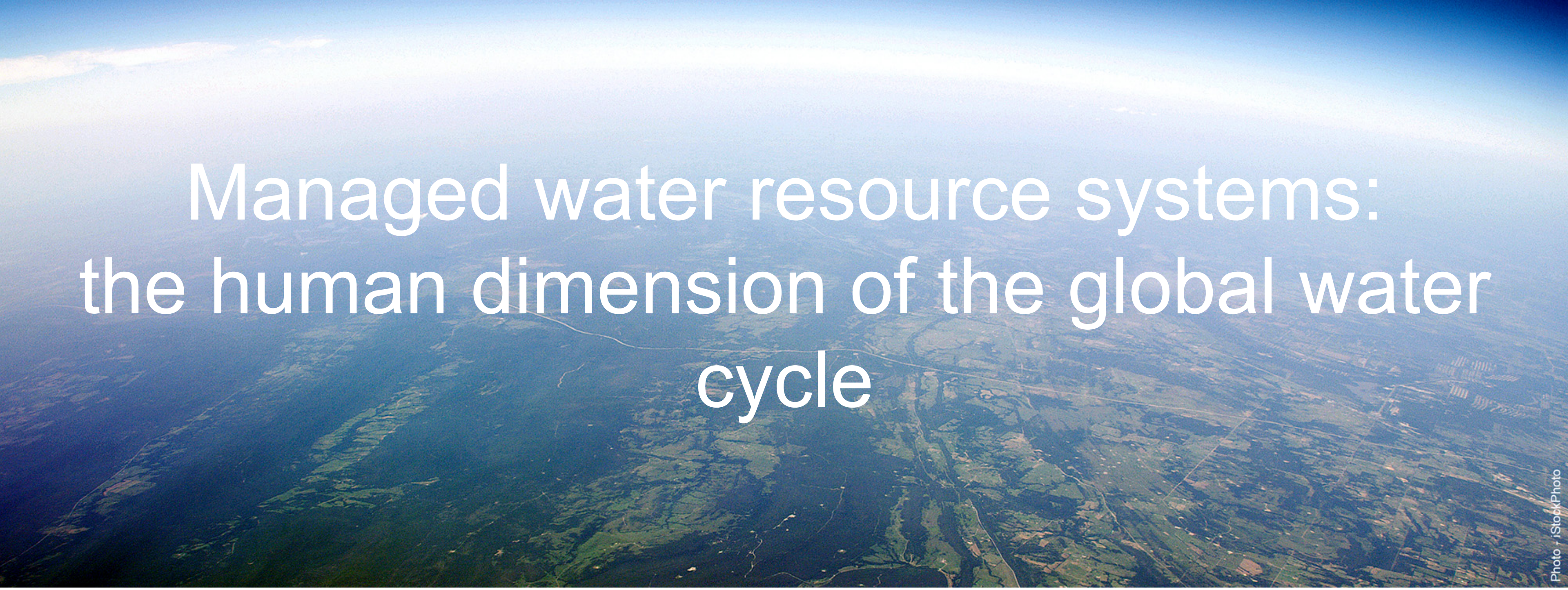
Managed water resource systems: the human dimension of the global water cycle



