Water Resources of the Ganga under a Changing Climate: interaction between Glaciers and Monsoon in the Himalaya

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Interactions and changes

- Glacier melt
- Changing monsoon patterns

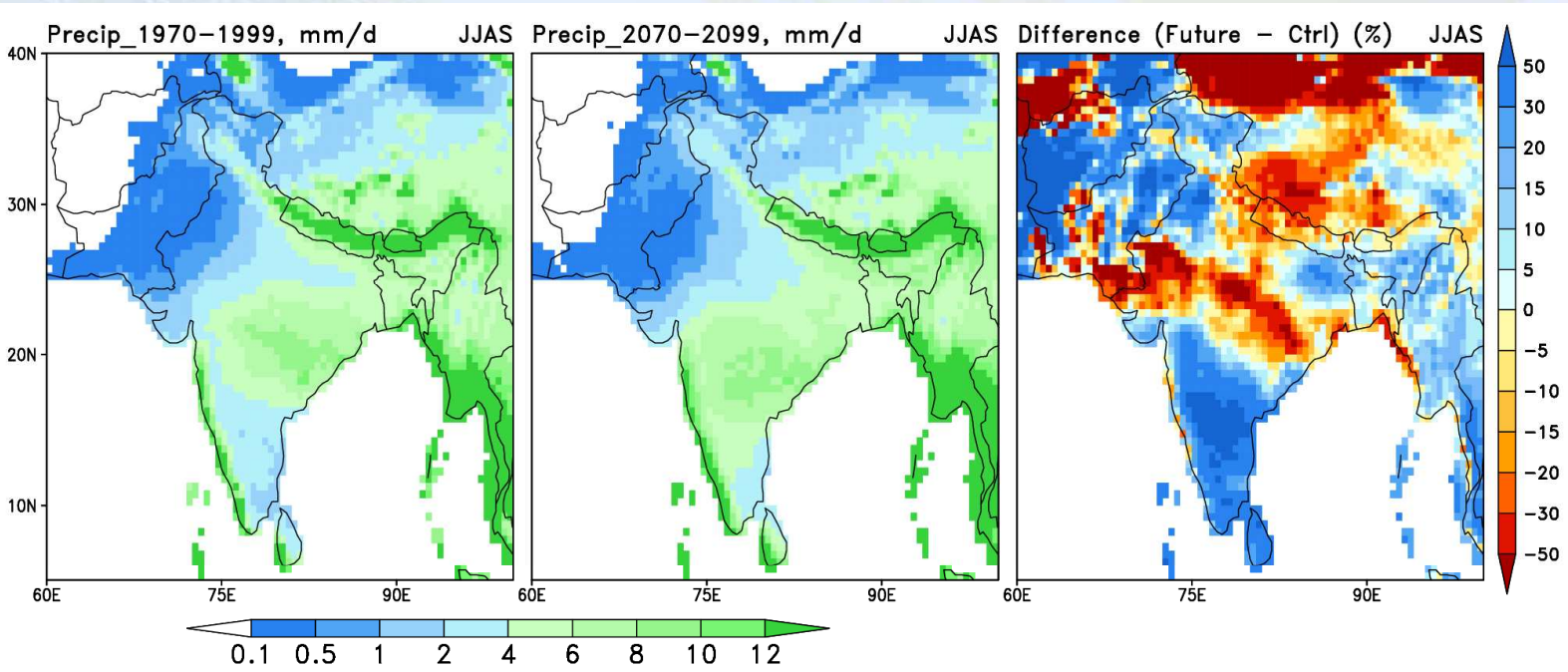
Recent findings glacier melt

- Western Himalaya: annual ice thickness loss of about 0.8 m w.e. per year (1999 – 2004).
  (Berthier et al., 2007 *Remote Sensing of Environment)*
- Global Glacier Changes: Facts and Figures
  (UNEP/WGMS, 2008)
- Mass loss on Himalayan glacier endangers water resources
  (Kehrwald et al, 2008. GRL)
- Climatic warming, glacier recession and runoff from Alpine basins after the Little Ice Age maximum
  (Collins, 2008. Annals of Glaciology)

(AX010 Fujita & Shresta)

Climate models disagree on future rainfall changes.

