Surface Water Availability in Morocco

Balancing Uncertainty in Biophysical Modeling of Climate Change Impacts

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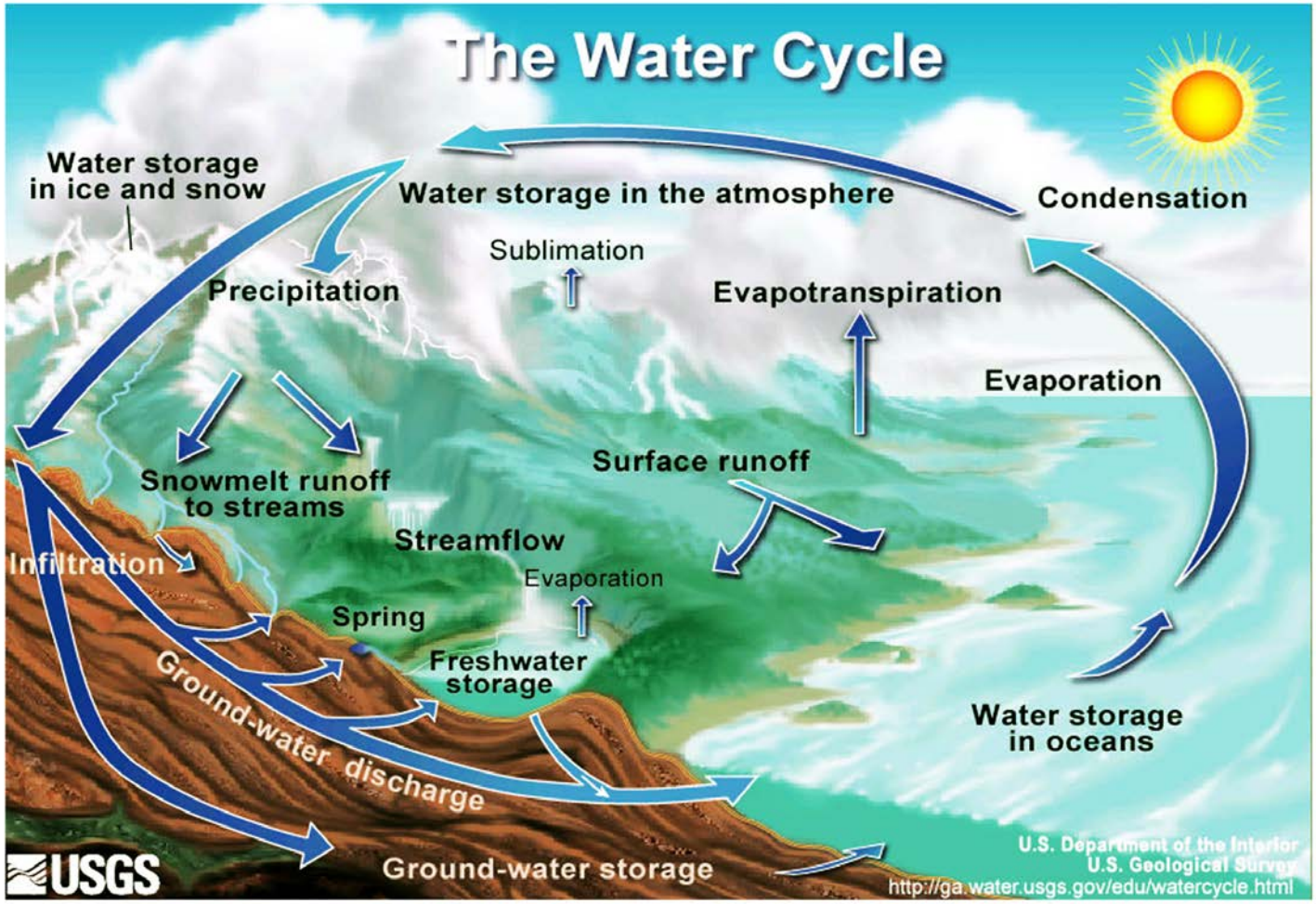
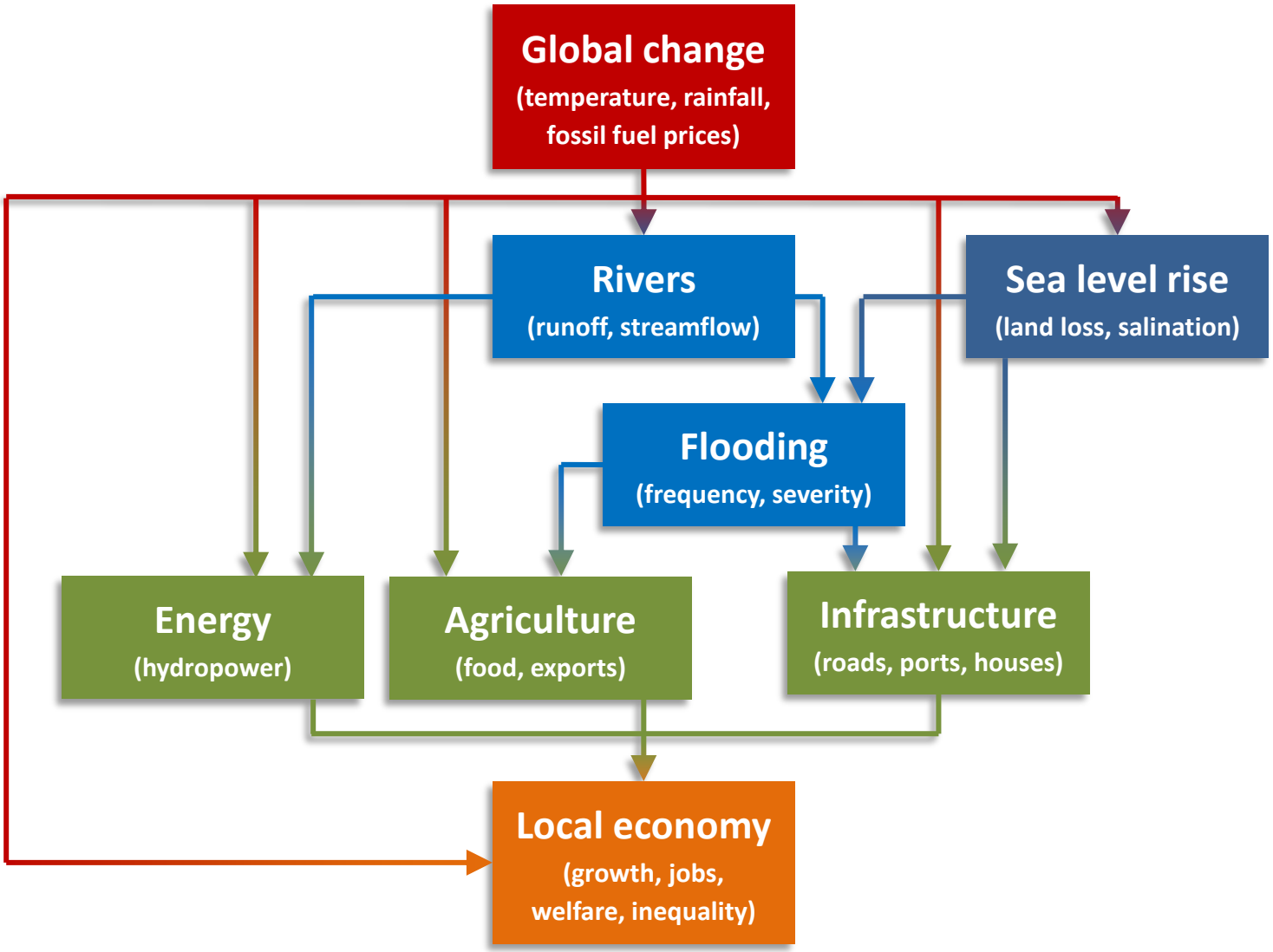

The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Surface runoff
Snowmelt runoff to streams
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS
U.S. Department of the Interior
U.S. Geological Survey
http://ga.water.usgs.gov/edu/watercycle.html