Richard Harding

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GEWEX

GEWEX is a core project of WCRP on Global Energy and Water Exchanges

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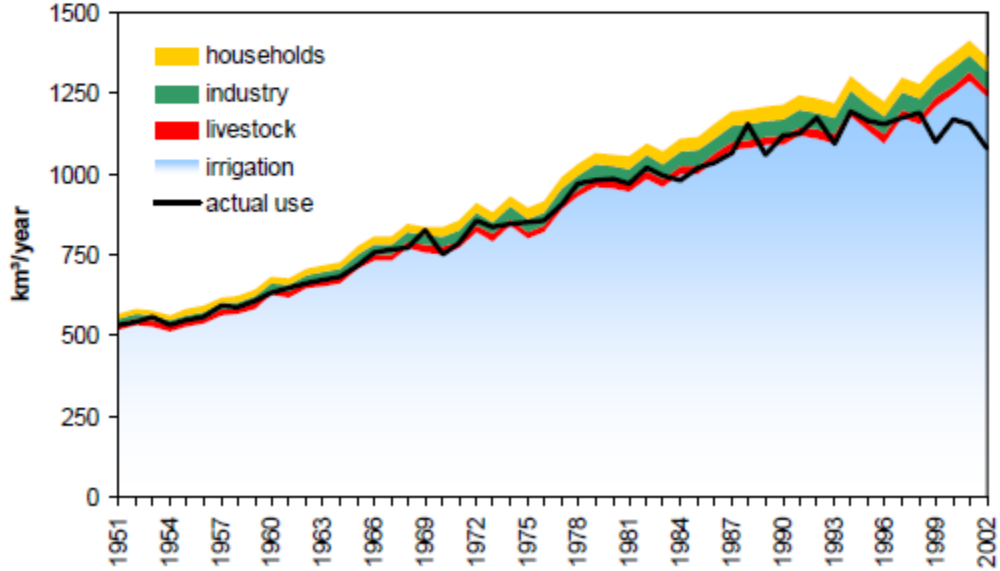
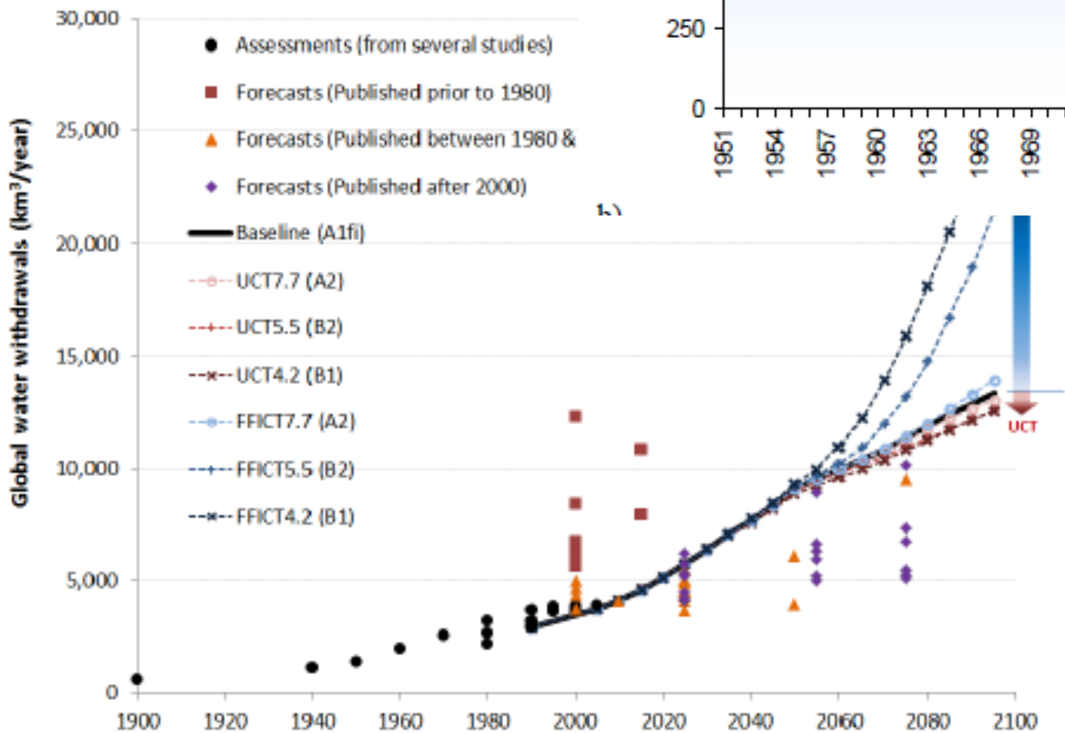
Global Water Use