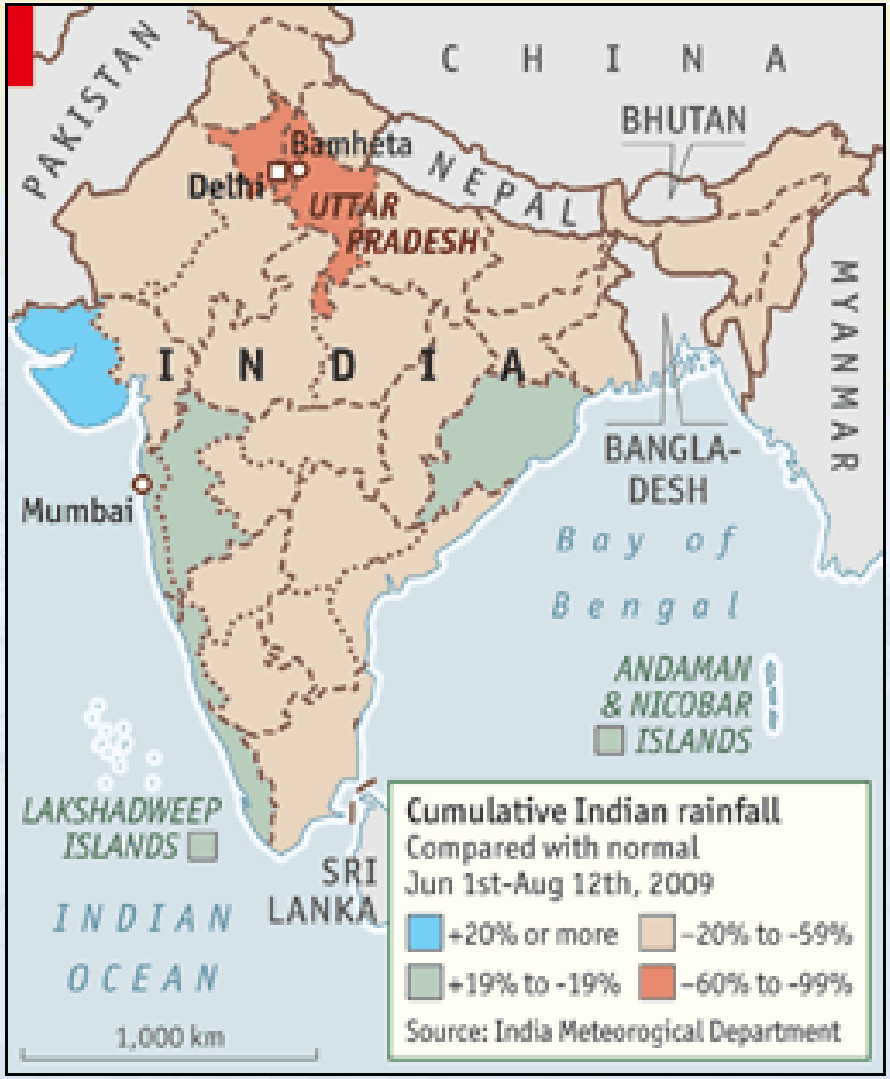
- ECHAM4 projects an increase of 13 percent in summer (kharif season) rainfall;
- HadCM2 projects a decline of 6 percent.