Integrated Framework



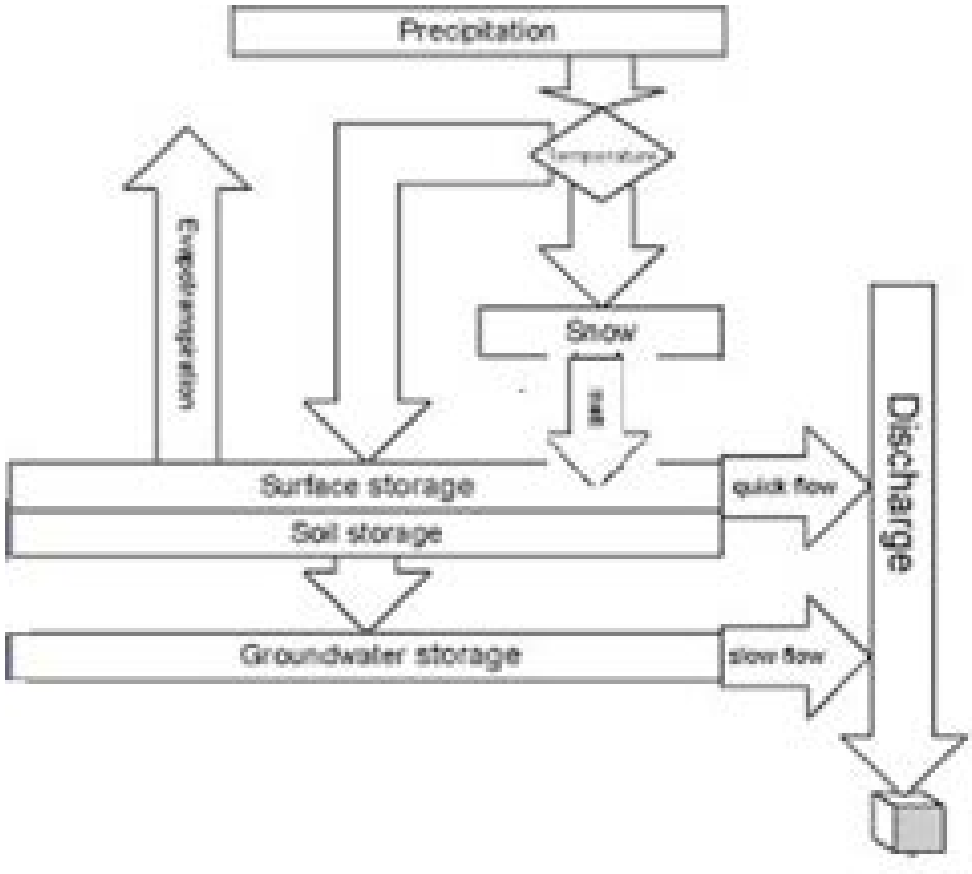
Overview of CLIRUN-II

- Rainfall-runoff model
- Focus on the impacts of changes in climate
- Calibration / validation procedure to build base model
- For the future, climate is adjusted