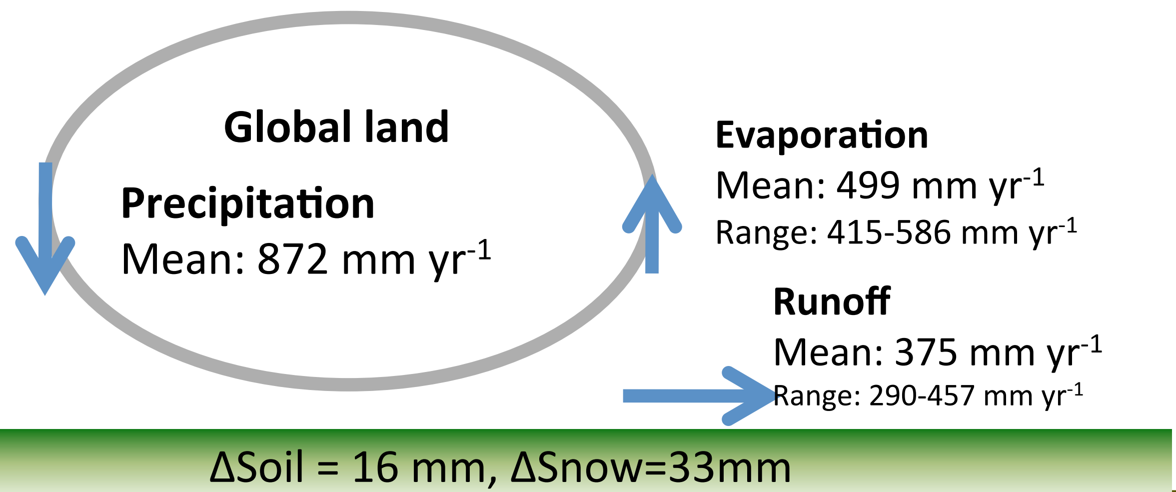


Hejazi et al 2013

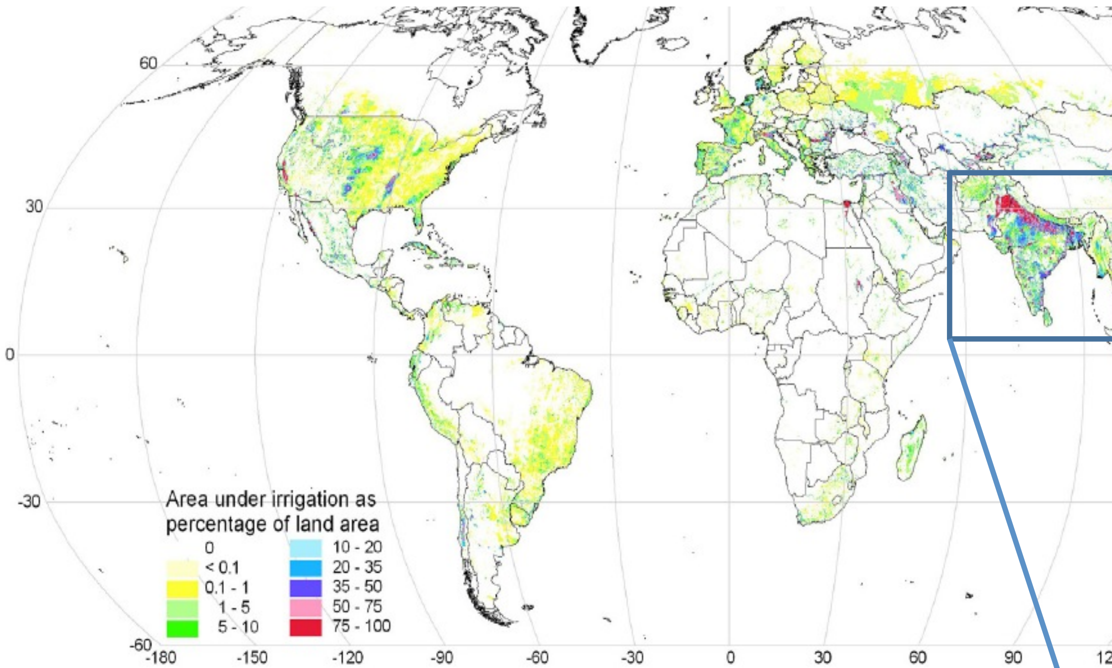
Global Water Resources

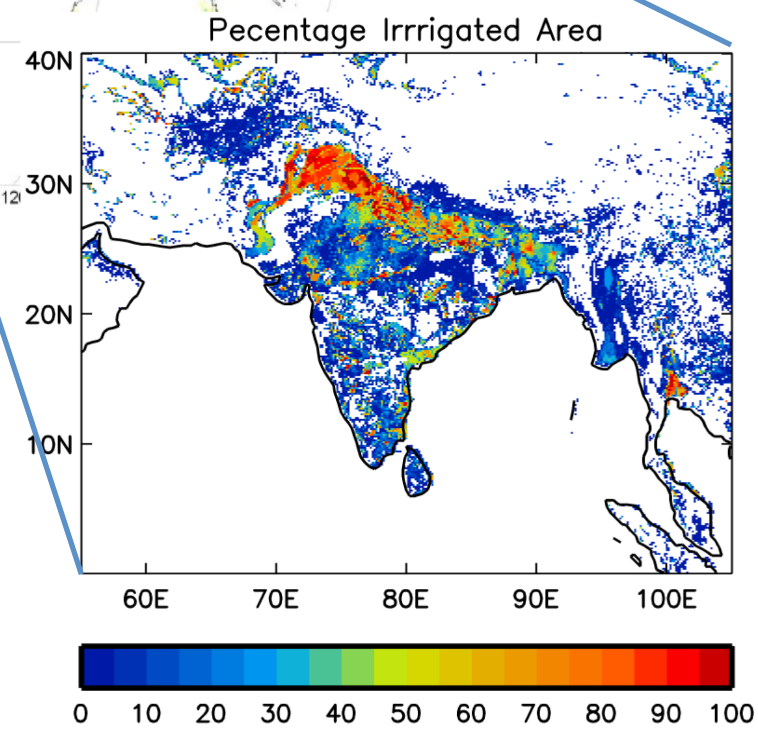
TOTAL ANNUAL LAND PRECIPITATION = 115×10^3 KM^3
TOTAL ANNUAL RUNOFF = 49×10^3 KM^3
TOTAL CAPACITY OF RESERVOIRS = 7.4×10^3 KM^3
ANNUAL WATER USE FOR IRRIGATION = $\sim 1.5 \times 10^3$ KM^3
UNSUSTAINABLE GROUNDWATER EXTRACTION = 0.23×10^3 KM^3 Y^{-1}

TOTAL GLOBAL LAND AREA = 149×10^3 KM^2
TOTAL IRRIGATED AREA (YEAR 2000) = 2.6×10^3 KM^2



Percentage Irrigated area





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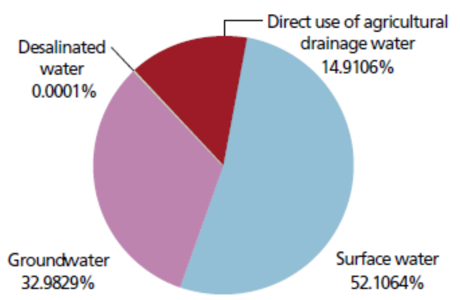
India: Water: sources and use

Renewable freshwater resources	
Precipitation (long-term average 1 170 mm/yr)	3.8×10^3 km^3 yr^{-1}
Internal renewable water resources (long-term average)	1.4×10^3 km^3 yr^{-1}
Total actual renewable water resources	1.9×10^3 km^3 yr^{-1}
Total dam capacity 2005	224 km^3
Water withdrawal	
Total water withdrawal 2010	761 km^3 yr^{-1}
- irrigation + livestock 2010	688 km^3 yr^{-1}
- municipalities 2010	56 km^3 yr^{-1}
-industry 2010	17 km^3 yr^{-1}
per inhabitant 2010	630 m3/yr
Surface water and groundwater withdraw as % of total actual renewable water resources 2010	40 %
Non-renewable extraction (Wada et al 2011)	68 km^3 yr^{-1}

FIGURE 2
Water withdrawal by source
Total 761 km^3 in 2010



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Water Scarcity 20th and 21st C