REMO precipitation Difference (%), A1B scenario – Control

Kumar and Jacob

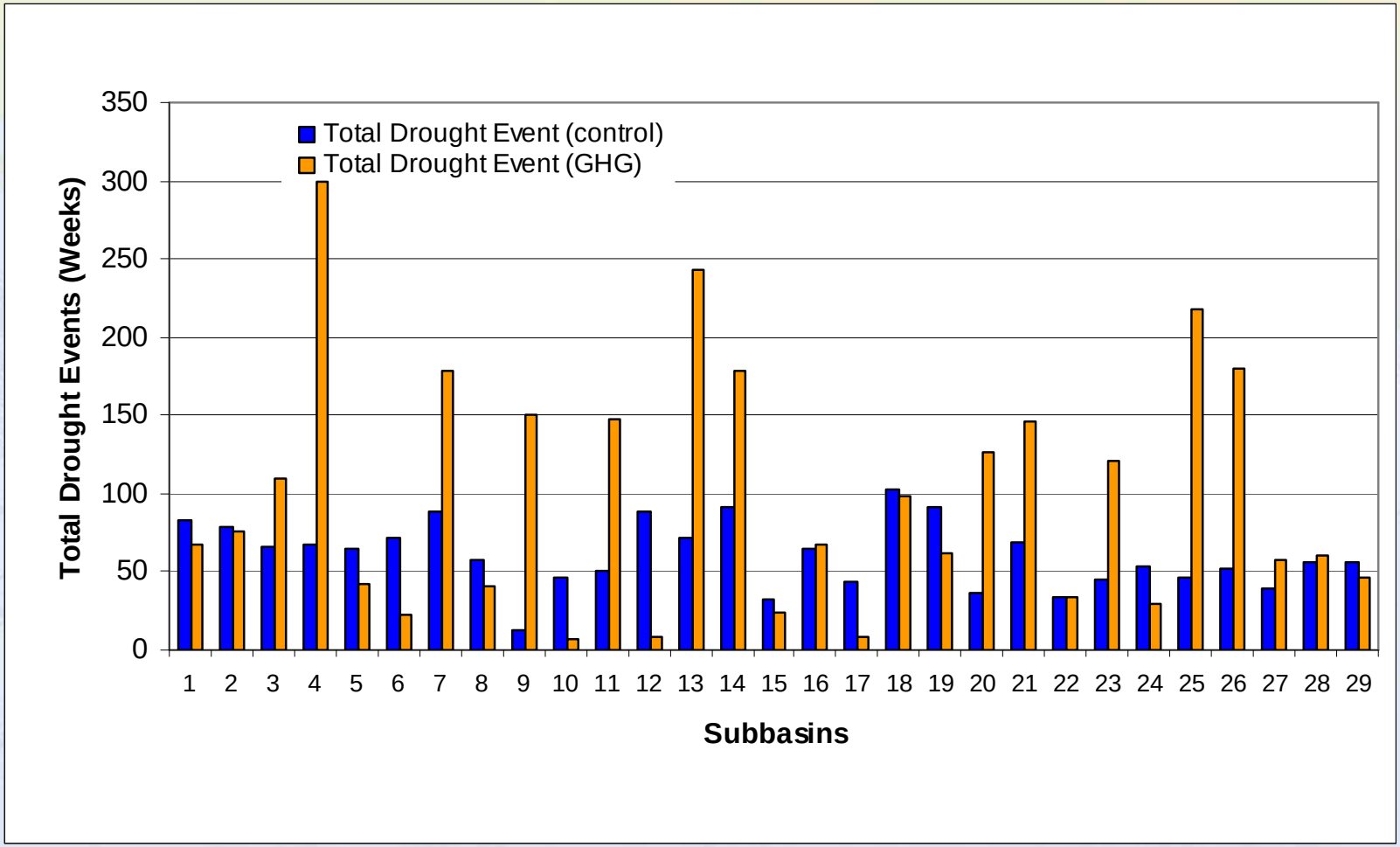
Impact



Climate change impact?

