International Hydrological Programme

Groundwater Resources Assessment under the Pressures of Humanity and Climate Changes

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GRAPHIC Vision

GRAPHIC promotes and advances sustainable groundwater management in the face of climate change and linked human impacts.

GRAPHIC Mission

GRAPHIC provides a platform for exchange of information through case studies, thematic working groups, research, and communication. GRAPHIC serves the global community through providing scientifically-based recommendations that are policy relevant. GRAPHIC uses regional and global networks to improve capacity to manage groundwater resources.

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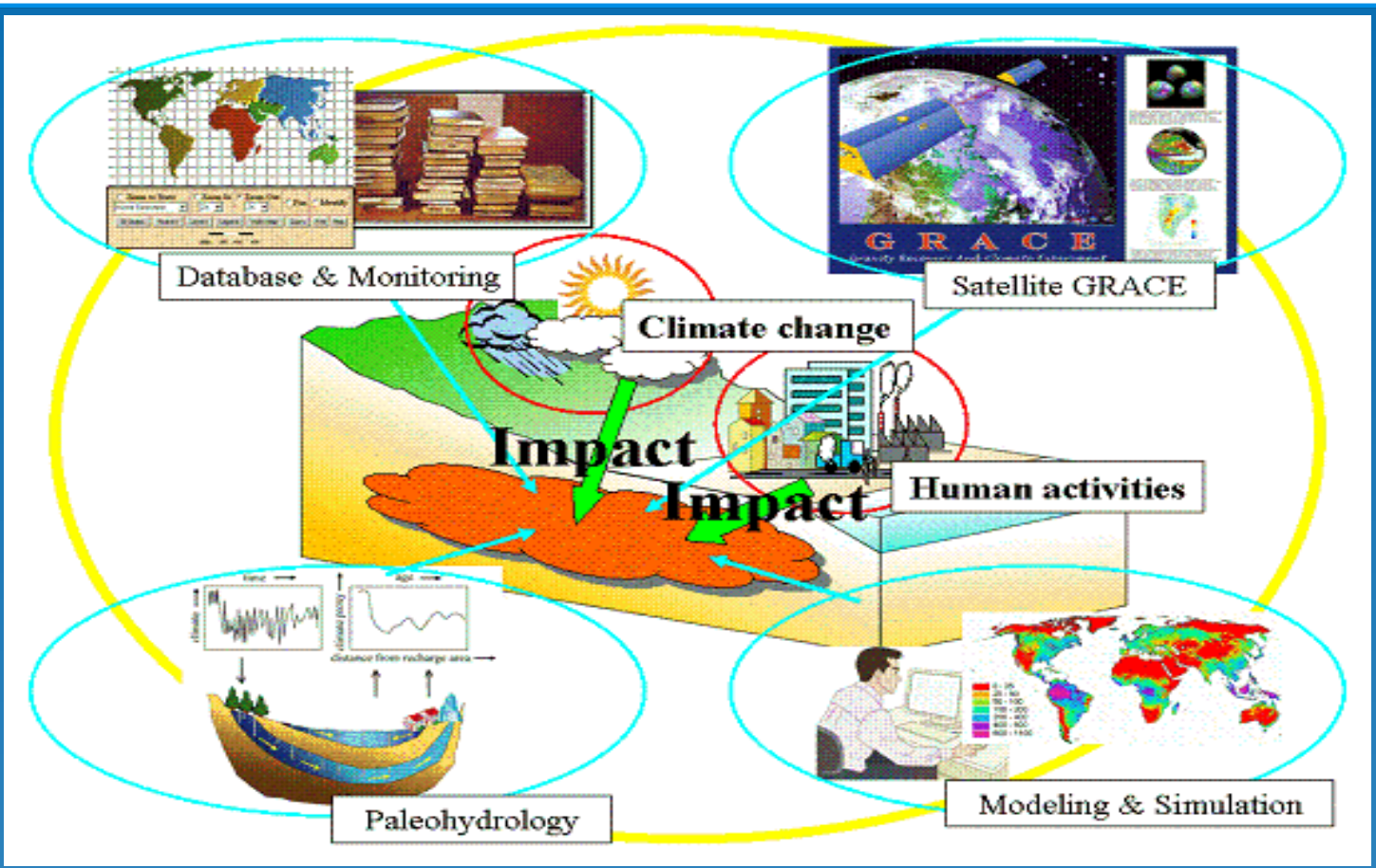
GRAPHIC – what's it all about?