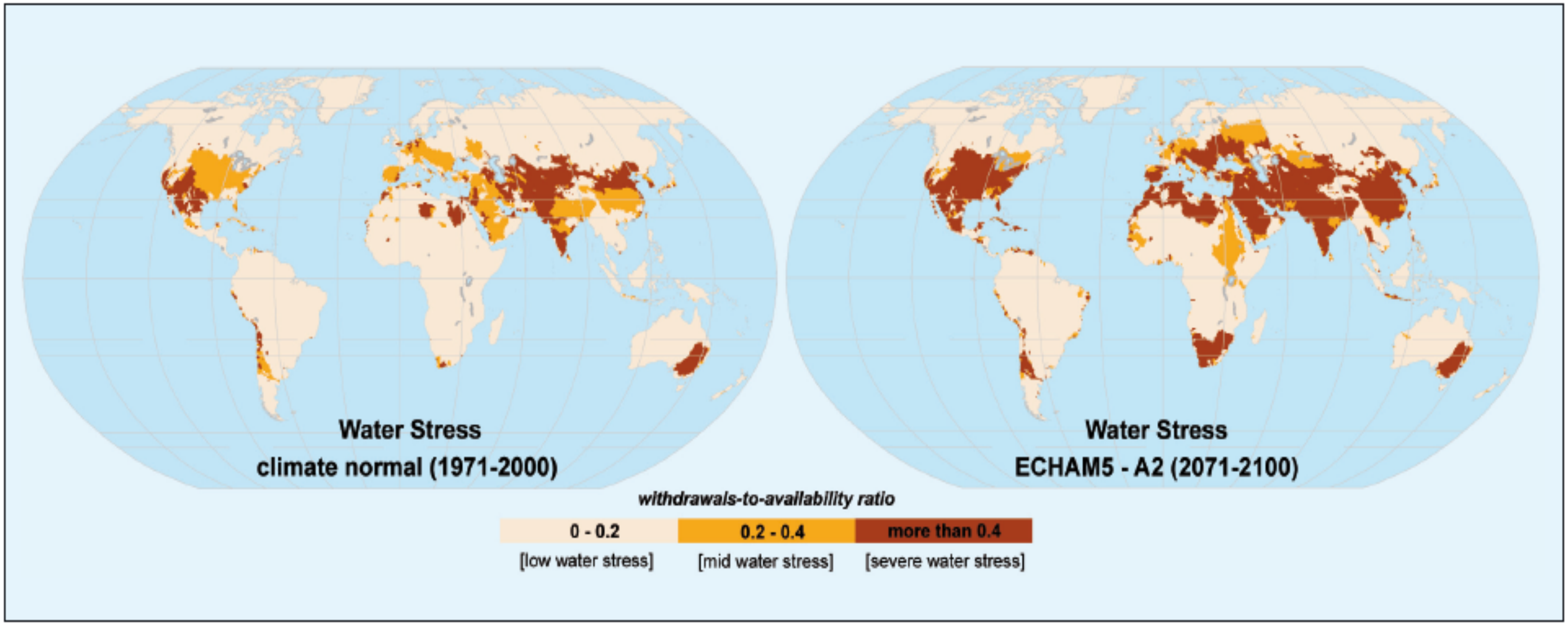
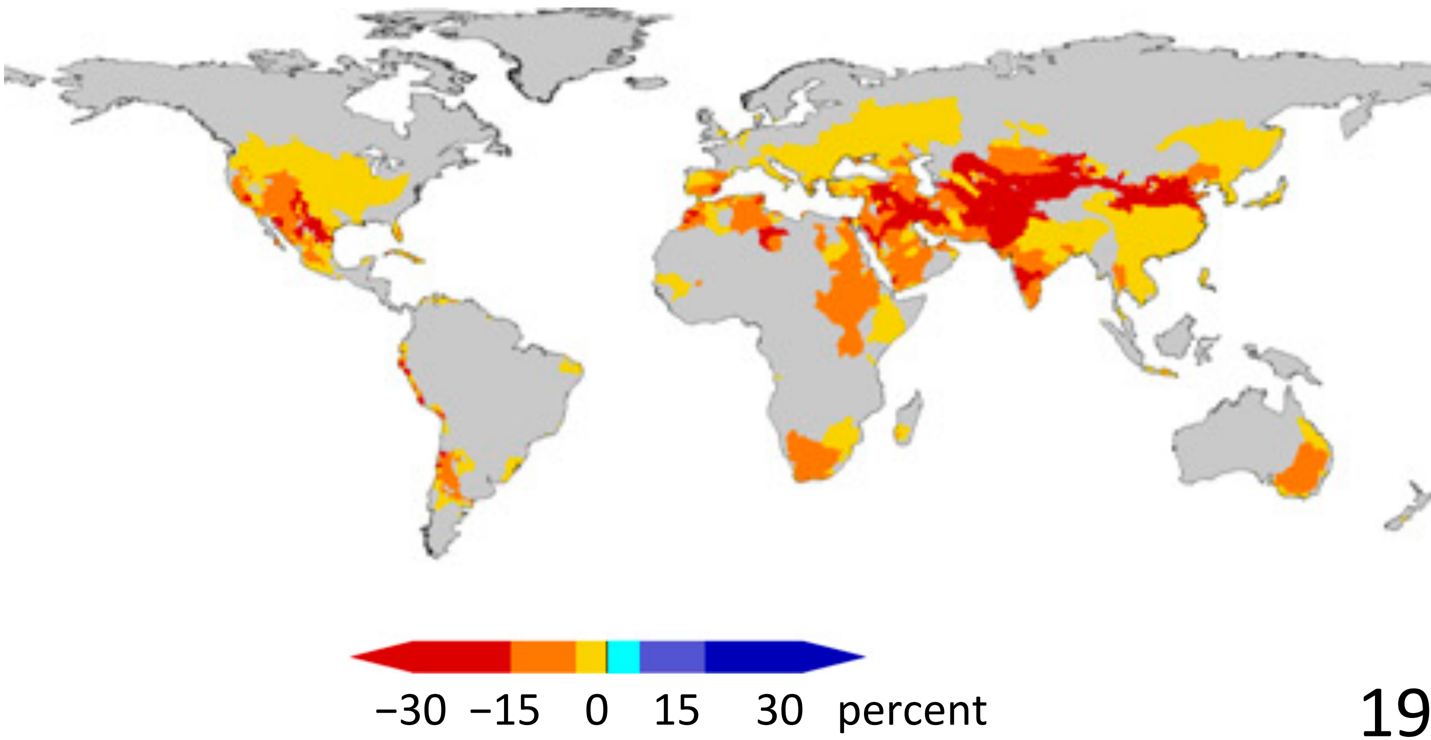