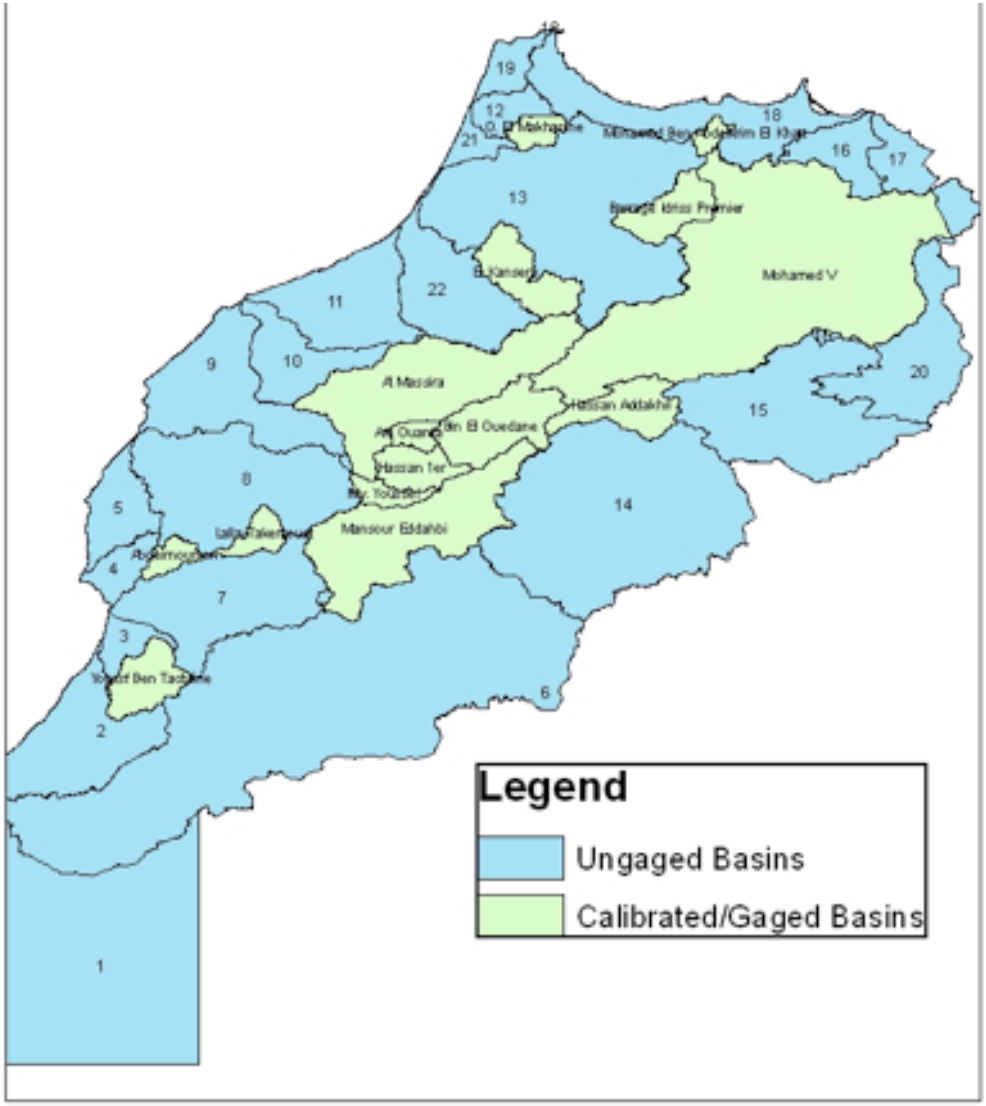
Overview of CLIRUN-II

Model Structure

- Input:
  - Temperature
  - Precipitation
  - PET
- Output
  - Total runoff
- Structure
  - Water enters system by rain and snowmelt
  - Two soil layers
  - Water exits the system by evaporation, quick runoff and slow runoff