- Groundwater is an extremely important natural resource as a primary source for agriculture, domestic, and industrial water supplies in many countries.
- Groundwater resources are under threat by climate change and coupled human activities
- Urgent need to improve our knowledge on how groundwater resources might react to these impacts
- In order to maintain the sustainable uses of groundwater resources, evaluations of changes in groundwater quantity and quality are necessary.
- Identify indicators of climate change impacts on groundwater resources and to evaluate tools and methods that could contribute to adaptation measures

Structure of GRAPHIC: Methods



Structure of GRAPHIC: Methods

- Information systems
  - Centralized data resources
    - Data and metadata requirements
    - Geographical Information Systems (GIS)
- Environmental Monitoring
  - Network design
    - Detection of climate change signals
    - Detection of spatiotemporal trends in GW quality and quantity
- Paleo-Indicators of Environmental Change
  - Past climate change
    - Response of hydrological systems to climate change
- Remote sensing
  - GRACE satellite
    - Land Use/Land Cover change analyses
    - Landsat and other sensors
- Geochemical, Isotopic, Bio-Indicator Studies
- Geophysical Methods
- Simulation and Modeling
- Inter-Regional Comparative Studies

Regional components of GRAPHIC and groups of experts

GRAPHIC - Latin America & Caribbean (Belize meeting, Nov. 2007)

GRAPHIC - Asia & Pacific (Toyama, Oct. 2008; Jaipur, 2008)

GRAPHIC – Africa (Kampala, June 2008)

GRAPHIC – Europe (EGU Vienna, April 2008)

GRAPHIC – Maghreb- CCAM (Marrakesh, November 2008)

GRAPHIC – North America (San Francisco, Dec. 2008)

Linkages with other UNESCO-IHP projects and programmes

- HELP (Hydrology for Environment, Life and Policy)
- ISARM (Internationally Shared/Transboundary Aquifer Resources Management)
- G-WADI (Water and Development Information for Arid Lands – A Global Network)
- JIIHP (Joint International Isotopes Hydrology Programme)
- GWES (Groundwater for Emergency Situations)
- GWHS (Groundwater for Human Security)

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Key Issues – Groundwater Discharge

- Discharge response times
- Groundwater/surface-water interaction and coupled responses under climate change
- Spatial variability of discharge related to landform and vegetation patterns
- Chemical and nutrient fluxes to surface-water bodies
- Land subsidence and landslides
- Quantifying submarine discharge in space and time

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Key Issues – Groundwater Recharge

- Spatial scaling from measurement to basin scales
- Further development of methodologies for predicting effects of climate change on recharge
- Process interactions and component/parameter interactions in complex models
- Model sensitivity to parameter uncertainty
- Quantifying stress responses of plants and potential species succession
- Hydrological interactions at groundwater recharge interfaces
- Changes in the spatial and temporal distributions of precipitation affecting hydrological fluxes at the land surface
- Fully coupled hydrologic-atmospheric processes
- Societal feedbacks

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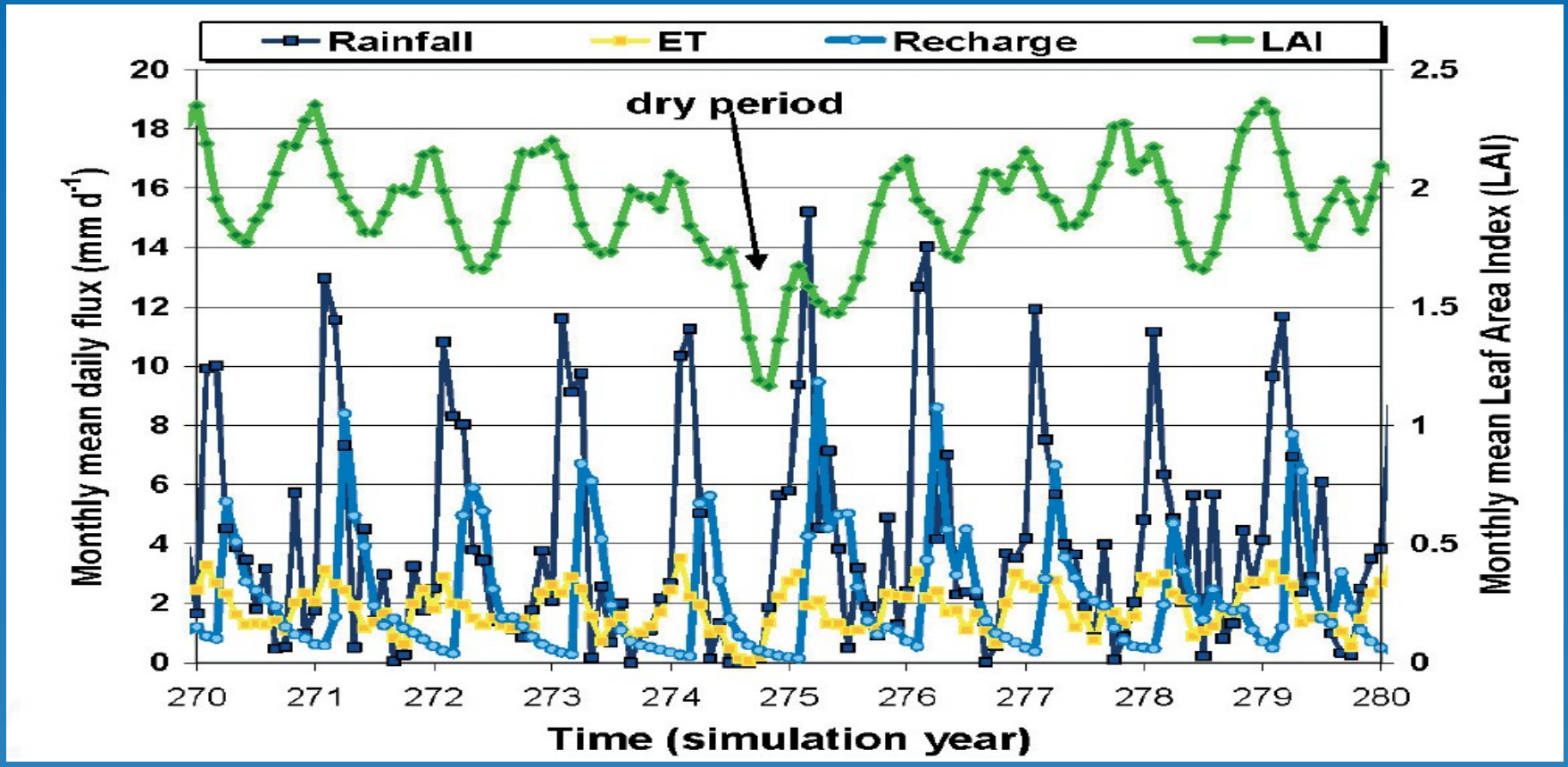
Simulated Water Fluxes



