Integrating remote sensing and models for water resources management

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FutureWater

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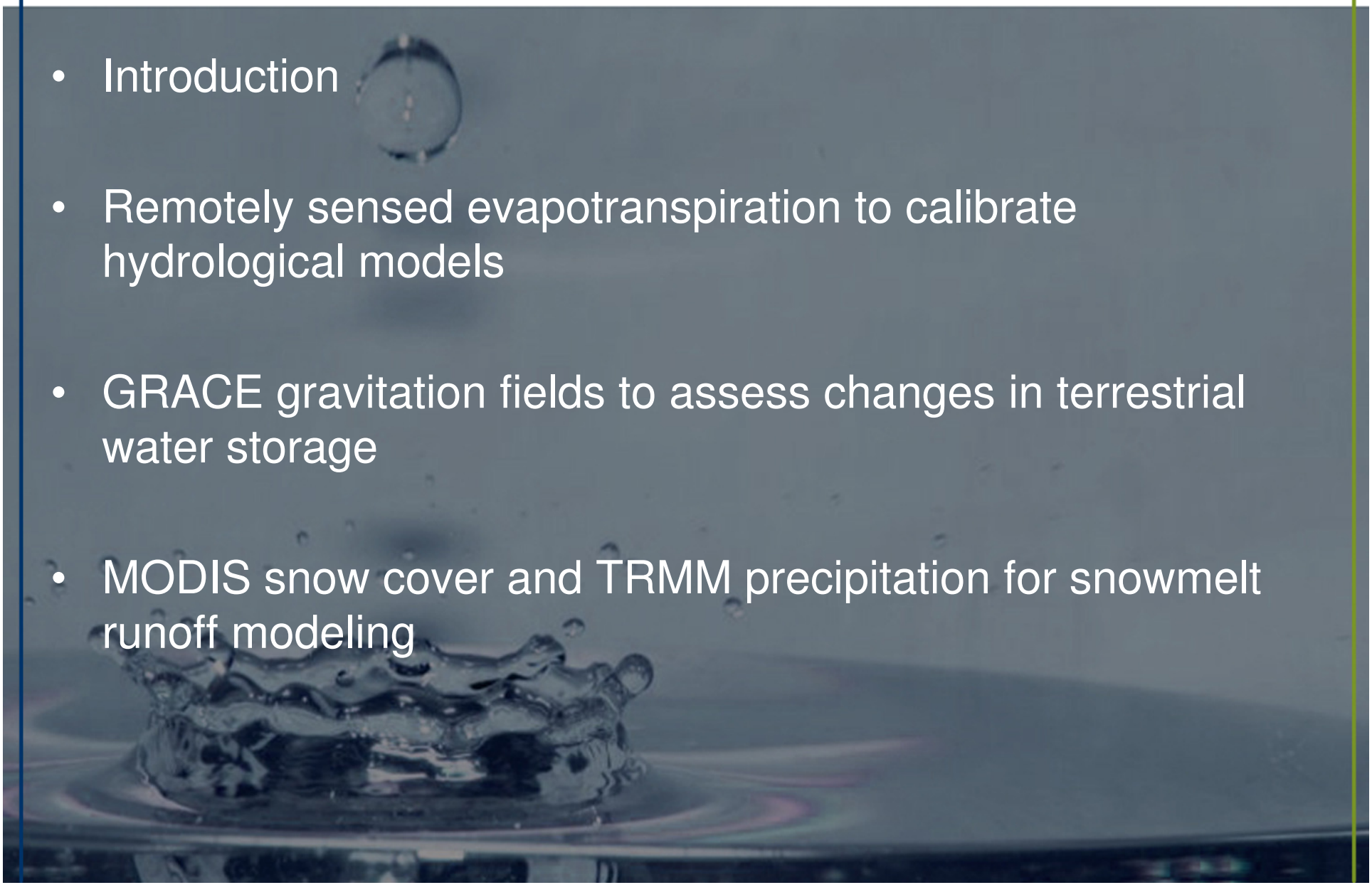
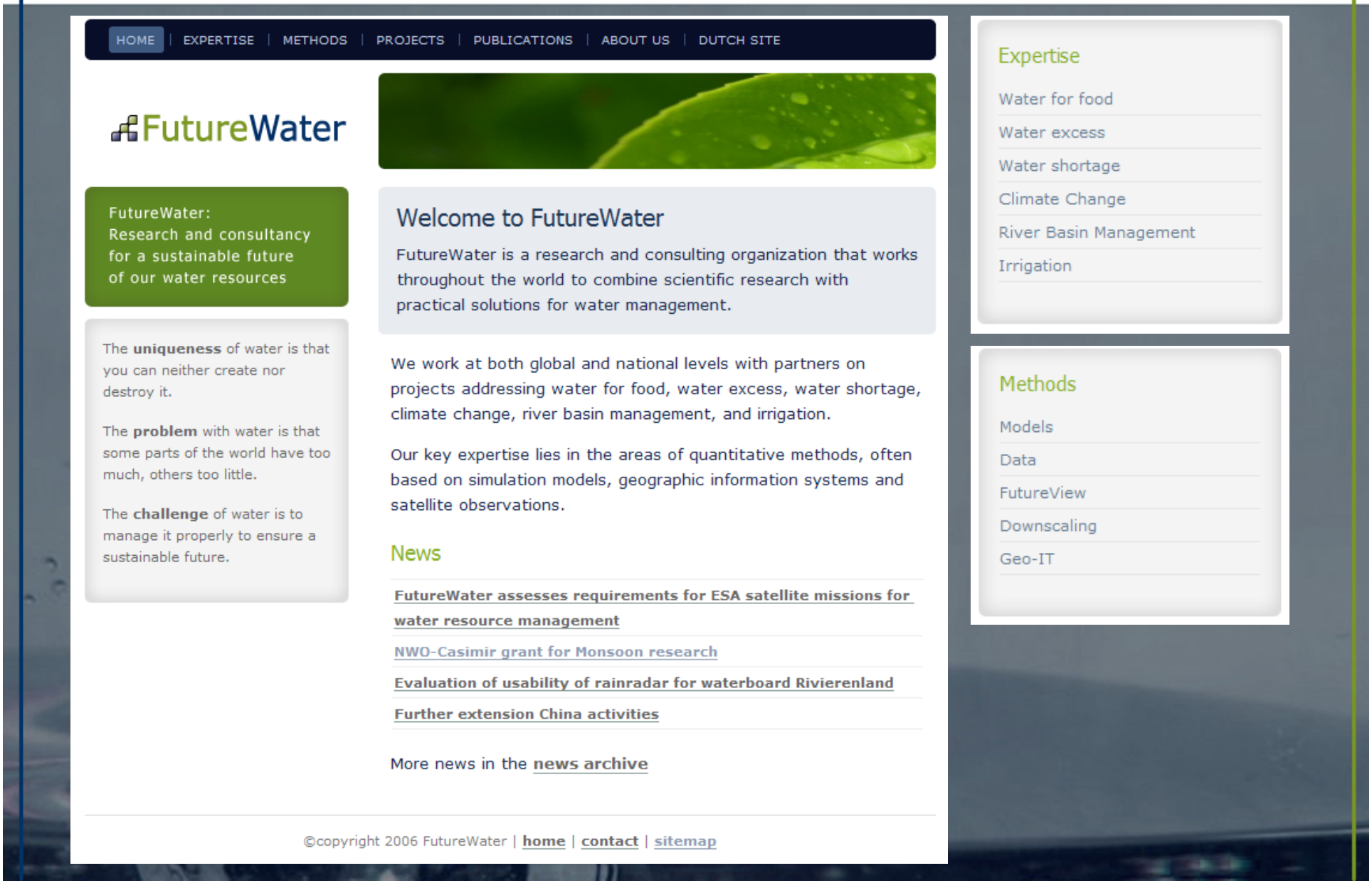