Basin delineation

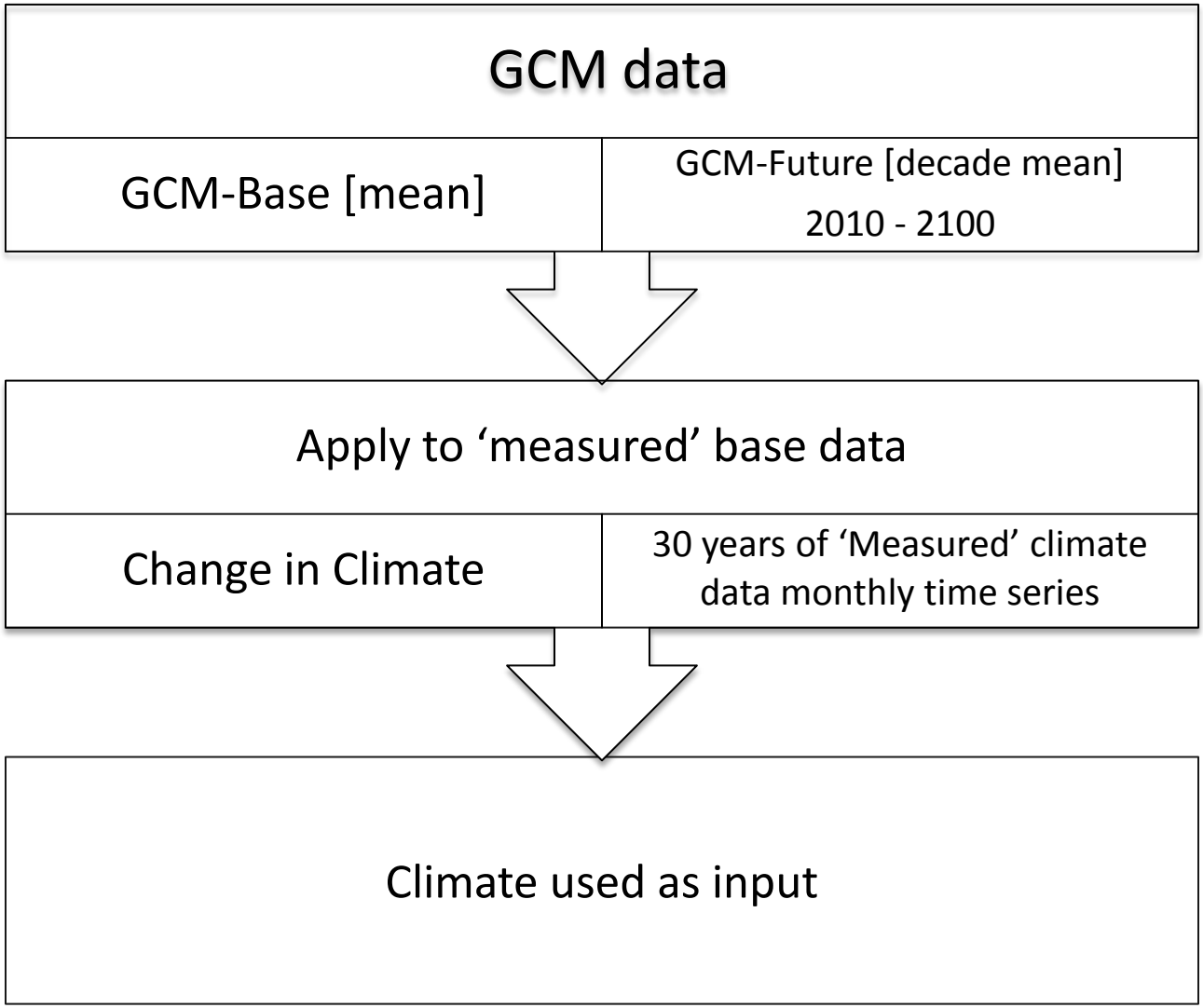


- 16 basins with “measured” stream flow
- 21 basins without measured stream flow
- Natural vs. actual stream flow