Figure 1: Water stress, calculated as the ratio between water withdrawals and availability, for the late 20th and 21st centuries (see Flörke and Eisner 2011).

Human Impact on river discharge



H08
LPJml
MPI-HM
PCR-GLOBWB
VIC
WaterGap
WBMplus

1971–2000

Haddeland et al. 2014

ISI-MIP

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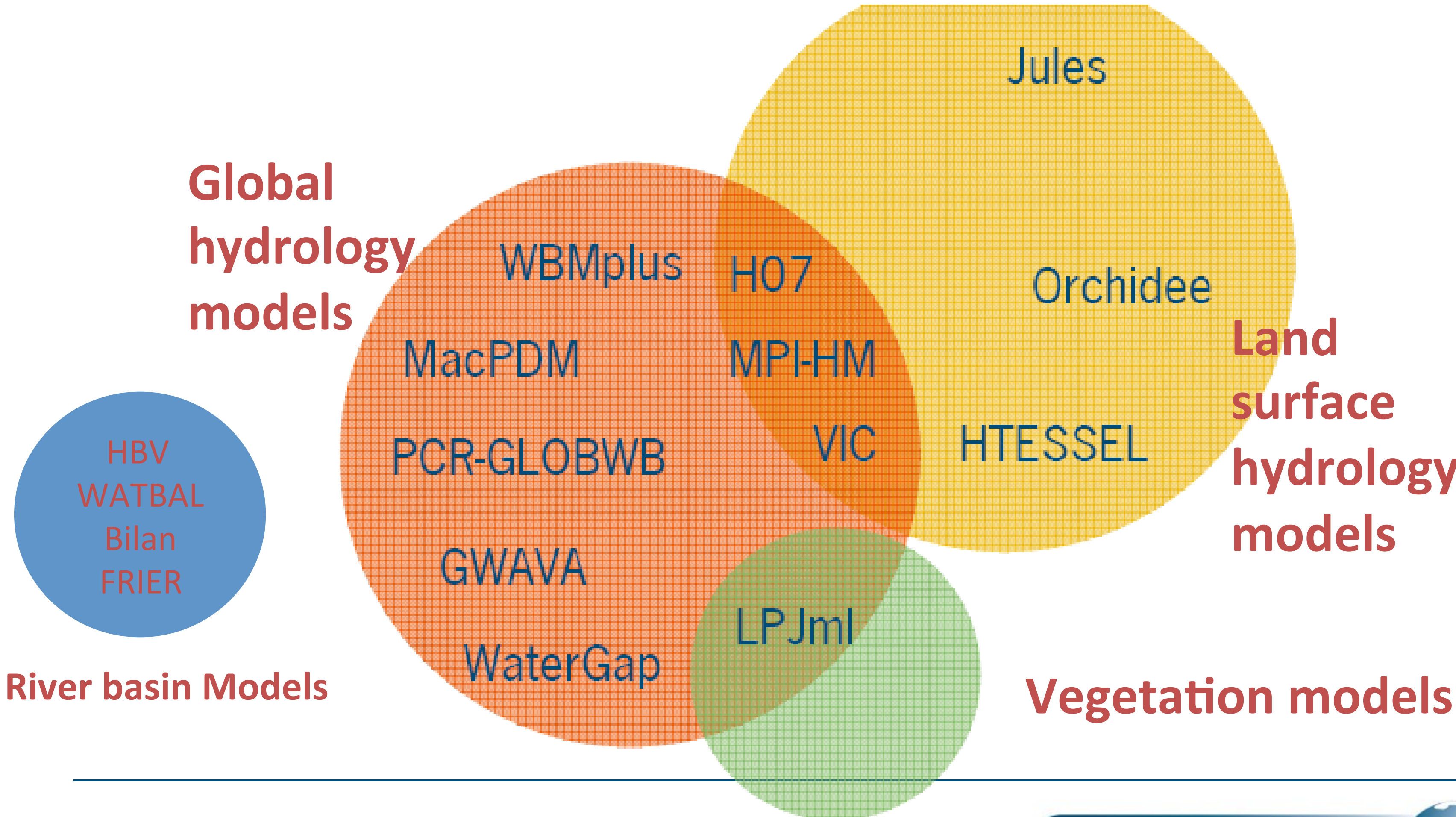
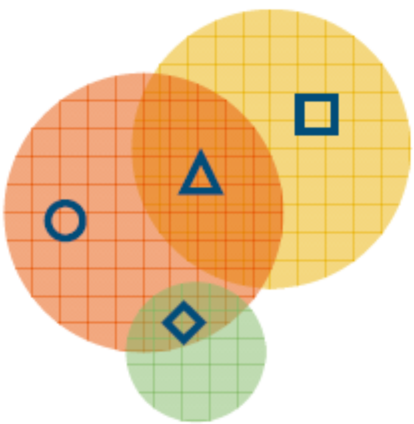
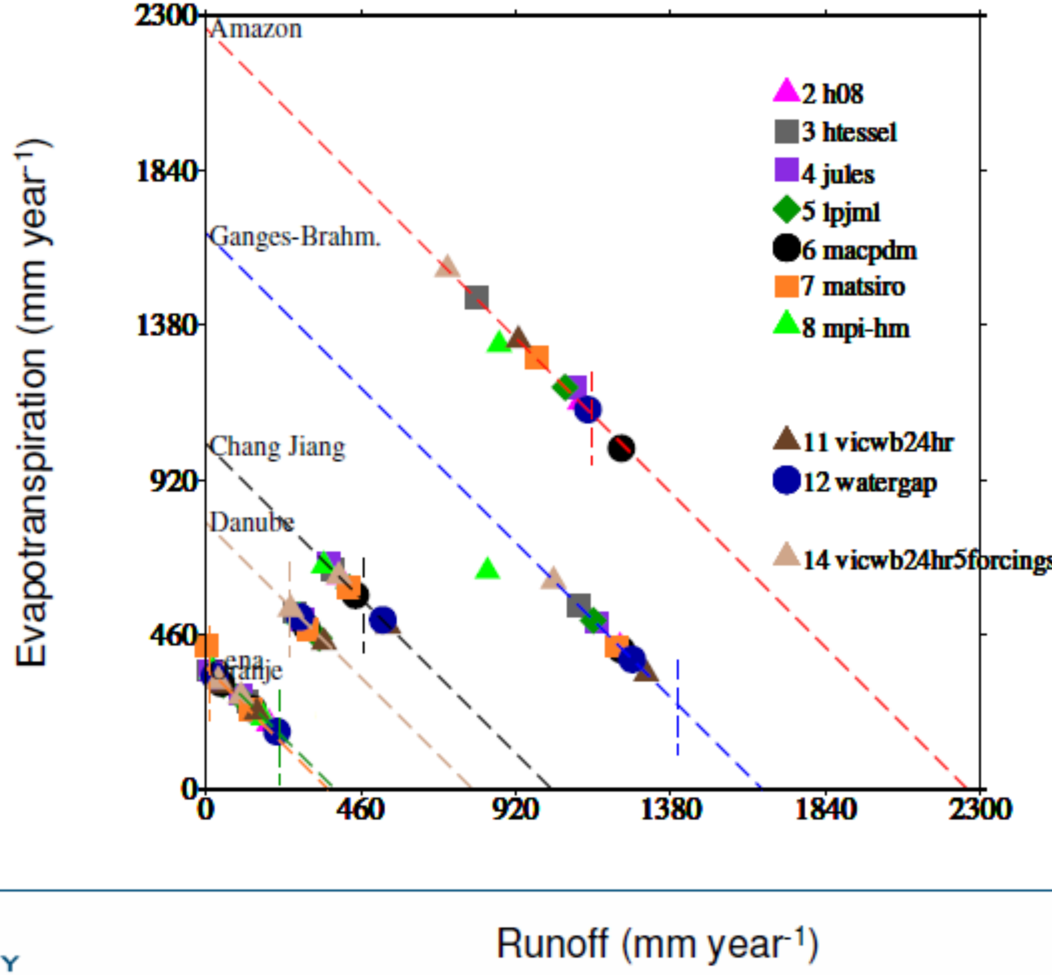
WaterMIP: Land Surface Hydrology Model/ Global Hydrology Model Intercomparison