Source: Green et. Al (2007), USDA, ARS

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November 26 – 27, 2008, Marrakech, Morocco

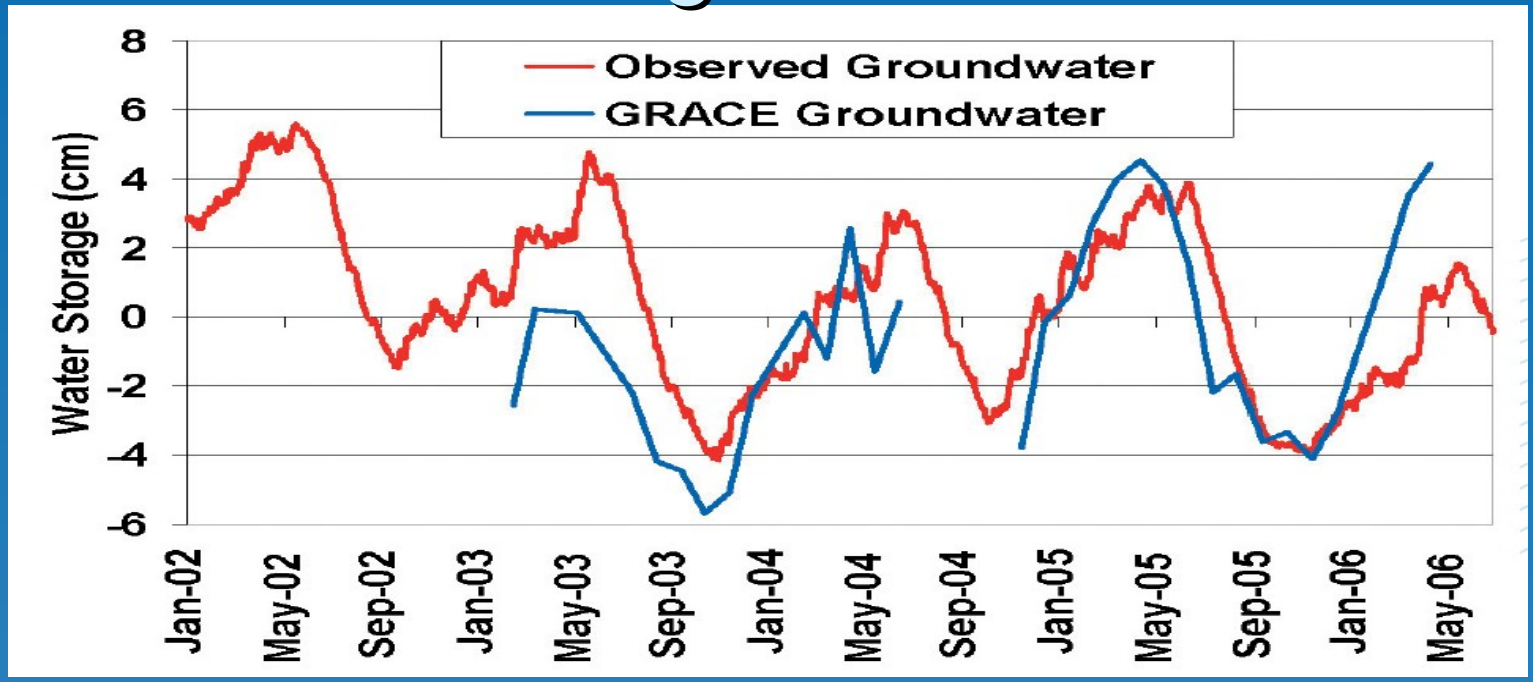
Key Issues - Storage

- The key storage issues that must be addressed for each of these main aquifer types are:
- Temporal dynamics of storage fluctuations
- Storage level triggers for management decisions
- Links to soil and vadose zone water