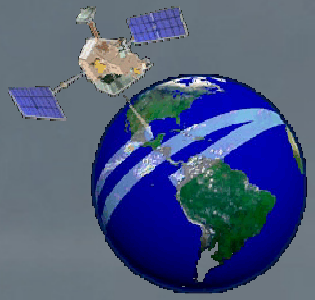
- Introduction
- Remotely sensed evapotranspiration to calibrate hydrological models
- GRACE gravitation fields to assess changes in terrestrial water storage
- MODIS snow cover and TRMM precipitation for snowmelt runoff modeling

Introduction: http://www.futurewater.nl

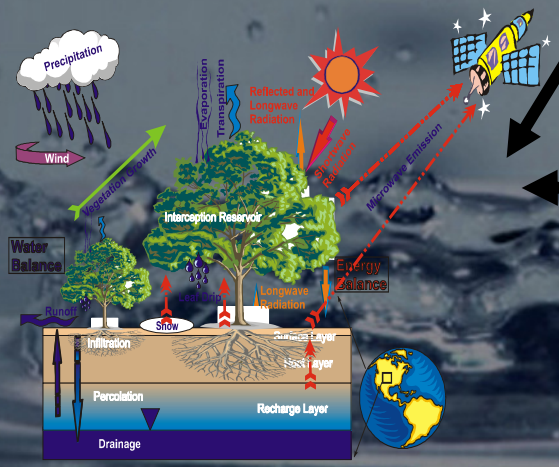


Introduction

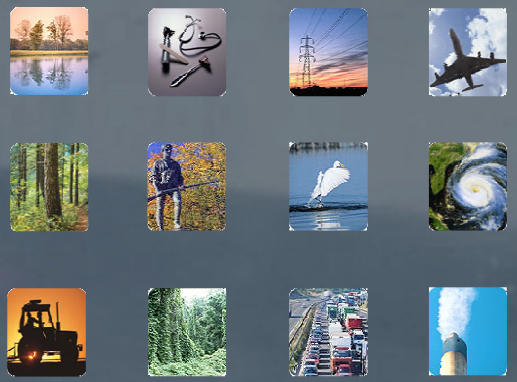
Remote sensing



Hydrological modelling



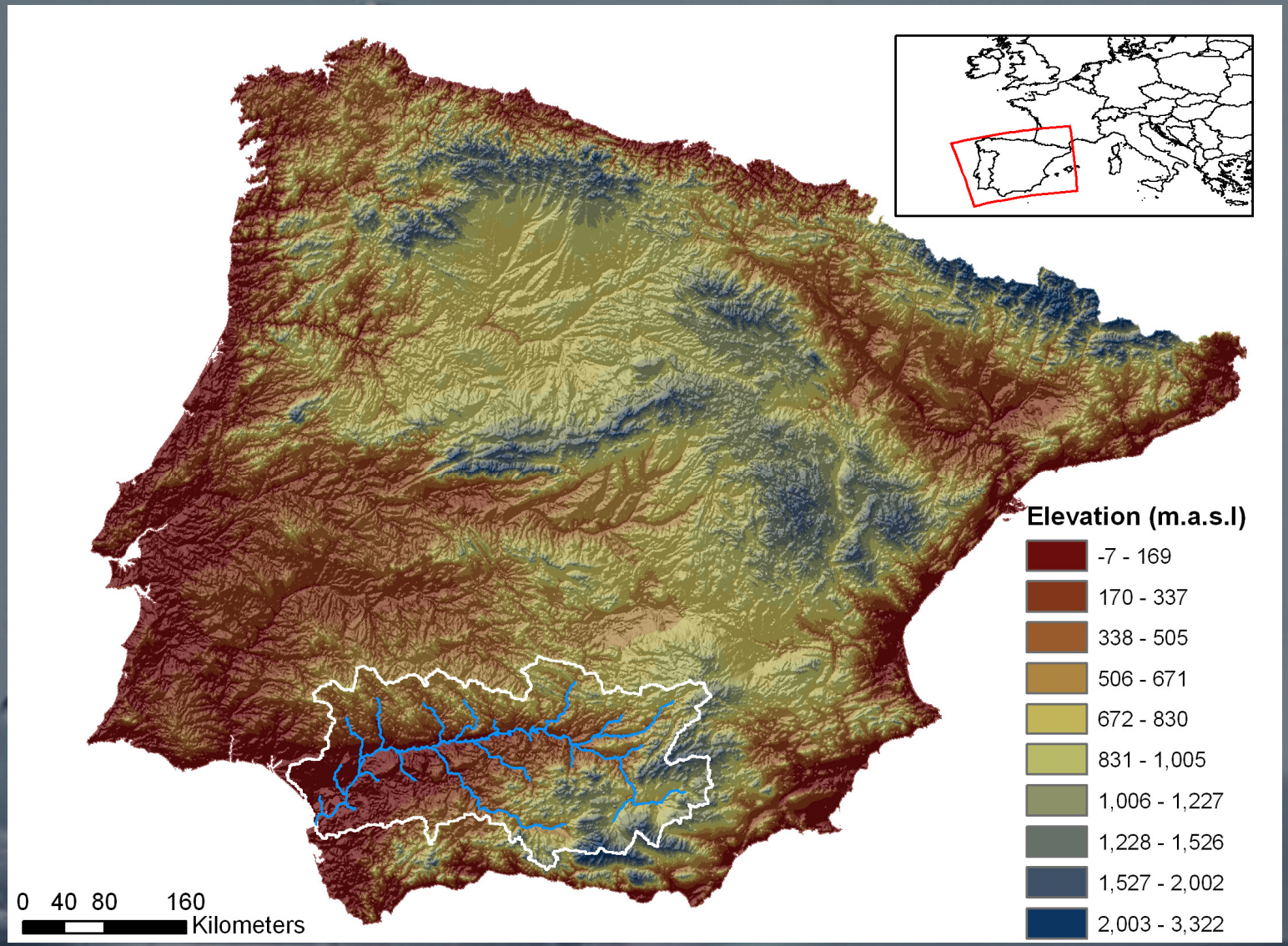
Applications



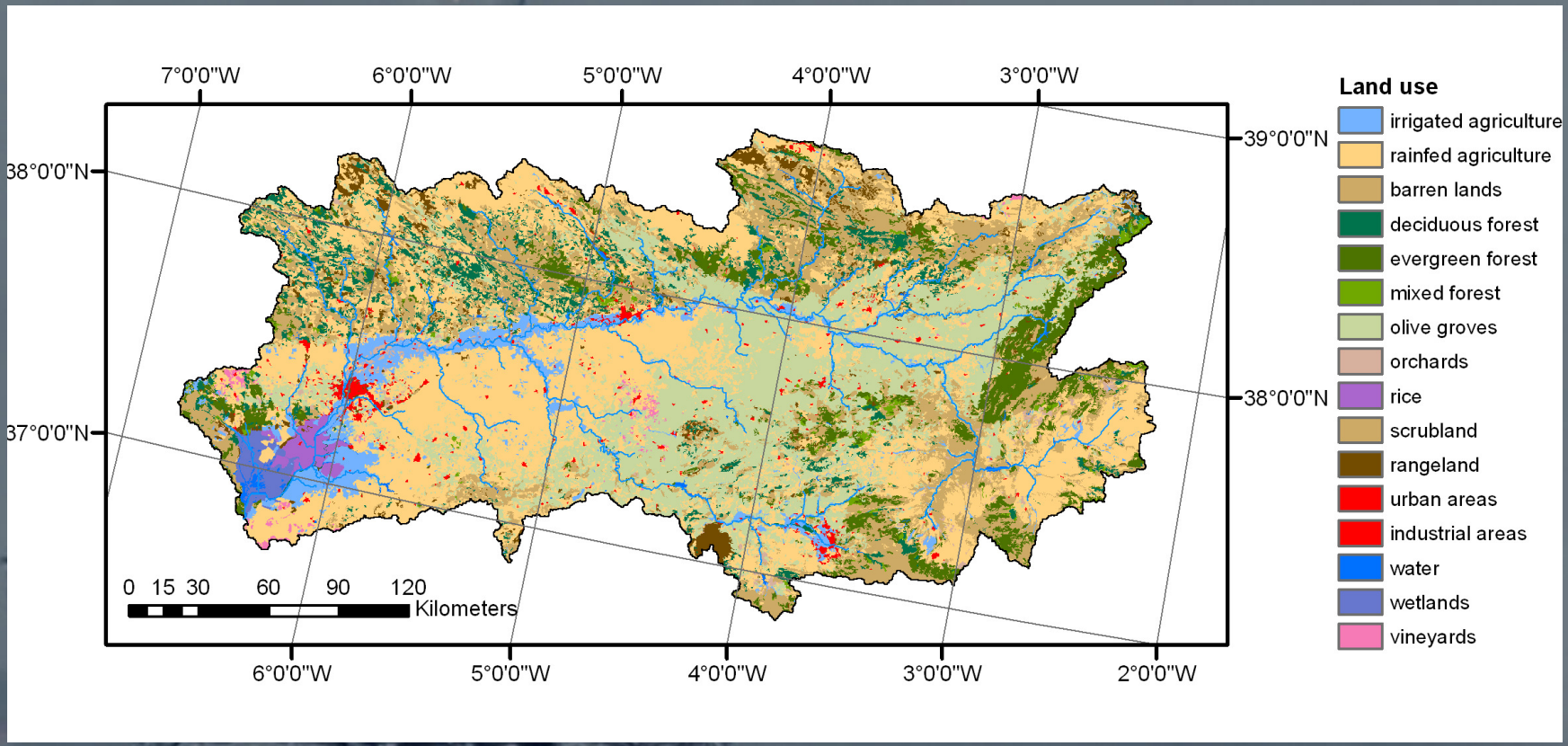
Remotely sensed ET and model calibration

- Problem:
  - Poor data availability in many countries