Economist, Aug 2009

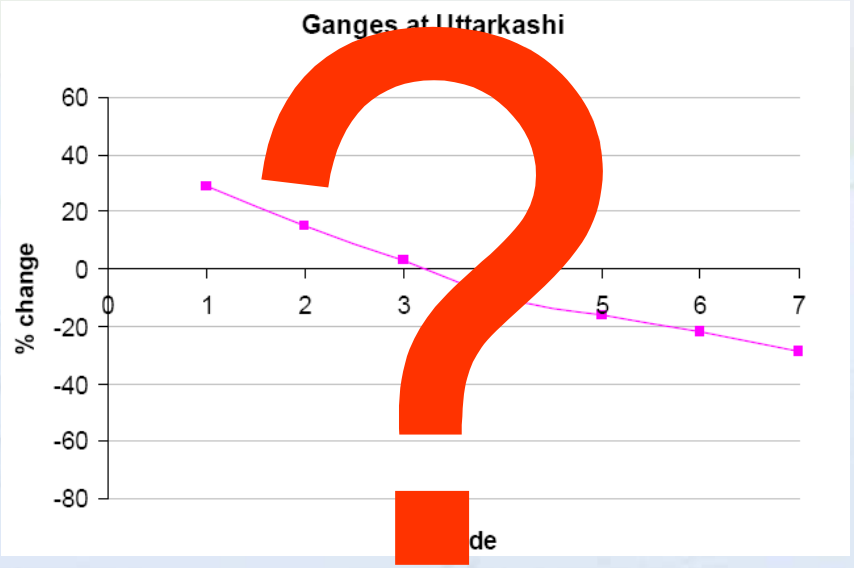
Number of drought weeks in Sub-basins of Ganga for Current (1981-2000) & GHG scenarios (HadRm2 2041-2060)



Gosain et al., 2006

Expected changes in discharge Ganges

- Trends
  - Glaciers retreating (e.g. Gangotri glacier 20-22 m per year)
  - Projected change in flow of Ganges



(e.g. Hasnain May 2004 New Scientist &

Rees, June 2004. New scientist)

Challenges

To support adaptation measures for different sectors:

- There is a need for time and space specific CC predictions.

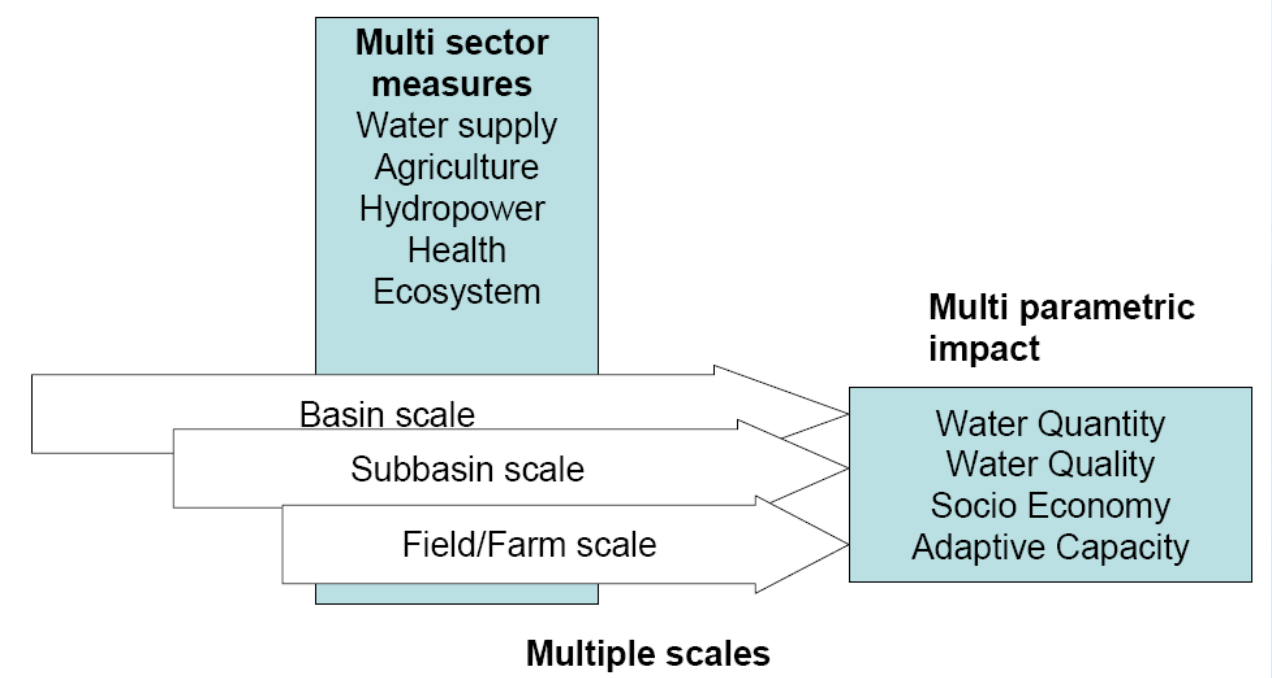
To achieve this we need to:

- Improve climate forecast skills at the regional scale by improving process knowledge and down-scaling techniques;

- Integrate socio-economic drivers in our studies to enable the assessment of other drivers than climate change and possible feedback mechanisms between them.