GRACE* vs. Observed Estimates of Water Storage Anomalies

Observed from 58 wells

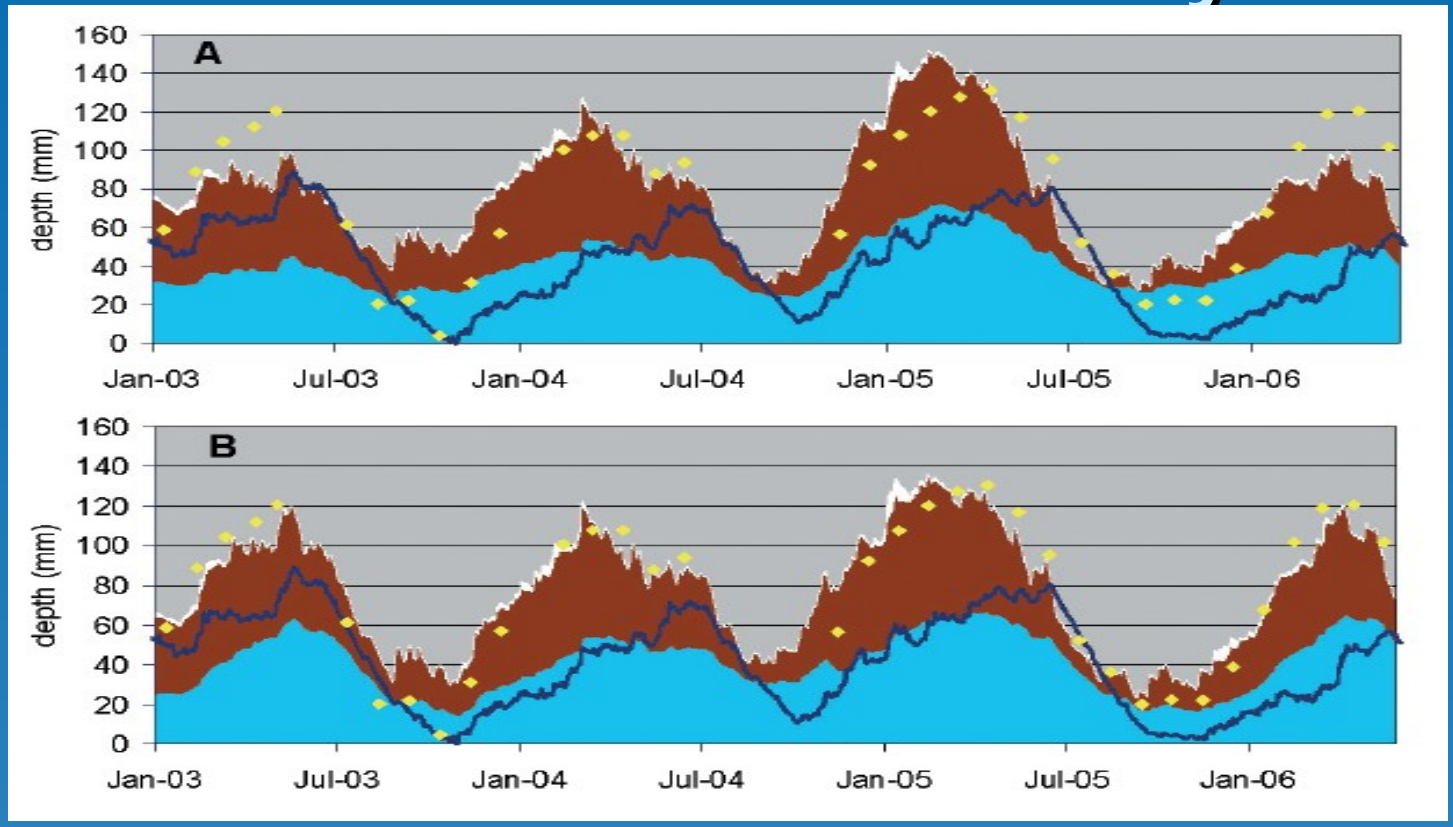
Mississippi River Basin Area



Rodell, 2007

*The Gravity Recovery and Climate Experiment (GRACE)