  - Absence of natural flow
  - Equifinality
  - Basin water balance vs. local water balance
- Scale and field of application
  - Medium to large scale river basins
  - Semi-arid and heterogeneous land use
  - Regulated basins
- Clients:
  - World Bank
  - River basin authorities
- Applications:
  - Hai basin in China
  - Rio Bravo basin in Mexico
  - Krishna basin in India
  - Guadalquivir basin in Spain

Remotely sensed ET and model calibration

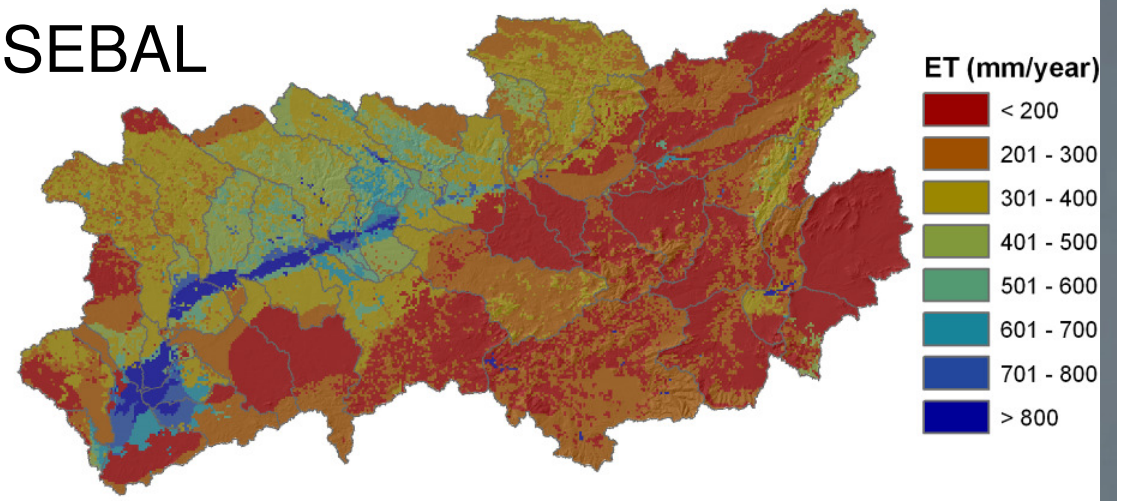


Remotely sensed ET and model calibration

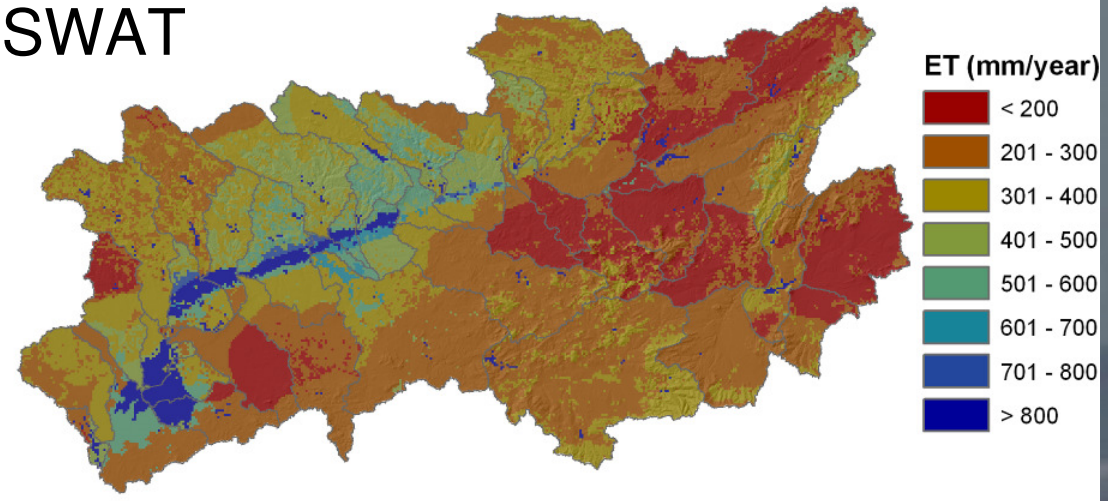


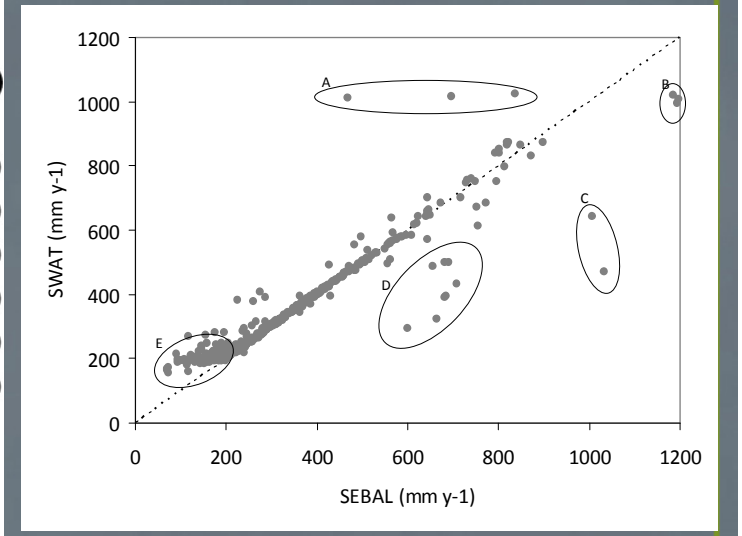
Remotely sensed ET and model calibration