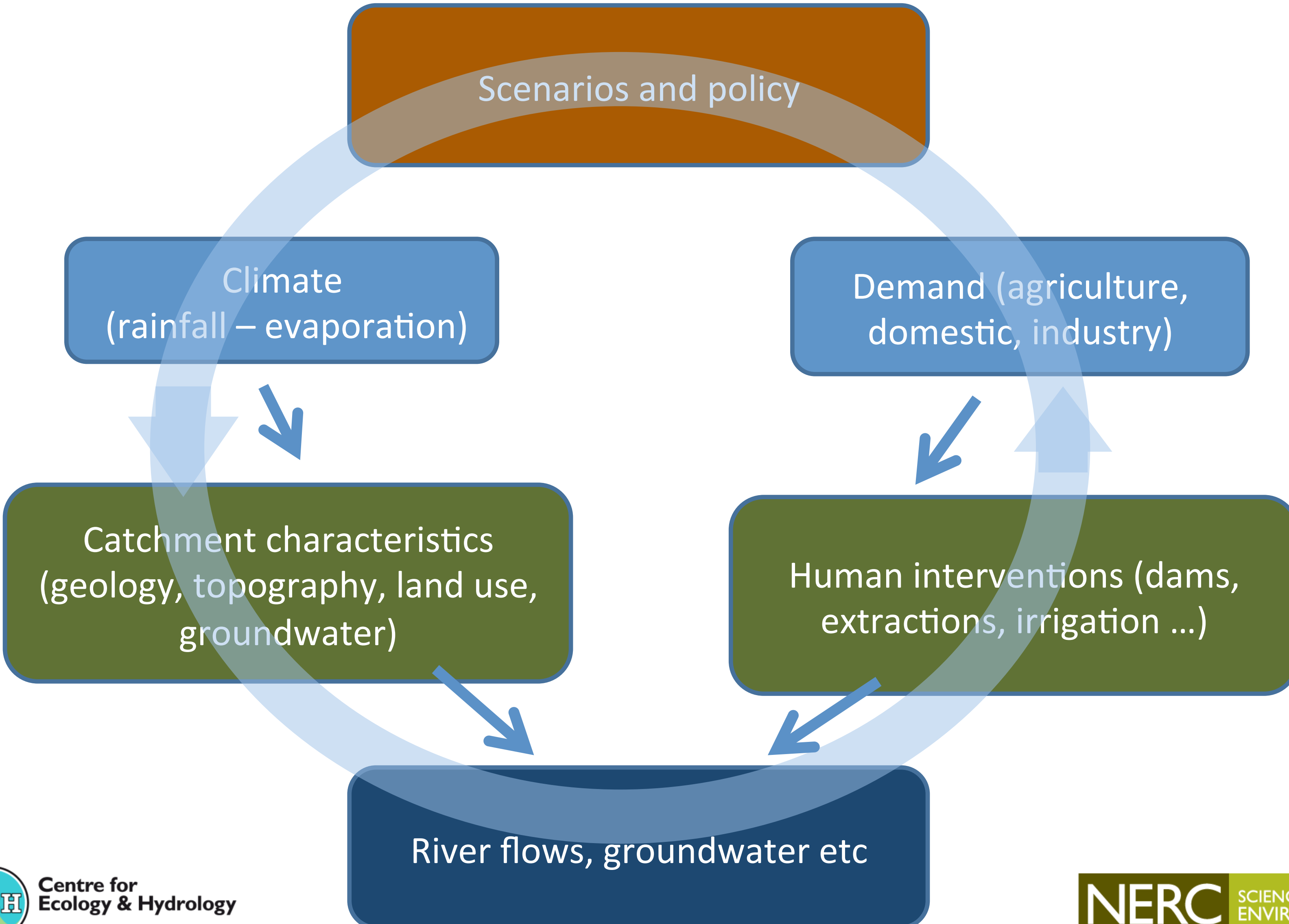
Water and Global Change

Mean annual water fluxes (mm year^{-1})





Estimating water resources



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Demand and allocation into Climate models?

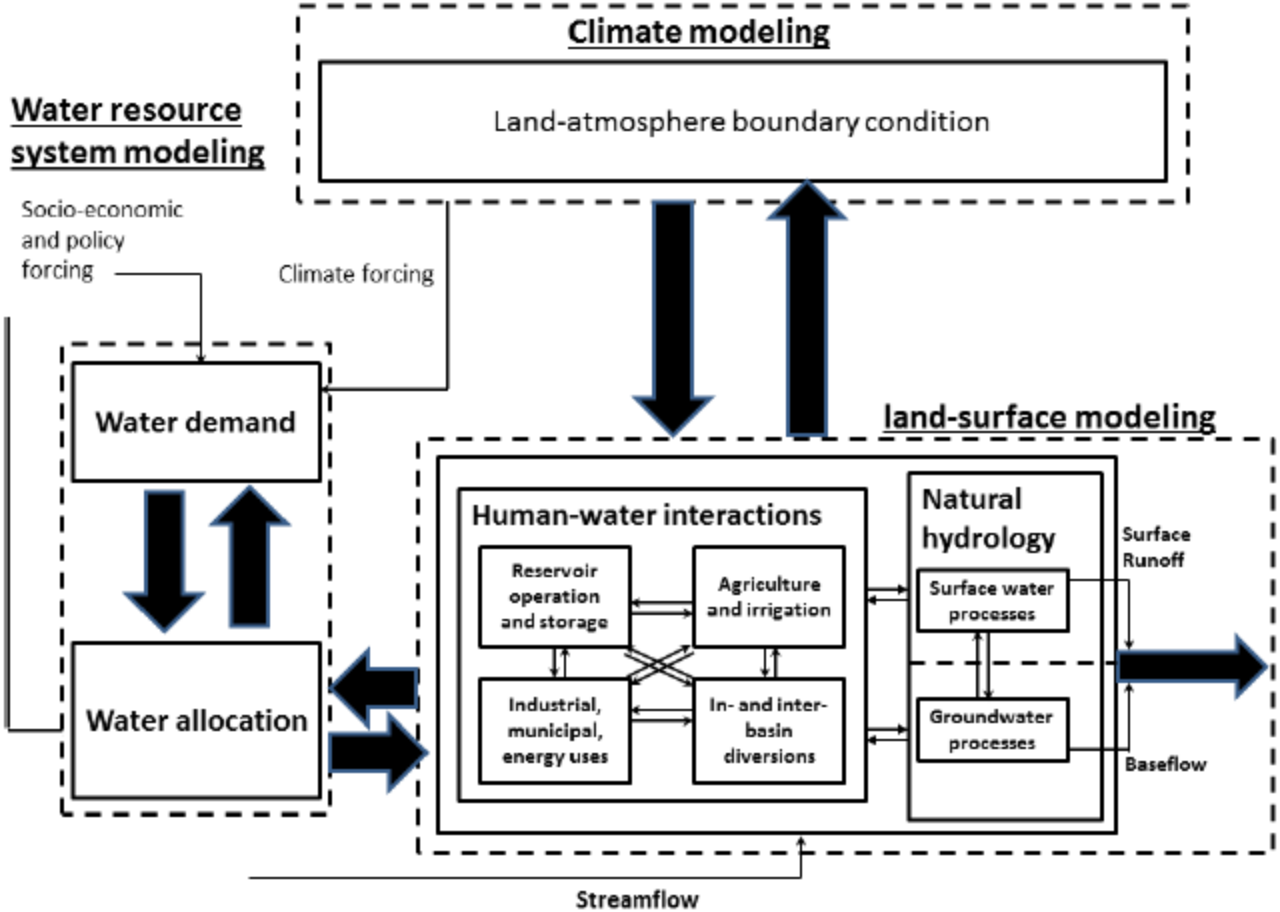

Figure 1. A fully coupled framework for inclusion of water resources management in a typical LSS grid.