Groundwater Salinity



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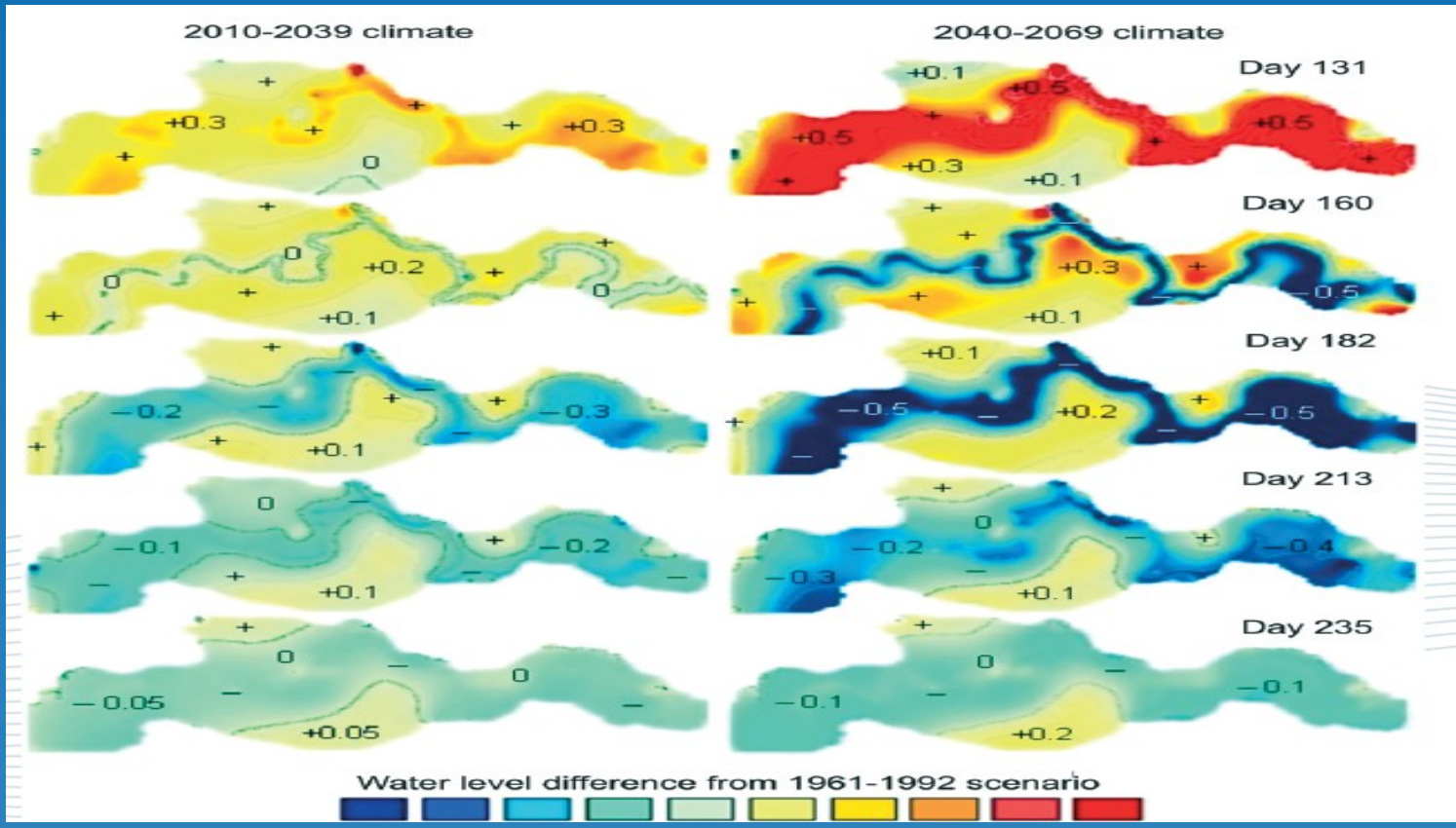
Impact of Extreme Event on Groundwater .. More Studies needed

Source: Scibek et al., 2007

Surface and groudwater coupled modeling

Shifts in peak and base flow causes significant change in GW



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Key Issues – Water Quality

- Agricultural:

  Increasing air temperatures could lead to increased irrigation demand or possibly to a shift to more heat tolerant crops.

  Increased chemical loading to the water table or a change in the chemistry of agricultural recharge

- Changes in subsurface thermal regimes could alter chemical and physical processes in the top soil and vadose zone, which could, in turn, affect groundwater quality.

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Geochemical Indicators of Climate and Linked Human Impacts on Groundwater

- Selected physical indicators:
  - Water temperature (controls on biological and abiotic reaction rates)
  - Specific conductance (potential for continuous measurements)