Climate Change Data

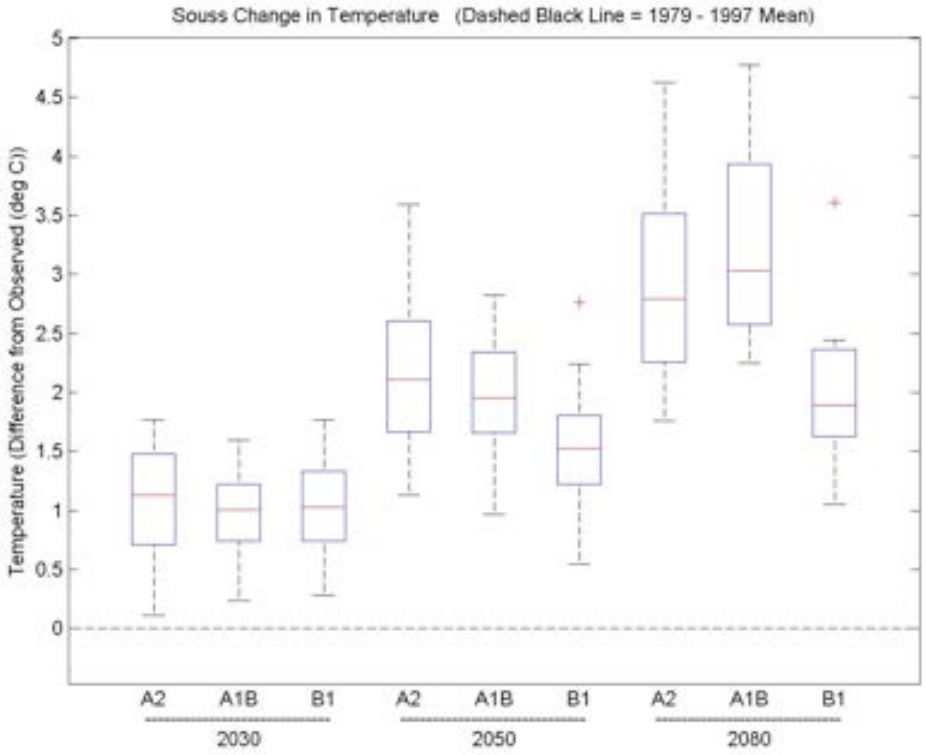
- Hadley Centre model
  - Downscaled to 0.1 degree from 2.75 X 3.75 deg grids
  - 2 scenarios: A2 and B2
- A suite of 56 GCM-SRES pairs
  - 22 GCMs
  - 3 SRES scenarios: A2, A1b, and B1
- GCM uncertainty
  - Best at predicting long-term global mean changes