SEBAL

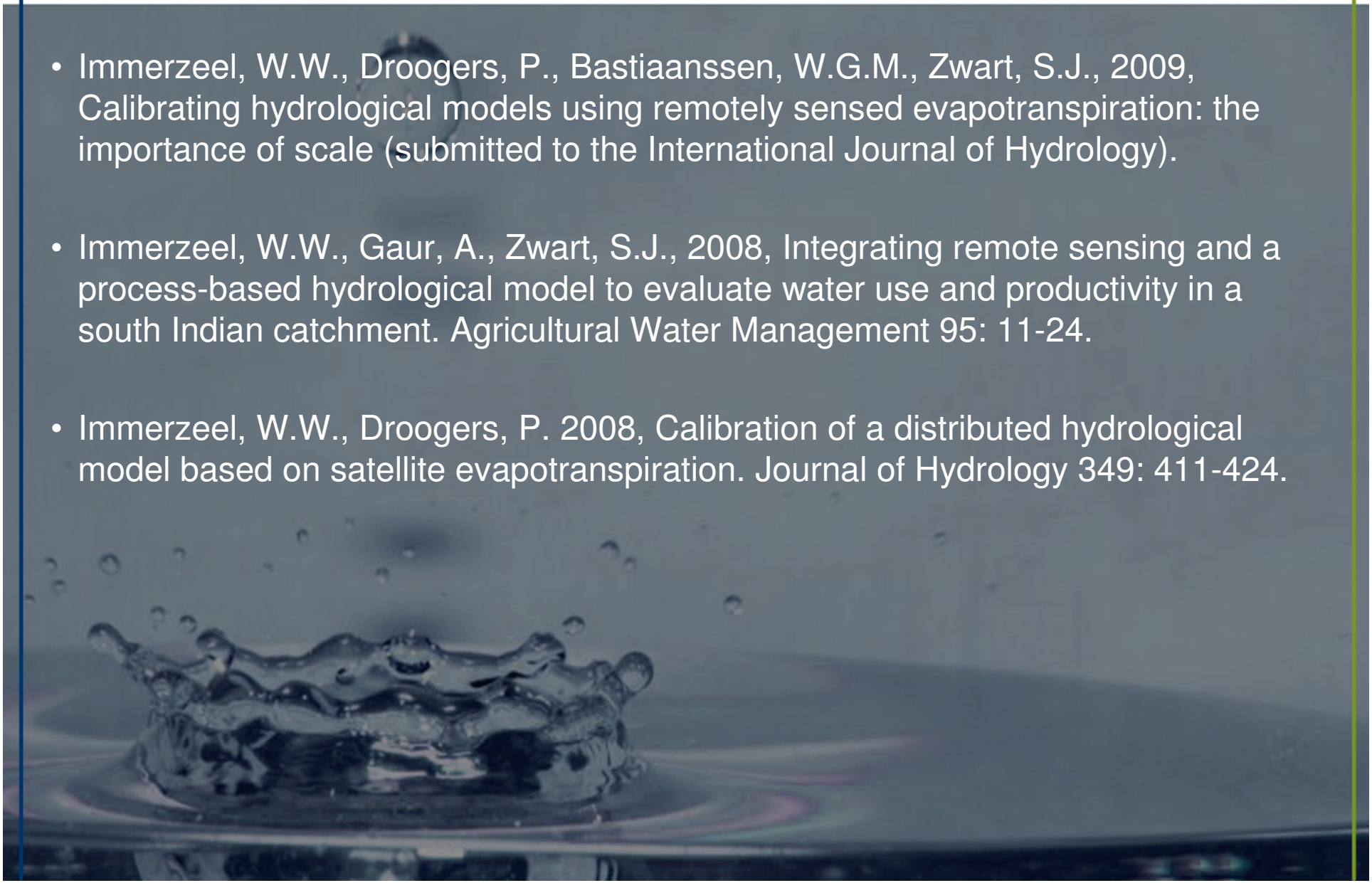


SWAT





Remotely sensed ET and model calibration



- Immerzeel, W.W., Droogers, P., Bastiaanssen, W.G.M., Zwart, S.J., 2009, Calibrating hydrological models using remotely sensed evapotranspiration: the importance of scale (submitted to the International Journal of Hydrology).

- Immerzeel, W.W., Gaur, A., Zwart, S.J., 2008, Integrating remote sensing and a process-based hydrological model to evaluate water use and productivity in a south Indian catchment. Agricultural Water Management 95: 11-24.

- Immerzeel, W.W., Droogers, P. 2008, Calibration of a distributed hydrological model based on satellite evapotranspiration. Journal of Hydrology 349: 411-424.

GRACE to assess changes in terrestrial water storage

- Problem:
  - Large scale groundwater information lacking
- Scale and field of application
  - Large scale river basins
- Clients:
  - World Bank
  - River basin authorities
- Applications:
  - GMEP project China
  - World Bank project Saudi Arabia

GMEP Northern China

The GMEP-project will demonstrate that advanced observations and planning tools can assist decision makers. The package will be demonstrated for two river basins:

- The large Yellow River Basin
- The relatively small Shiyang River Basin

GMEP is based on:

- Satellite Monitoring by GRACE
- Water Allocation by WEAP

NEW: The GMEP Google Maps Tool
for monitoring and a planning in the Yellow River Basin.

State of the Art Report from February 2008 can be downloaded here. A draft-version of the scenario analyses report can be downloaded here.

Conference
FutureWater has successfully organised a conference on "Advanced tools in water resources management" from May 26 to May 27, 2008. Further details and the conference proceedings can be found here.

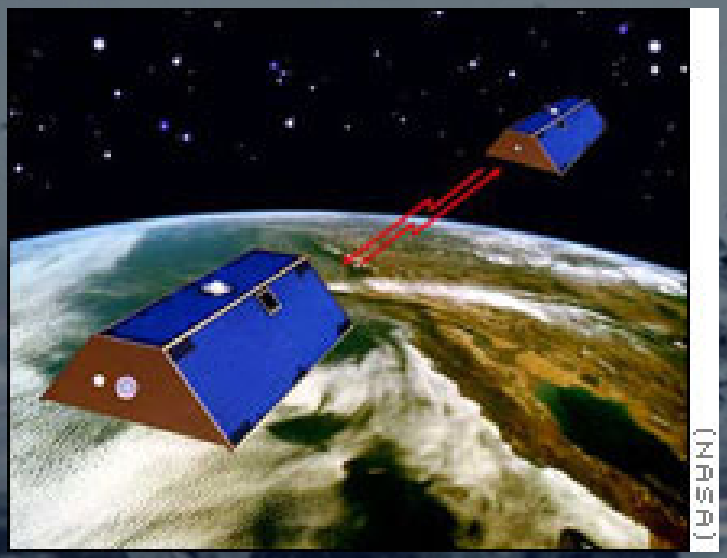
GMEP

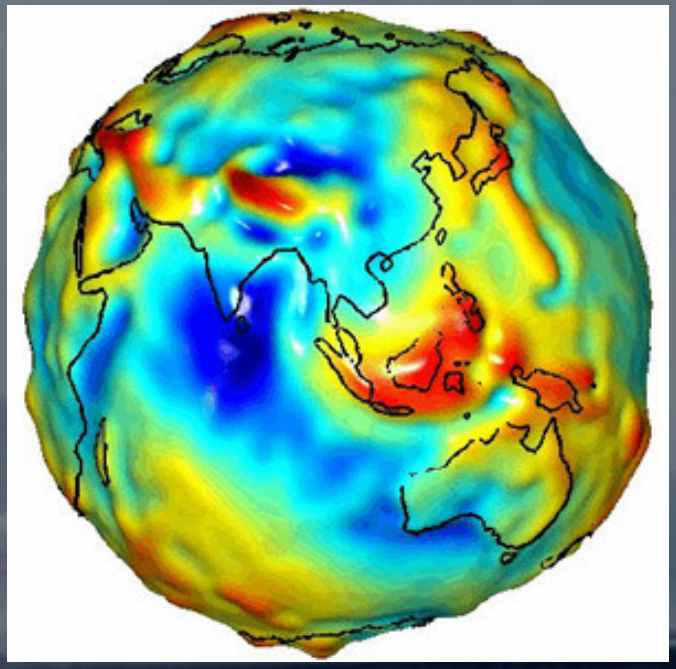
- Conference
- Background
- GMEP-tools
- Yellow River Basin
- Shiyang River Basin
- Publications
- Links
- Contact