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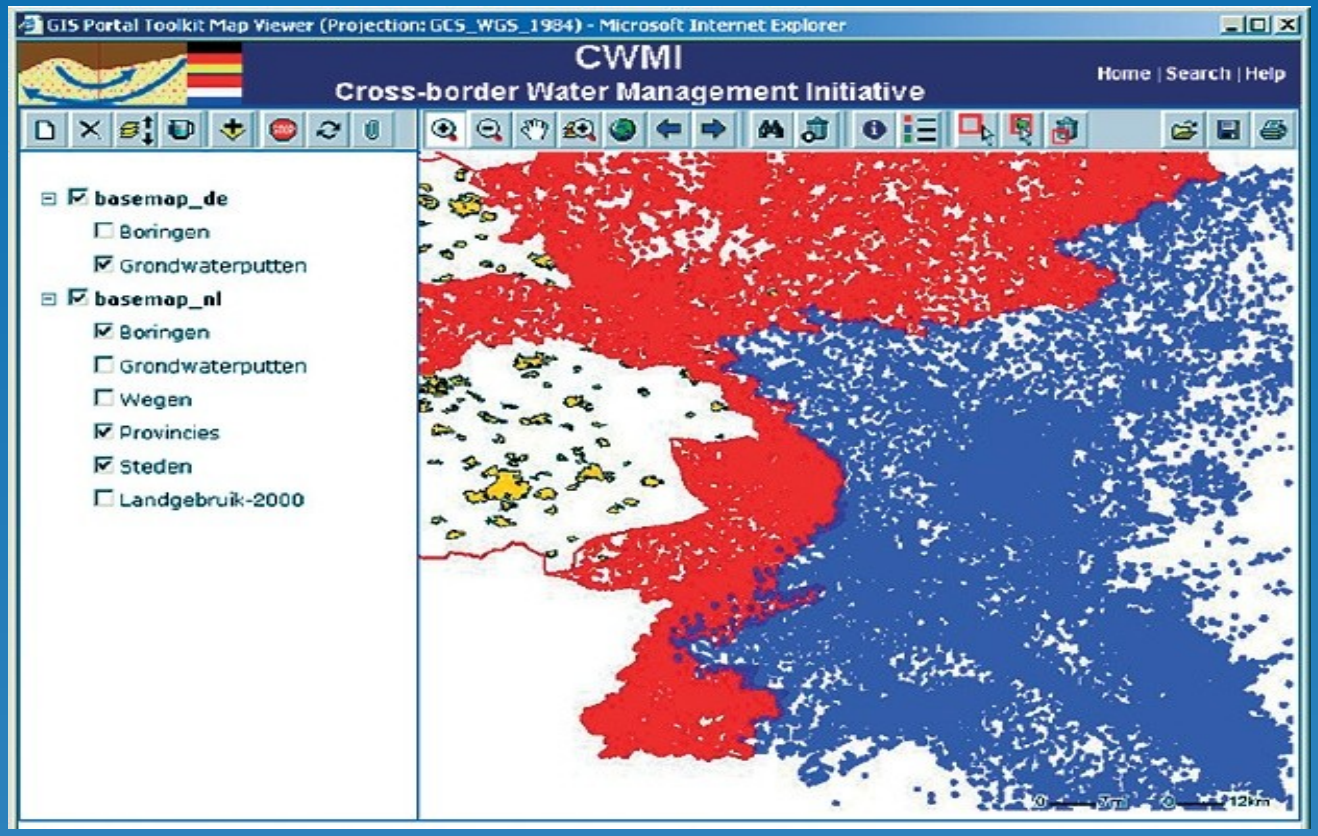
Geochemical Indicators of Climate and Linked Human Impacts on Groundwater

- Selected inorganic indicators
  - a. Nitrate and ammonium
  - b. Chloride
  - c. Trace elements (would vary depending on site geology/issues)

Geochemical Indicators of Climate and Linked Human Impacts on Groundwater

- Selected organic indicators
  - Pesticides (would vary depending on land use/ crop type)
  - Waste-water indicators (fecal bacteria and viruses, caffeine, hormones, pharmaceuticals)
  - BTEX (Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) are the volatile components commonly associated with petroleum products.
  - Common solvents (PCE, TCE, chloroform)

Harmonization of data between different countries



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Developing a groundwater data model

Take a variety of spatial information and integrate into one geospatial database with a common terminology

- Better communication
- Integration of data
- Base for applications

Source: Strassberg, Gil, 2003, Arc Hydro groundwater data model, CRWR GIS Hydro CD, ESRI Annual International User Conference.

Geologic maps

Time series observations

Borehole data

Groundwater data model (geospatial database)