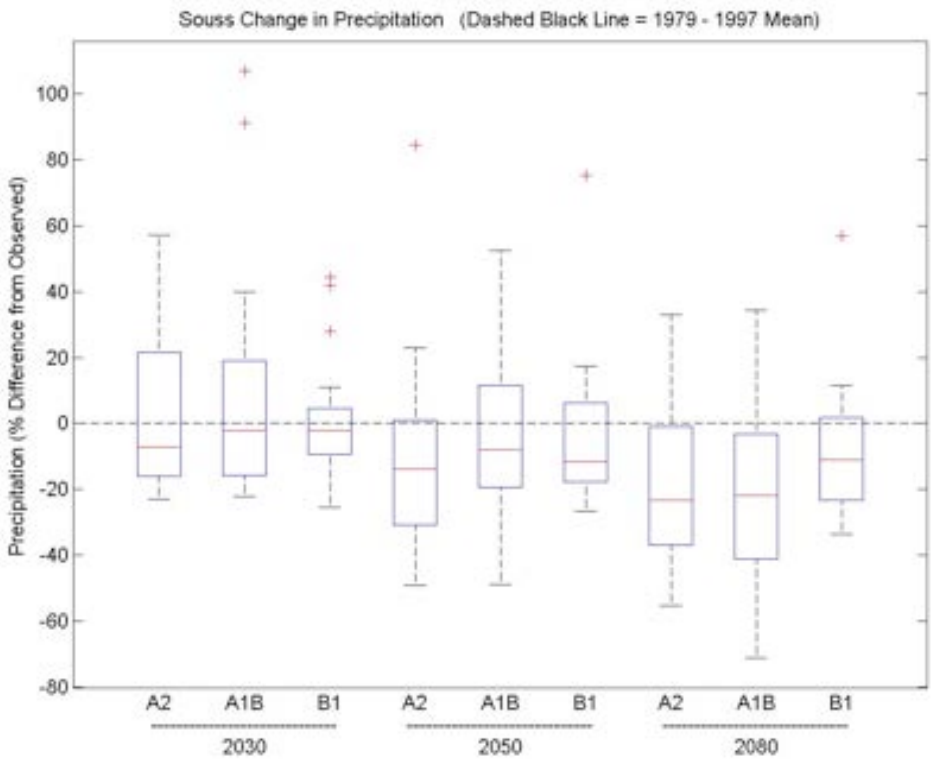
Climate Change Data



Results

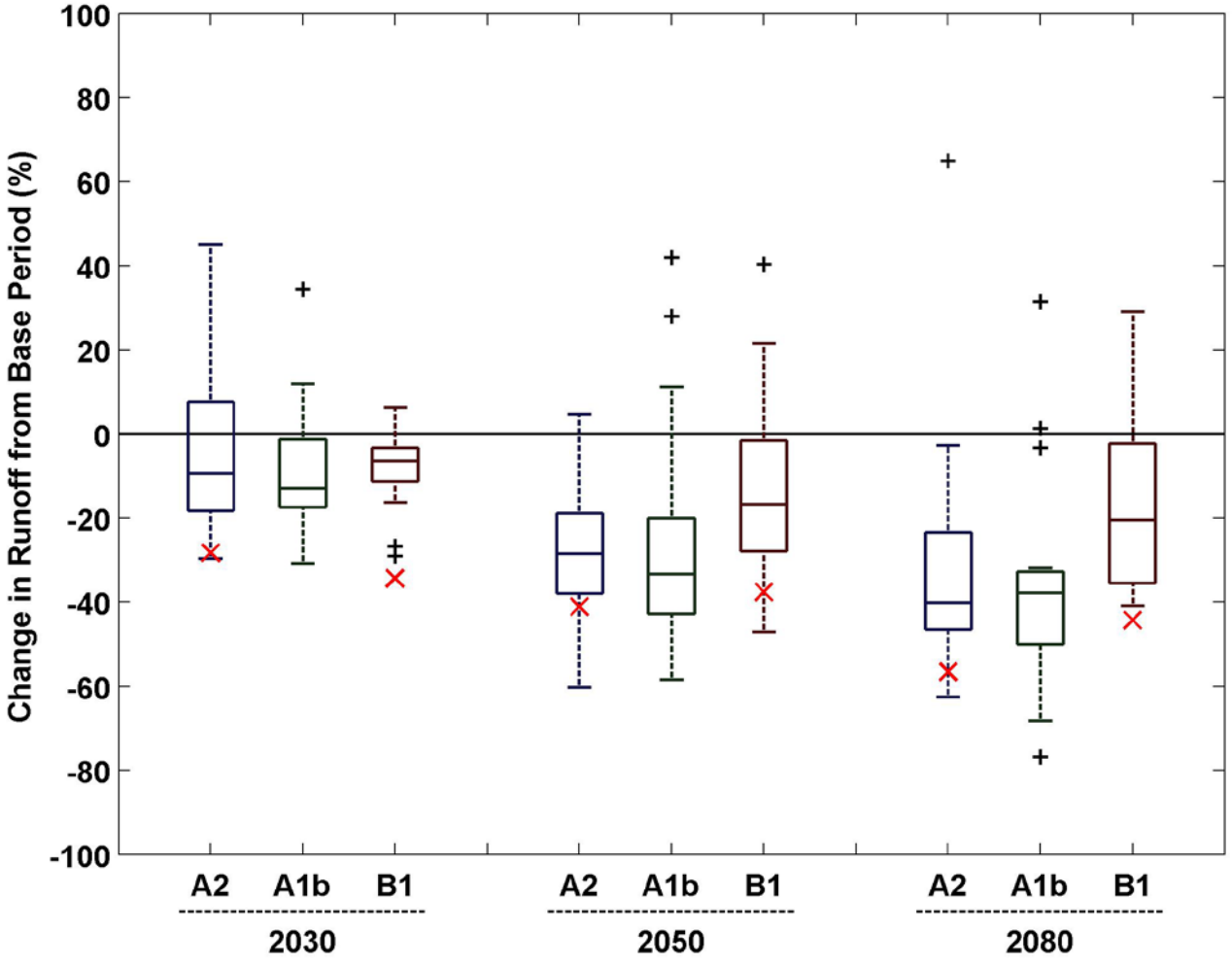
Change in climate for a basin





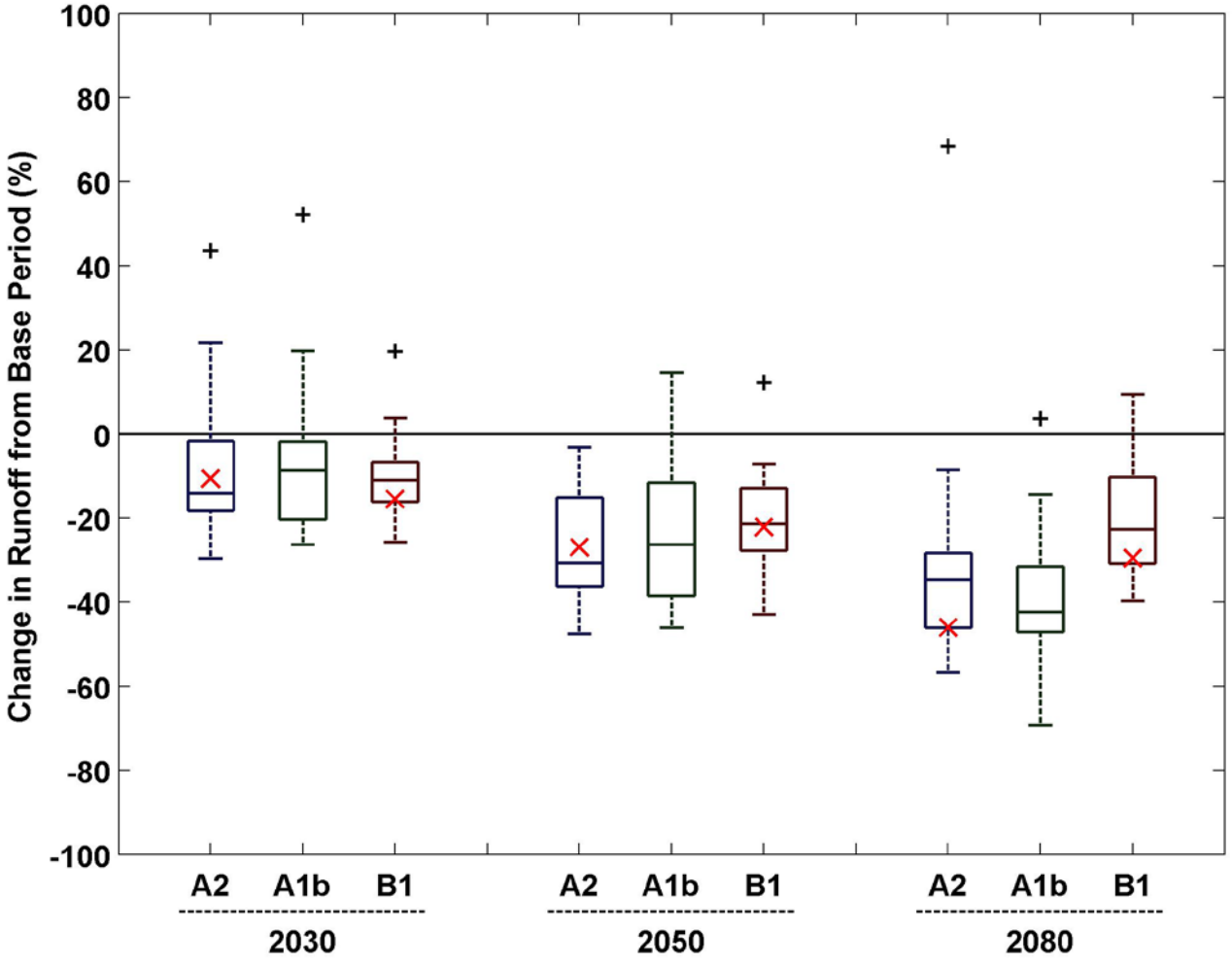
Results

Change in runoff for the Souss Basin



Results

Change in runoff overview for Morocco



Conclusions

- The future is uncertain
- GCMs are the most advanced tools currently available for estimating the long-term effects of climate change
- Impact studies are more valuable if we understand the impacts in terms of a range of possible outcomes