www.futurewater.nl/gmep

Satellite observations: groundwater (GRACE)

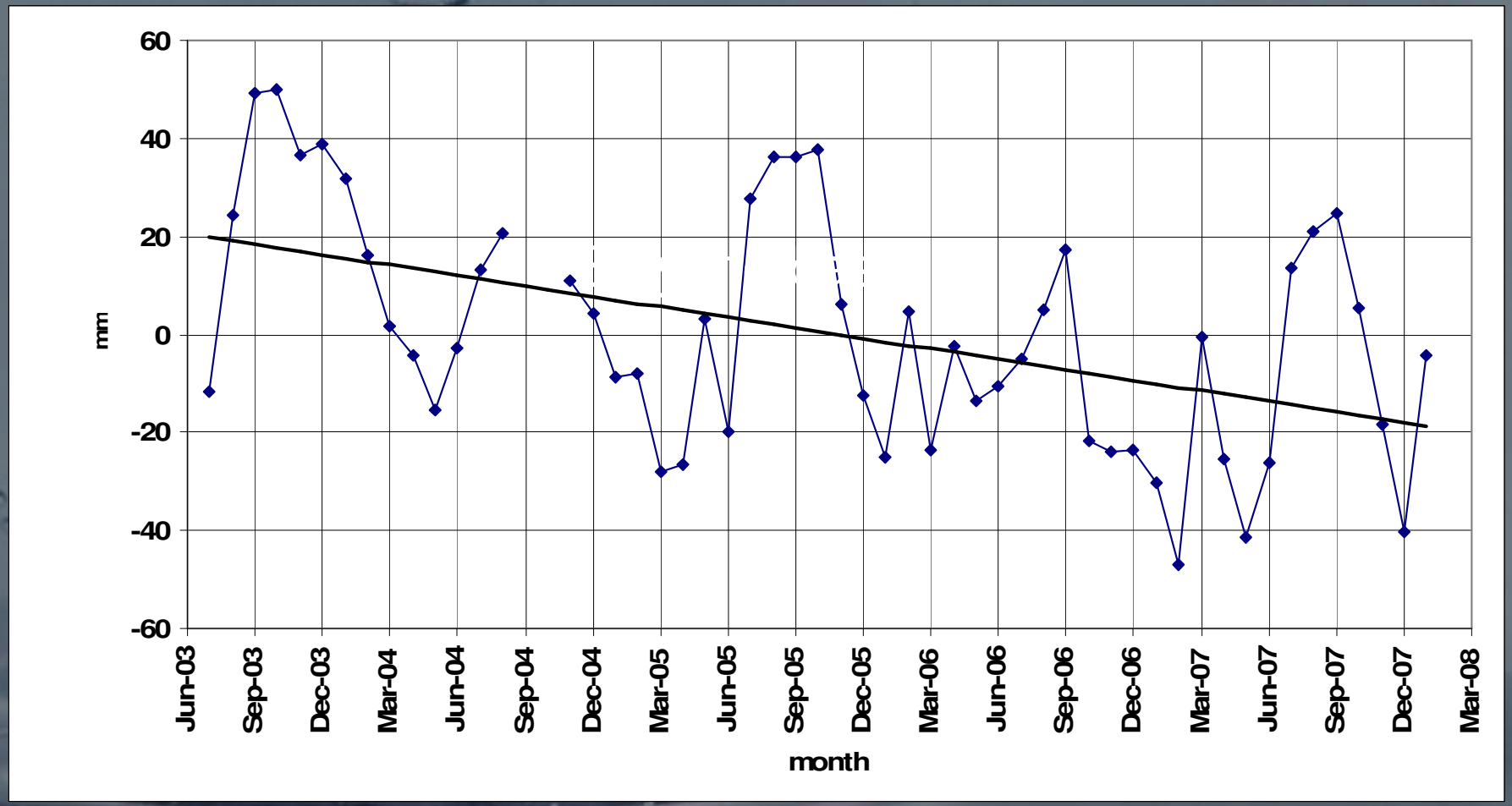
- GRACE: Gravity Recovery and Climate Experiment
  - NASA satellite
  - Two satellites, co-orbiting at 300-500 km altitude
  - Seperated along track by 220 km
  - Launched March 2002