Hydrostratigraphy

Geospatial vector layers

Numerical models

Gridded data

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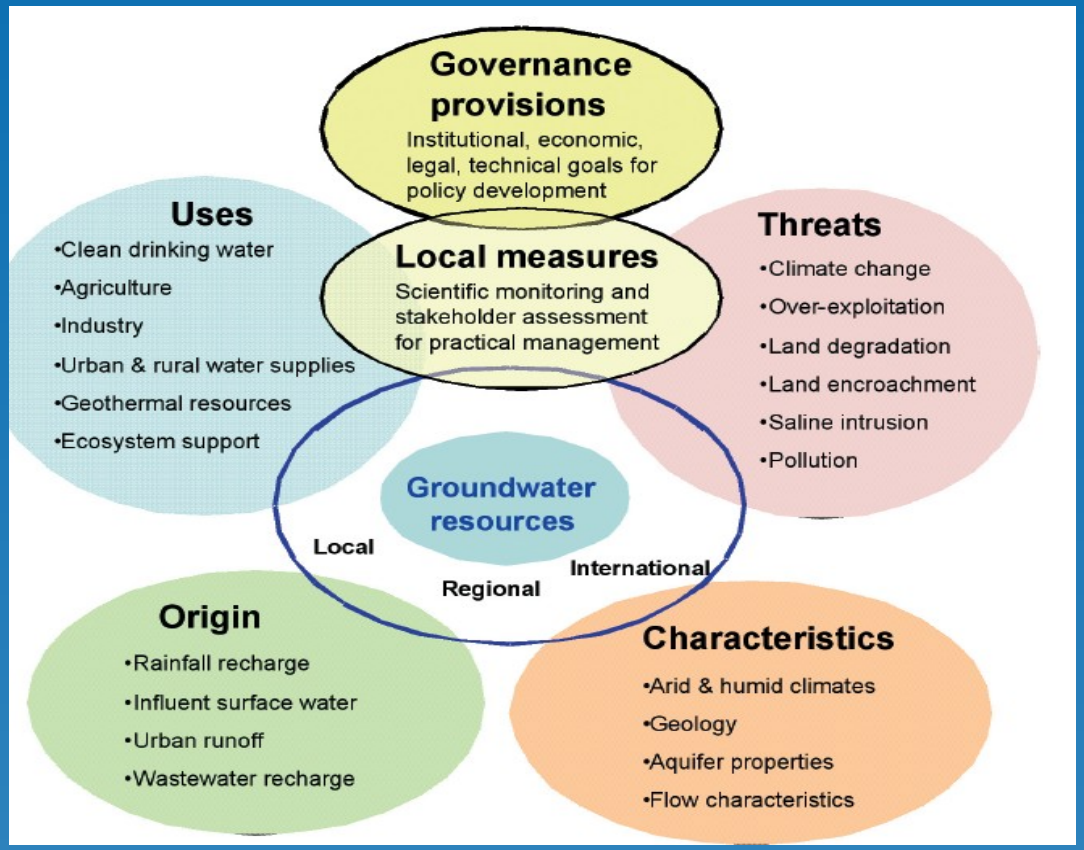
Uses, Threats, Origin, and Characteristics



Useful Web sites for regional and local data

- GRACE

http://disc8.sci.gsfc.nasa.gov/hydrology/secondary/s

- CGIAR

http://www.csi.cgiar.org/CGIARGeoSpatialTools.asp

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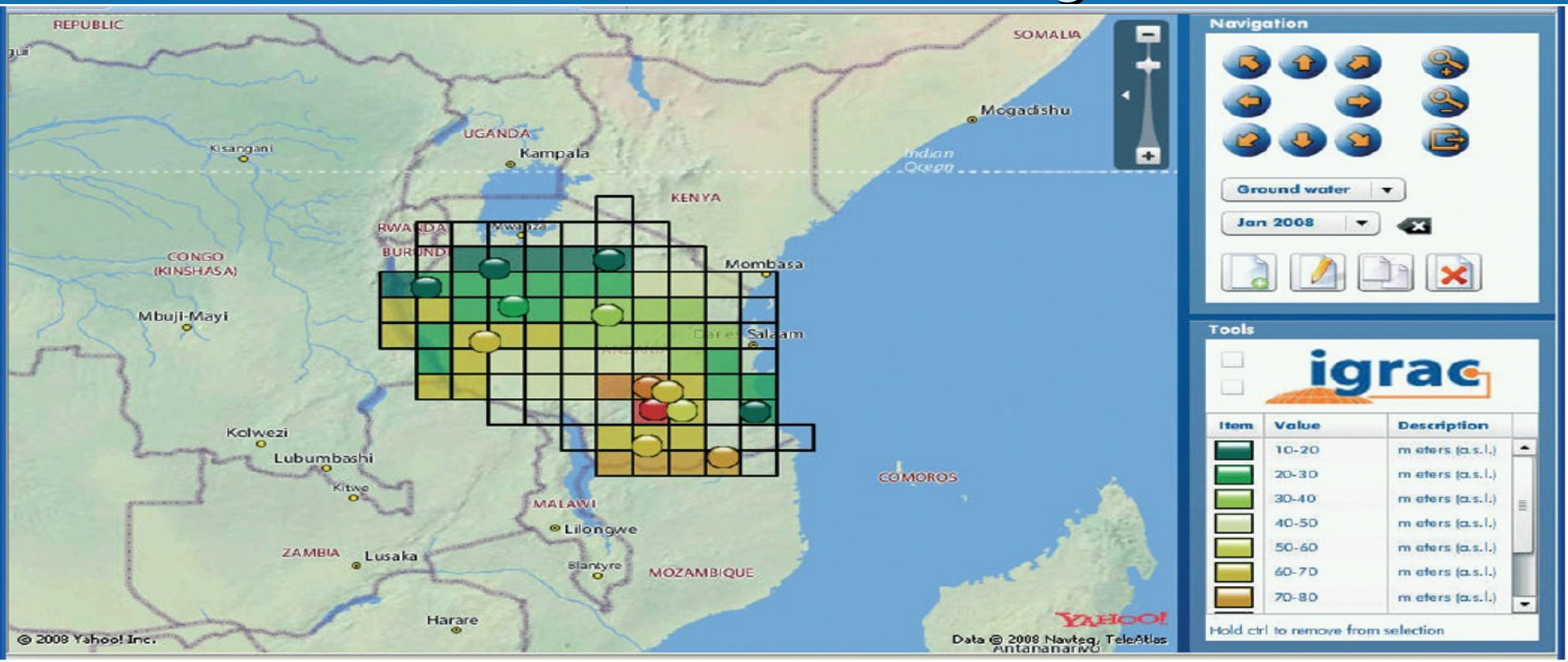
Meta-info Module
International Groundwater Resources Assessment Centre- igarc