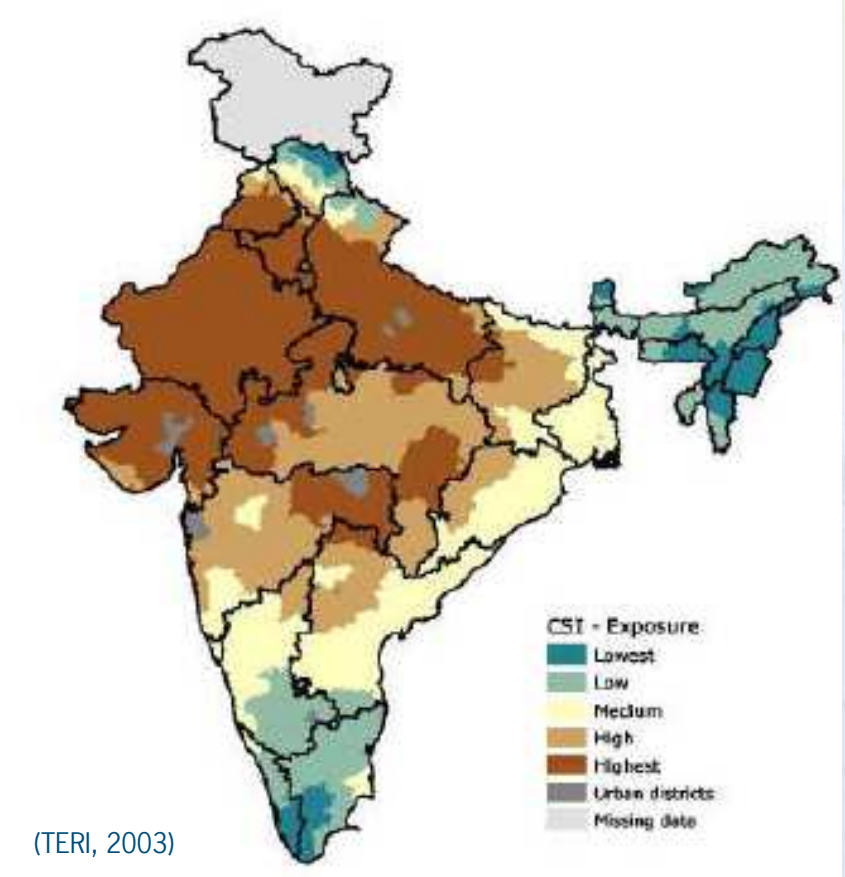
HighNoon approach: Adaptation strategy

- Improved boundary conditions (CC & socio-economic)
- Consideration and integration of relevant dimensions in the development of adaptation measures
- Transdisciplinary approach – combining tacit knowledge with scientific discovery



