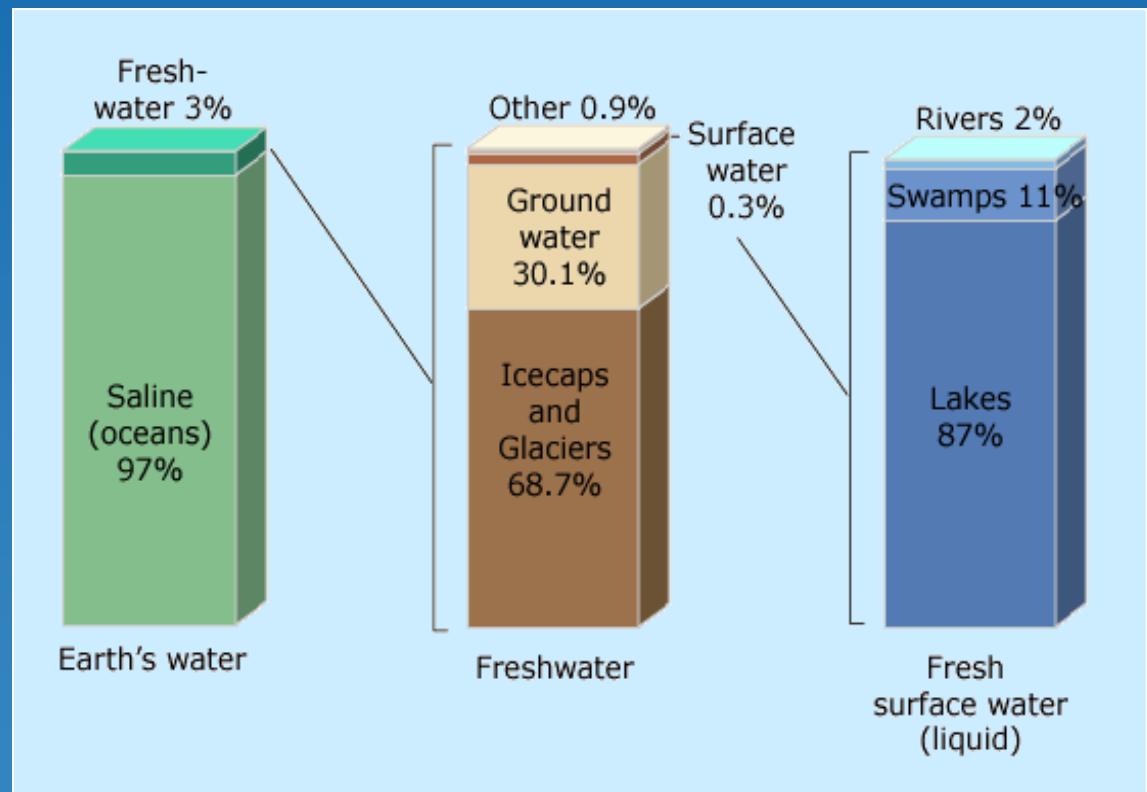
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Role of Groundwater in adapting to the impacts of climate change?

- world's largest
accessible store of
freshwater

Increasingly being
used, e.g. by
managed aquifer
recharge



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Conclusions

- Improve the understanding of groundwater – climate interactions
- Communicate the knowledge – to scientists, project managers and policy/decision makers (different languages!)
- Contribute to making groundwater visible at the policy level – e.g. IPCC AR5
- Raise awareness on the opportunities that groundwater can offer in adapting to CC impacts
- (Ground)water is cutting across the MENARID portfolio



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Thank you



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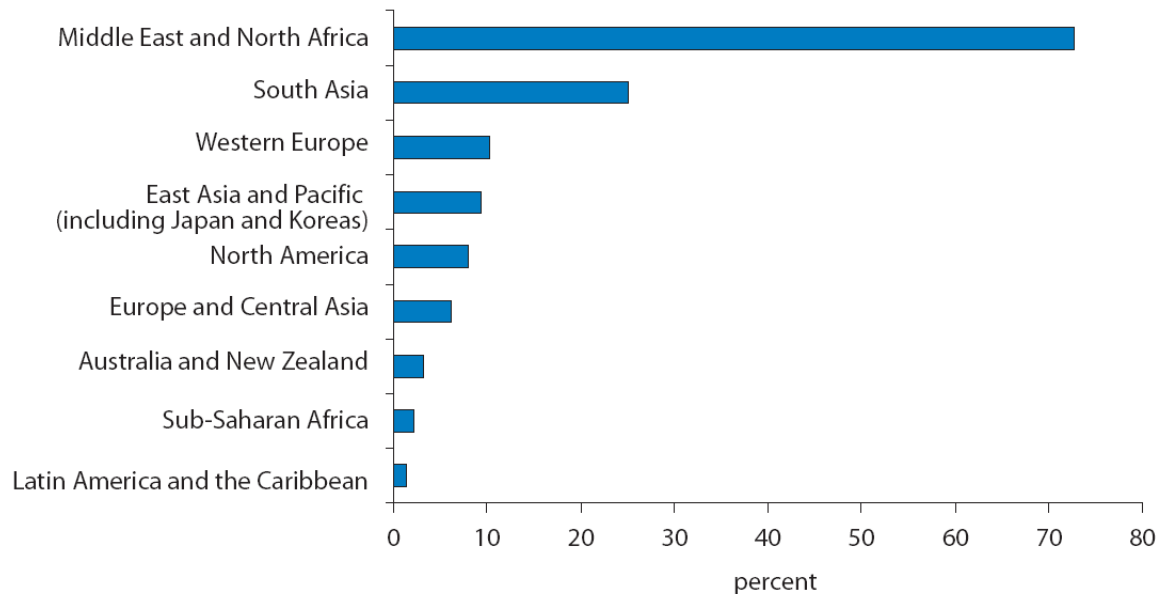


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Climate change in MENA

Percentage of Total Renewable Water Resources Withdrawn, by Region



Source: Compiled from FAO AQUASTAT data for 1998–2002.

Note: The figure shows the sum of withdrawals across all countries in a region, divided by the sum of all the renewable water available in each country.



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