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Nazami and Wheater 2014

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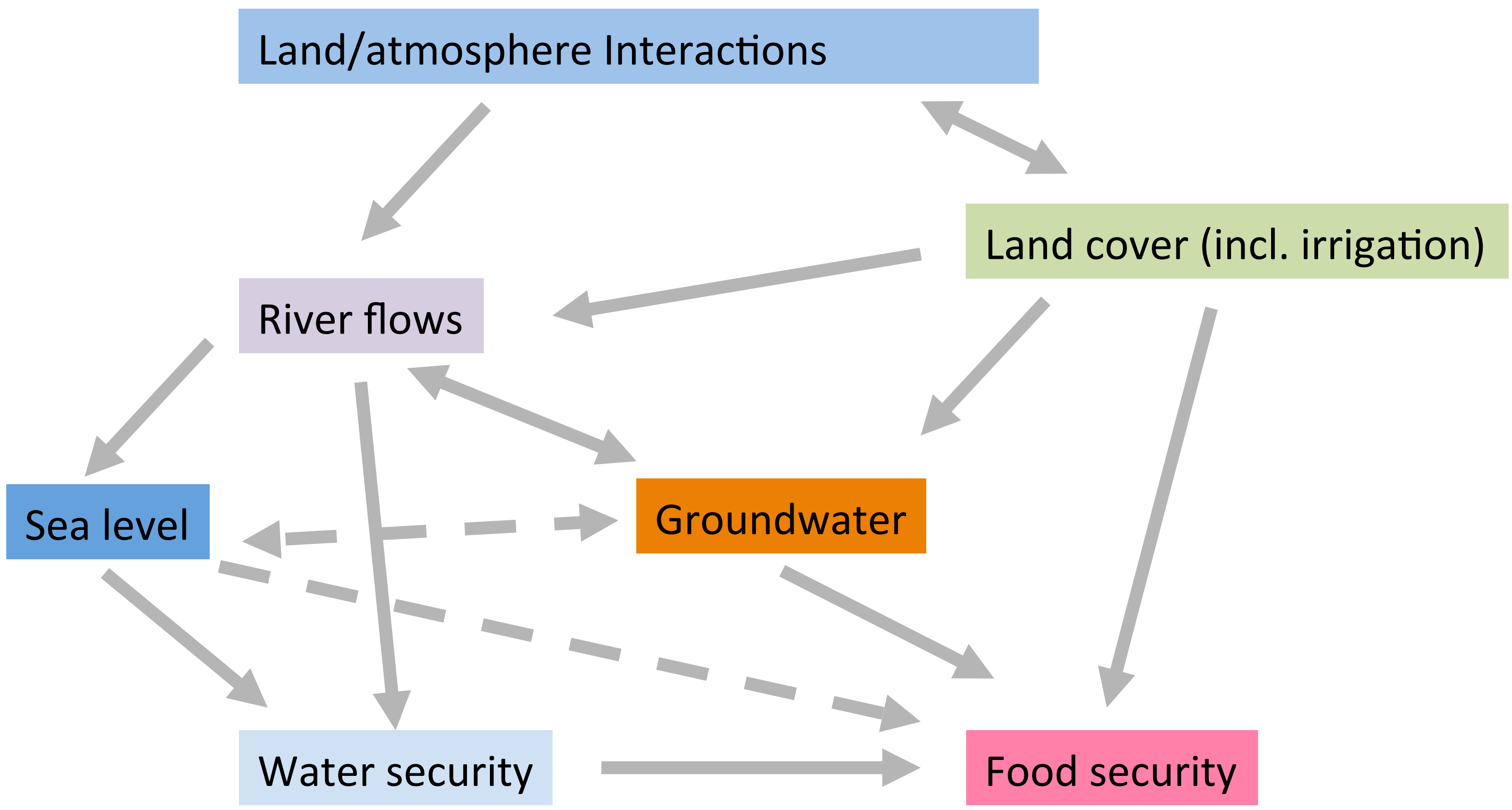
Human impacts - interactions



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Crosscut: Modelling Human Impacts on freshwater 1: topics

Quantifying the Human Impact on the World's freshwater

- Water supply – *uncertainties in P-E*
- Demand – *linked to supply*
- Management – *seasonality and extremes, ground water extraction, basin transfers*
- Land cover? – *irrigation, rainfed agriculture and deforestation etc*

- Coupled models?
- Scale – regional vs global?
- Data issues
- Complexity
- Role of calibration
- Scenarios

Crosscut: Modelling Human Impacts on freshwater 2: activities

Progress so far:

Hague July 2014 – proposed

Informal committee: Richard Harding, Howard Wheater, Taikan Oki, Ruby Leung, Jan Polcher, Eric Wood, Ali Nazemi ….

Pasadena Dec 2014 – draft plan

- Ongoing review (web based? – what are we doing?
  - where are the global data gaps?
- Modelling Workshops
  – with GLASS
  - RHPs
  - link to local operational models
- Inter-comparison?
  - land MiP
- Sessions at International meeting

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