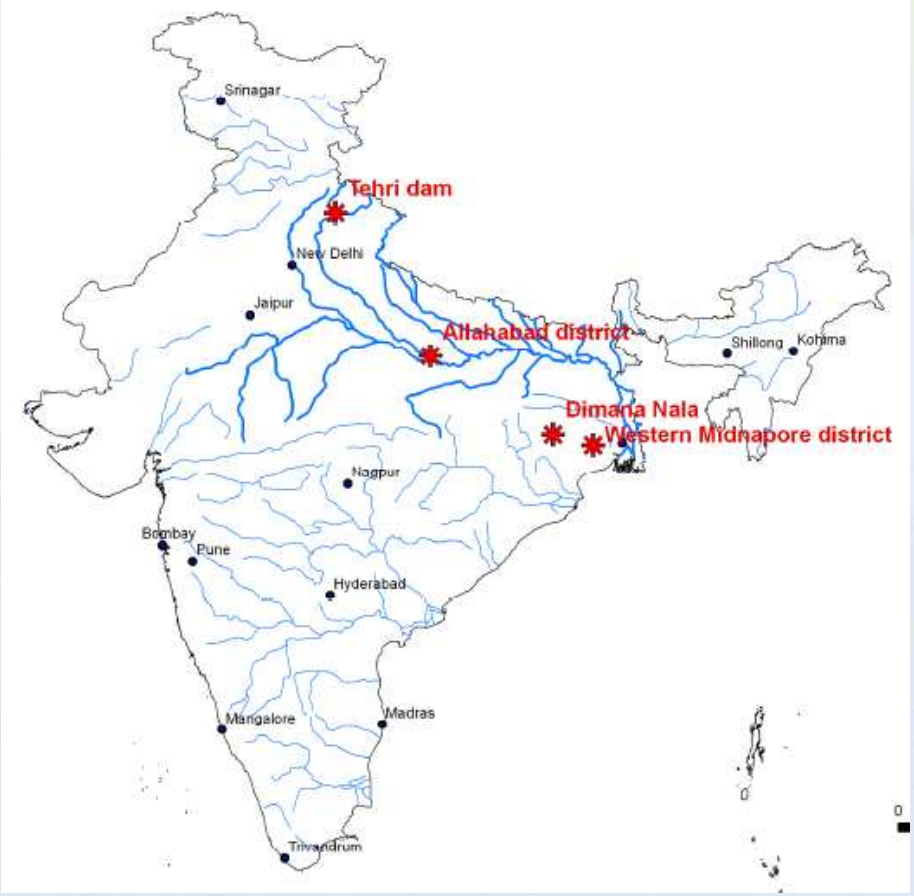
Different scales

Exposure to CC impact



(TERI, 2003)

Location of case study sites



Socio economic dynamics

- Make consistent scenarios for socio-economic changes in the region (large scale model)
  - Population and GDP
  - Food and water demand
  - Land use changes
- Explore physical boundary conditions for adaptation options in these scenarios.
- Refinement of geographical and management detail to local level scenarios
- Evaluate impacts of adaptation measures

Use of a nested approach to assure consistency amongst scales.

Spatial scale

Global

Scenario in global context
(Scenario model)

Simulation of impact of the selected adaptation measures at larger scale

Regional projections in global context, Potential boundaries for infrastructure measures tuned between spatial scales

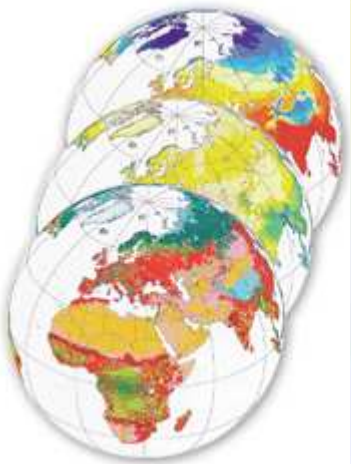
Scenario at district level
(Statistical method)

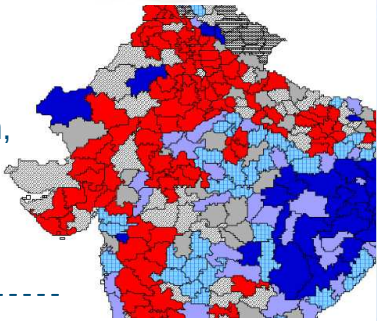
Set of selected adaptation measures

District scale projections on population, economy, water use;
Boundary conditions for adaptation

Local

Set of adaptation measures
(stakeholder process)





Expected outcomes:

Improved knowledge of:

- Glacier melt, lake formation and glacier lake outburst floods;
- CC affecting monsoon patterns
- Impacts on water resources

Products:

- Improved ice/snow feedbacks routine for RCM's (PRECIS & REMO)
- Consistent modeling results of ice/snow between RCM's and hydrological models
- Assessment of water resources for consistent scenario's at different scales
- Set of tools to facilitate prioritization of adaptation measures
- Extension of indicator framework to assess impact of adaptation measures
- Adaptation strategies over multiple scales and sectors