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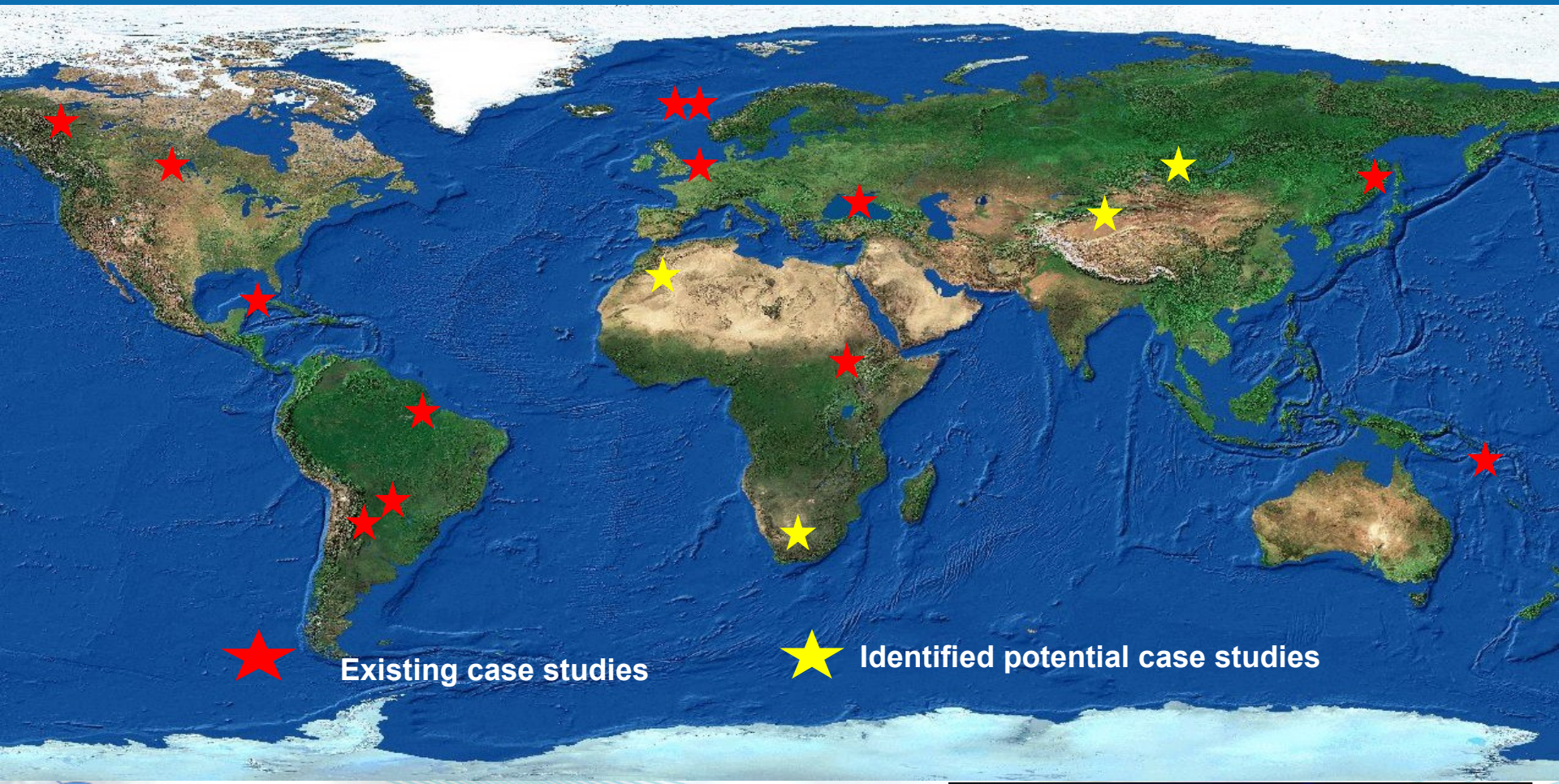
GRAPHIC: Case studies (existing and potential)



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CALL FOR AFRICAN CASE-STUDY

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International vs. Regional

Open Discussion