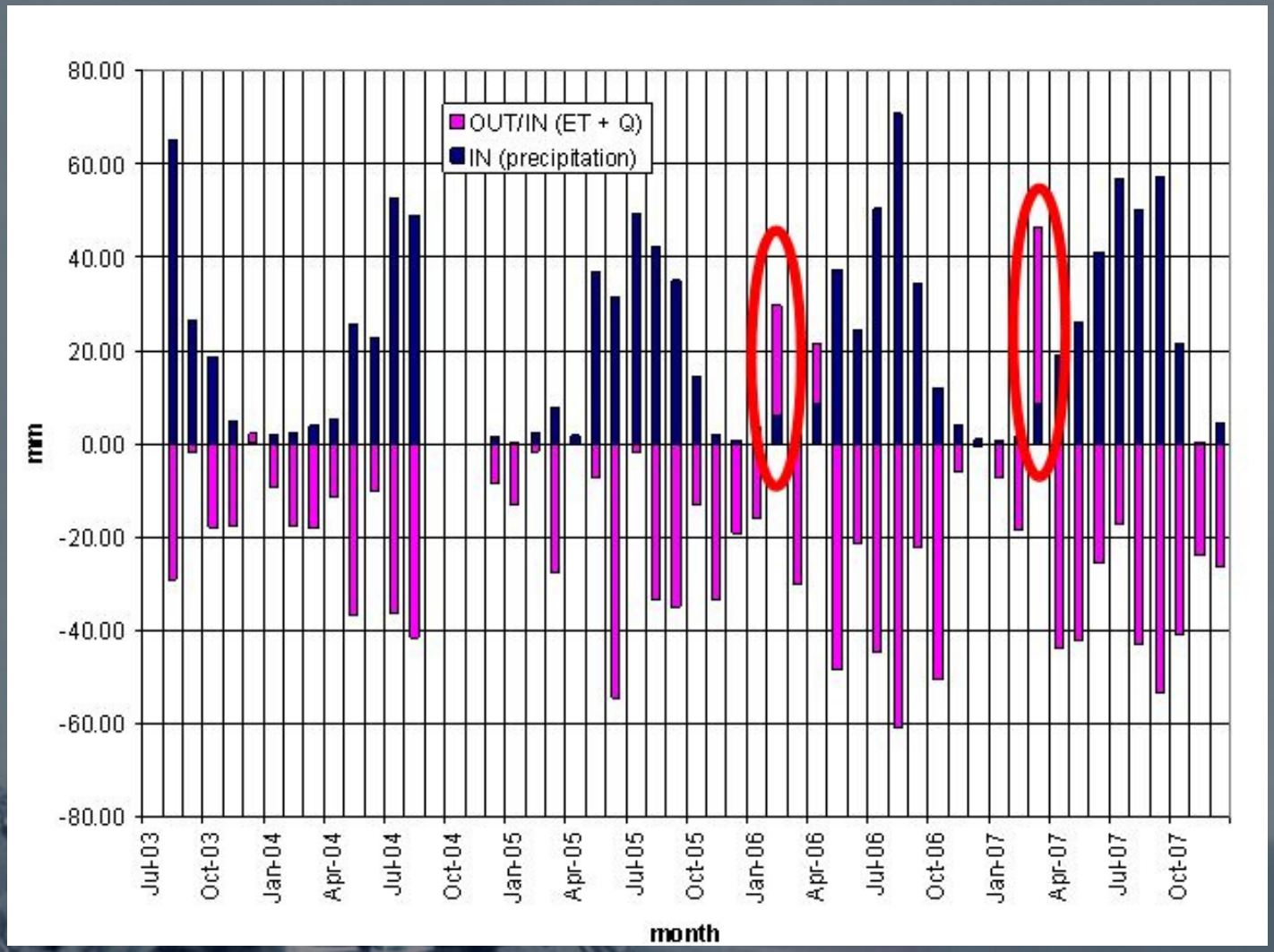


Shiyang River Basin: GRACE results

Storage change with respect to the long term average

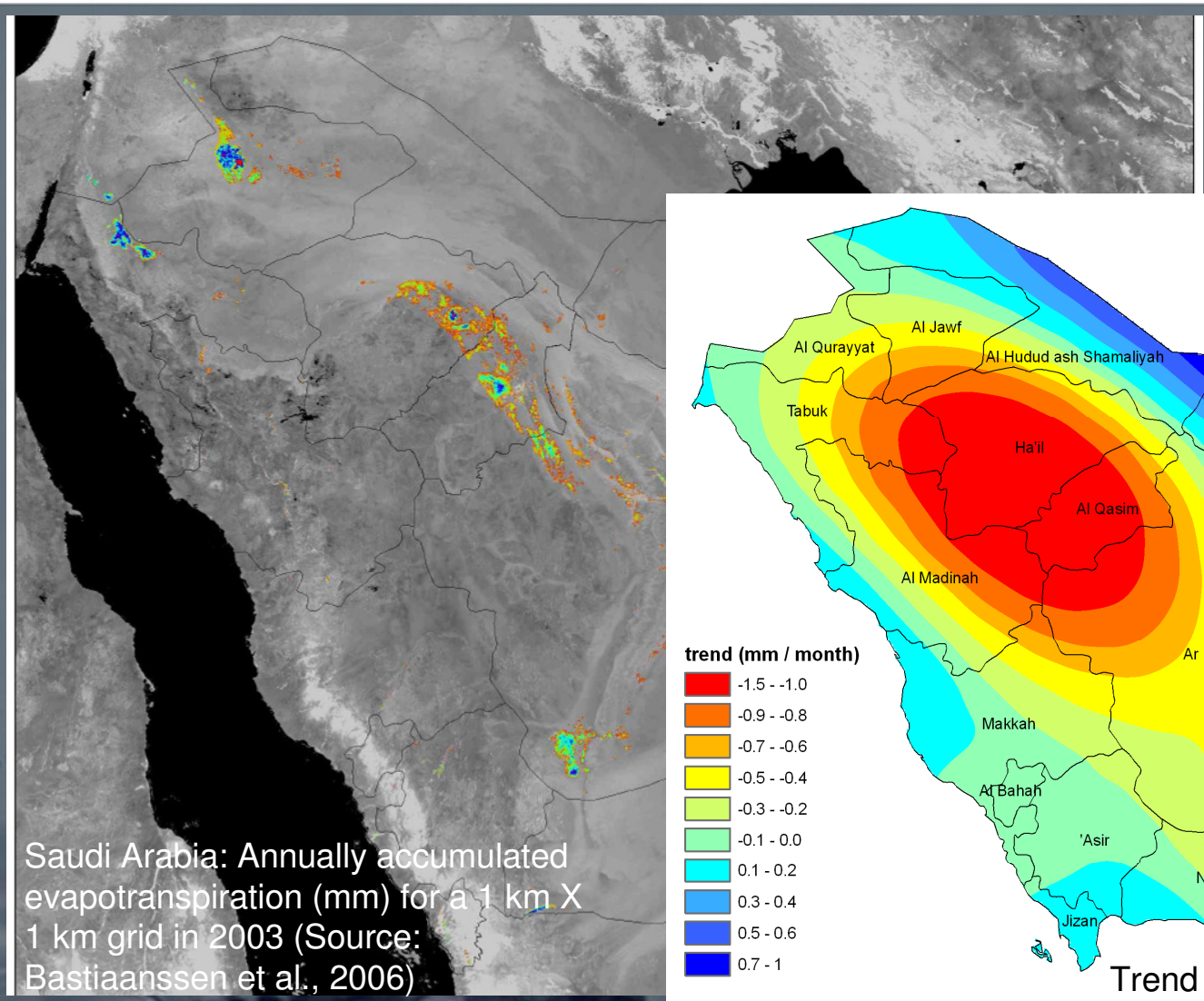


Shiyang River Basin: GRACE results



Source: Brian Gunter (TU Delft)

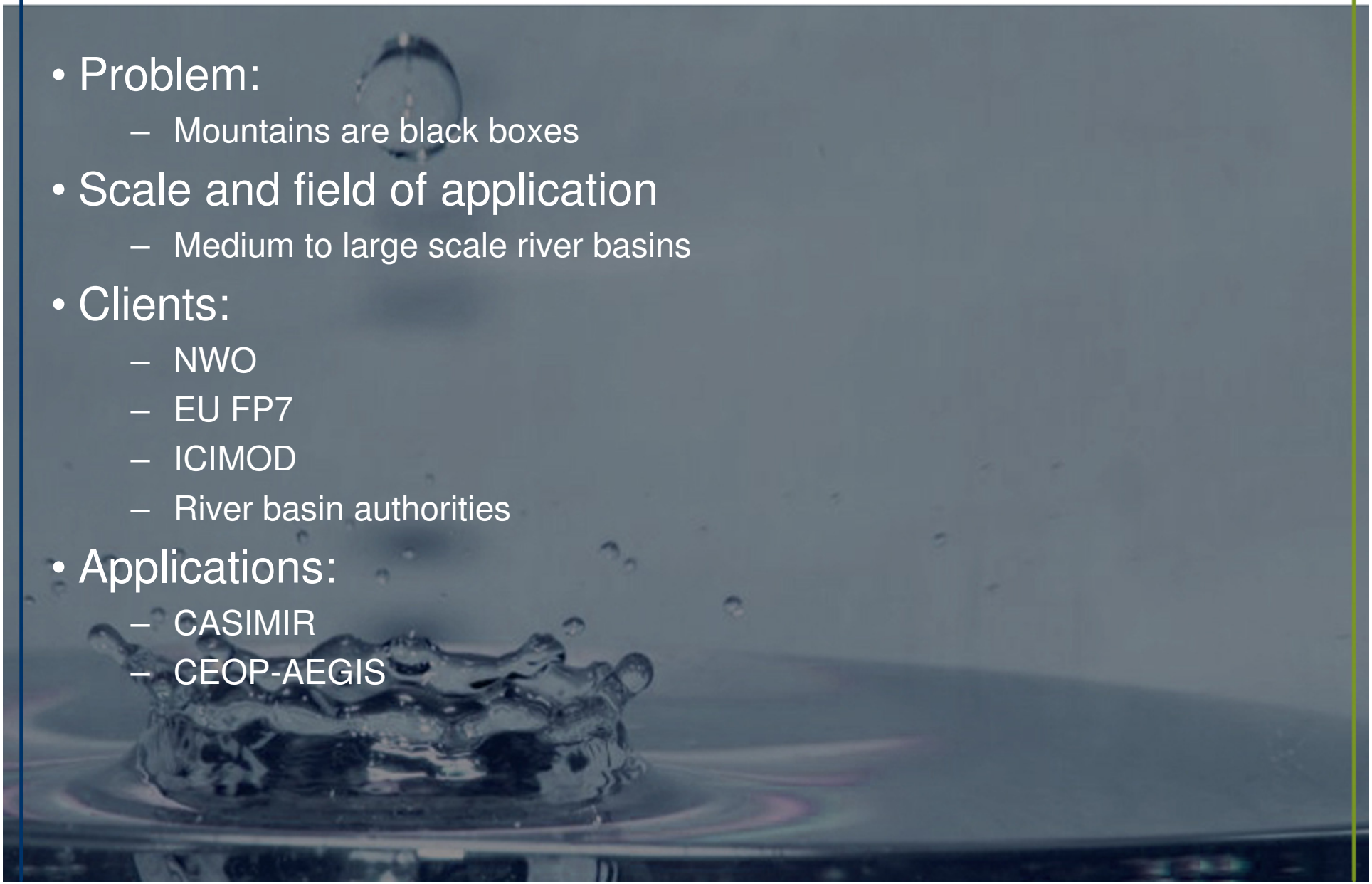
Saudi Arabia



Saudi Arabia: Annually accumulated evapotranspiration (mm) for a 1 km X 1 km grid in 2003 (Source: Bastiaanssen et al., 2006)

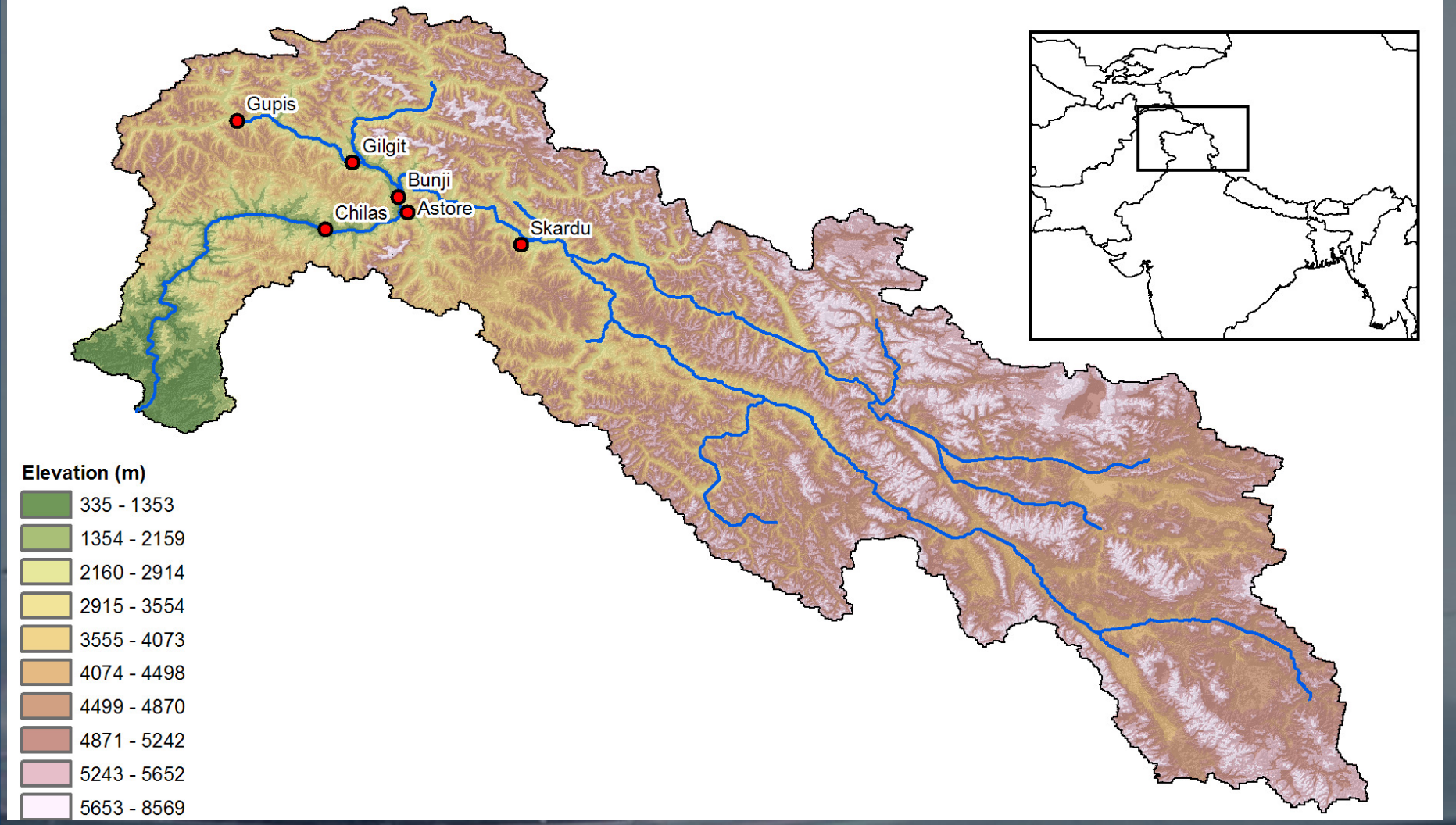
Trend in terrestrial water storage (2003-2008) based on GRACE data (based on 100 x 100 km2).

Remote sensing and snow melt runoff modelling



- Problem:
  - Mountains are black boxes
- Scale and field of application
  - Medium to large scale river basins
- Clients:
  - NWO
  - EU FP7
  - ICIMOD
  - River basin authorities
- Applications:
  - CASIMIR
  - CEOP-AEGIS

Study area


Gupis
Gilgit
Bunji
Astore
Chilas
Skardu
Elevation (m)
335 - 1353
1354 - 2159
2160 - 2914
2915 - 3554
3555 - 4073
4074 - 4498
4499 - 4870
4871 - 5242
5243 - 5652
5653 - 8569

Datasets

MODIS 8-day snow cover at 0.05°resolution (MOD10C2 product)

- Normalized Difference Snow Index:

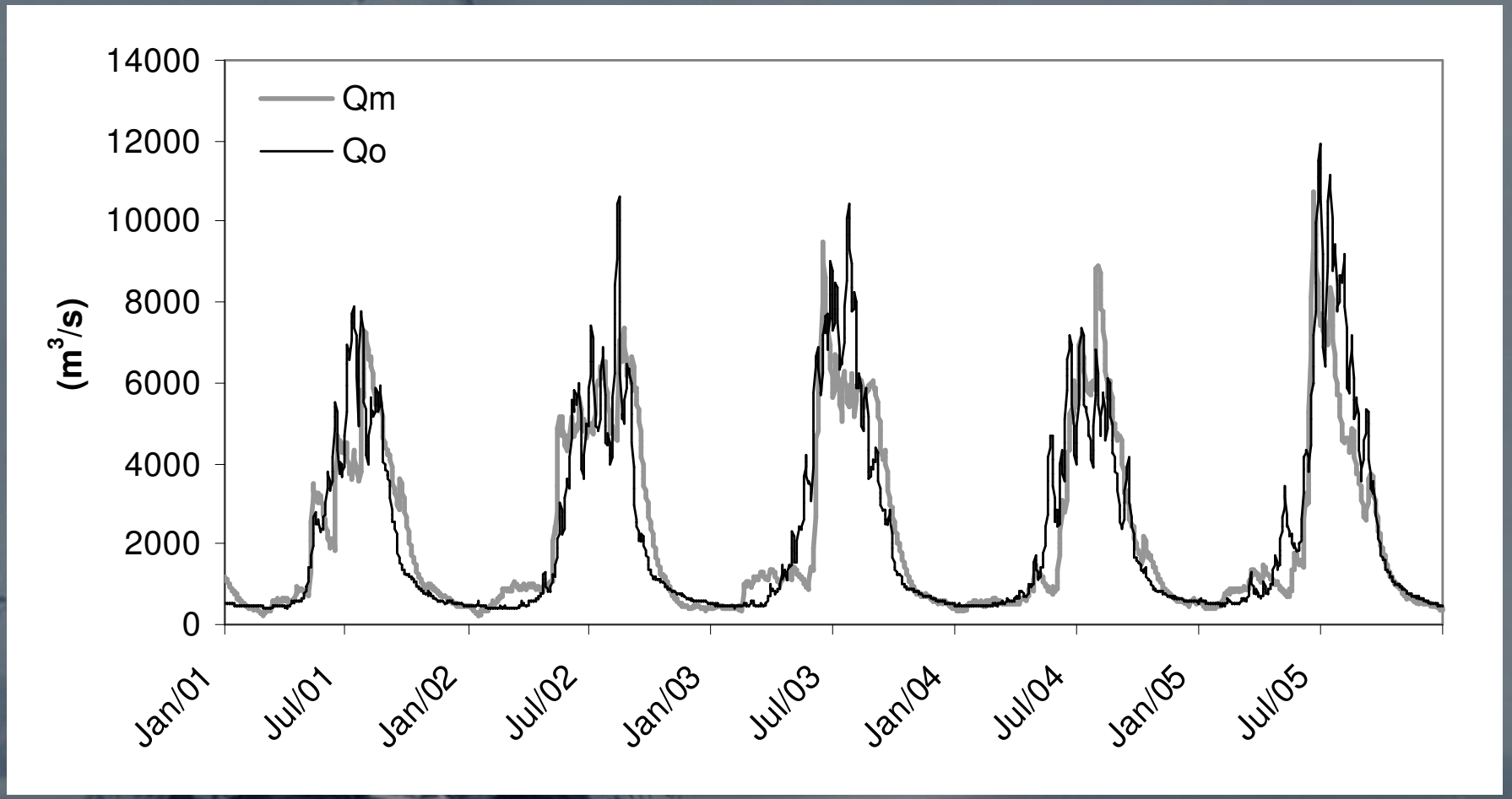
  NDSI = (GREEN – NIR) / (GREEN + NIR)

  Green = 0.545–0.565 µm

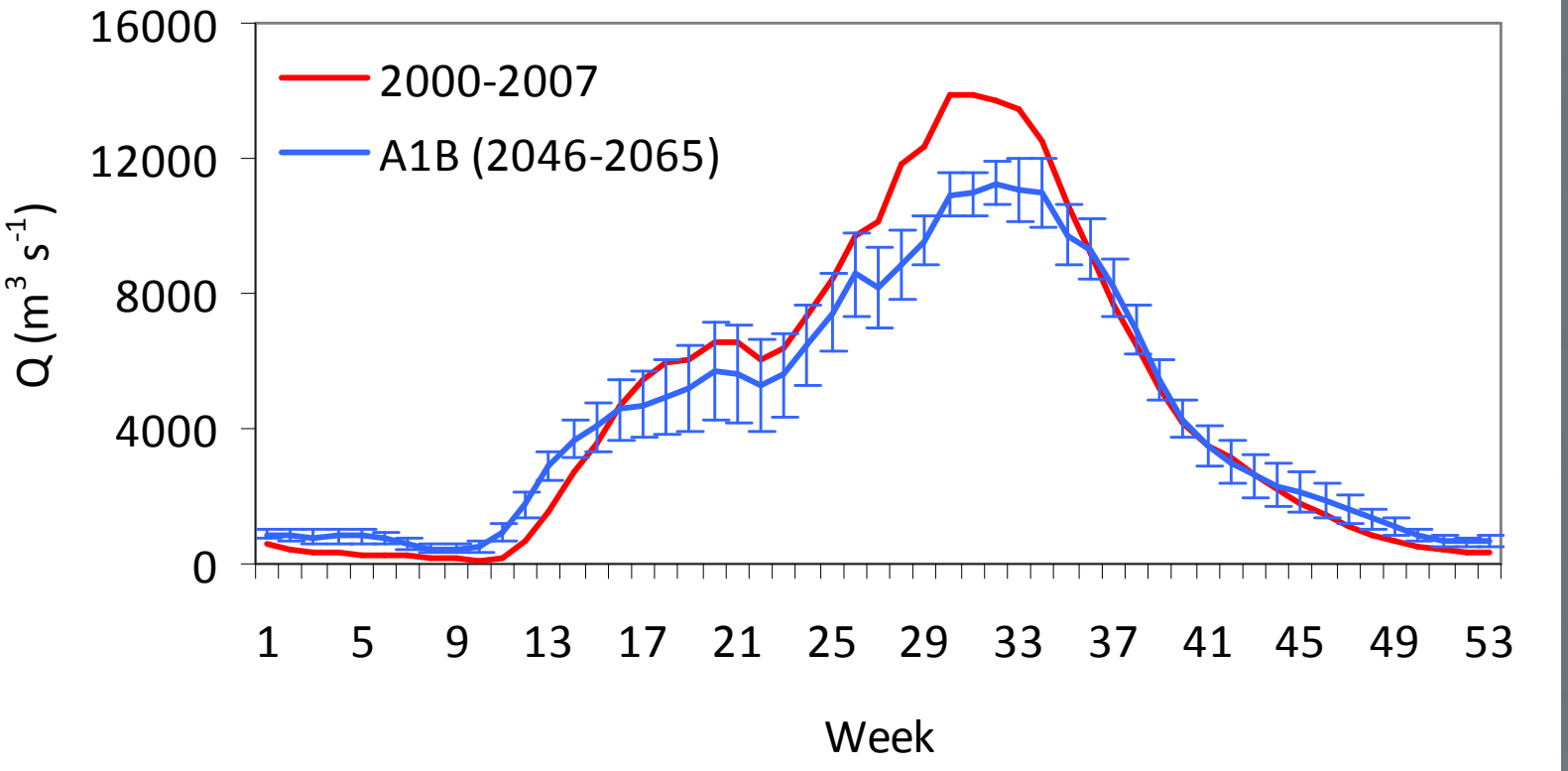
  NIR = 1.628–1.652 µm

- TRMM precipitation
  - 3B43 monthly blended multi-satellite and gauge corrected precipitation estimates at 0.25°resolution
- Daily precipitation and temperature data from 6 different stations

Snowmelt Runoff Model



Snowmelt Runoff Model



Immerzeel, W.W., Droogers, P., de Jong, S.M., Bierkens, M.F.P., 2009, Large-scale monitoring of snow cover and runoff simulation in Himalayan river basins using remote sensing Remote Sensing of Environment 113: 40-49.

Conclusions

- The water balance is closing!
- Unique (Dutch) expertise in the coupling between remote sensing and models has been developed over the last years!
- Further commercialize this expertise both in the national and international markets!