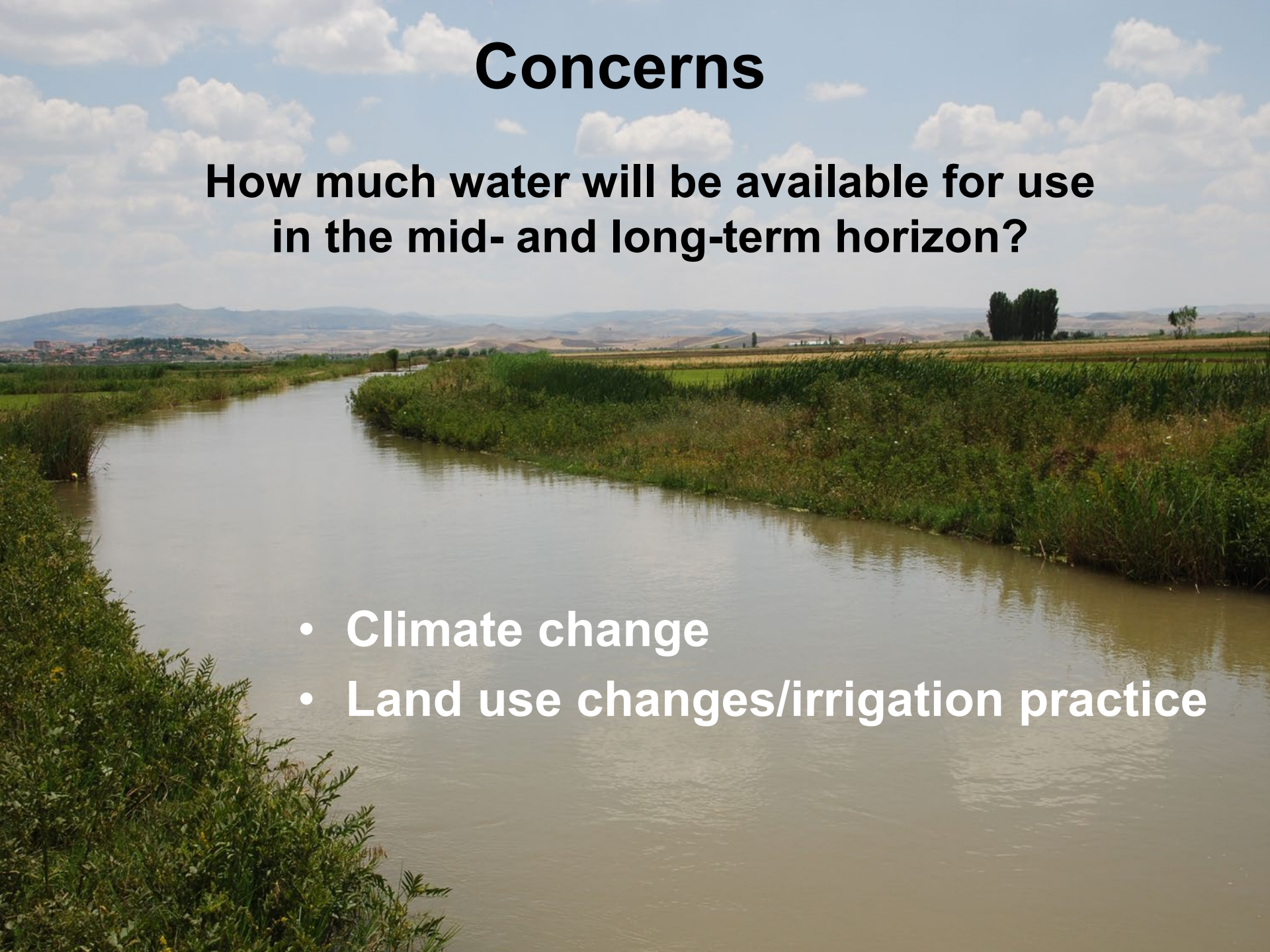
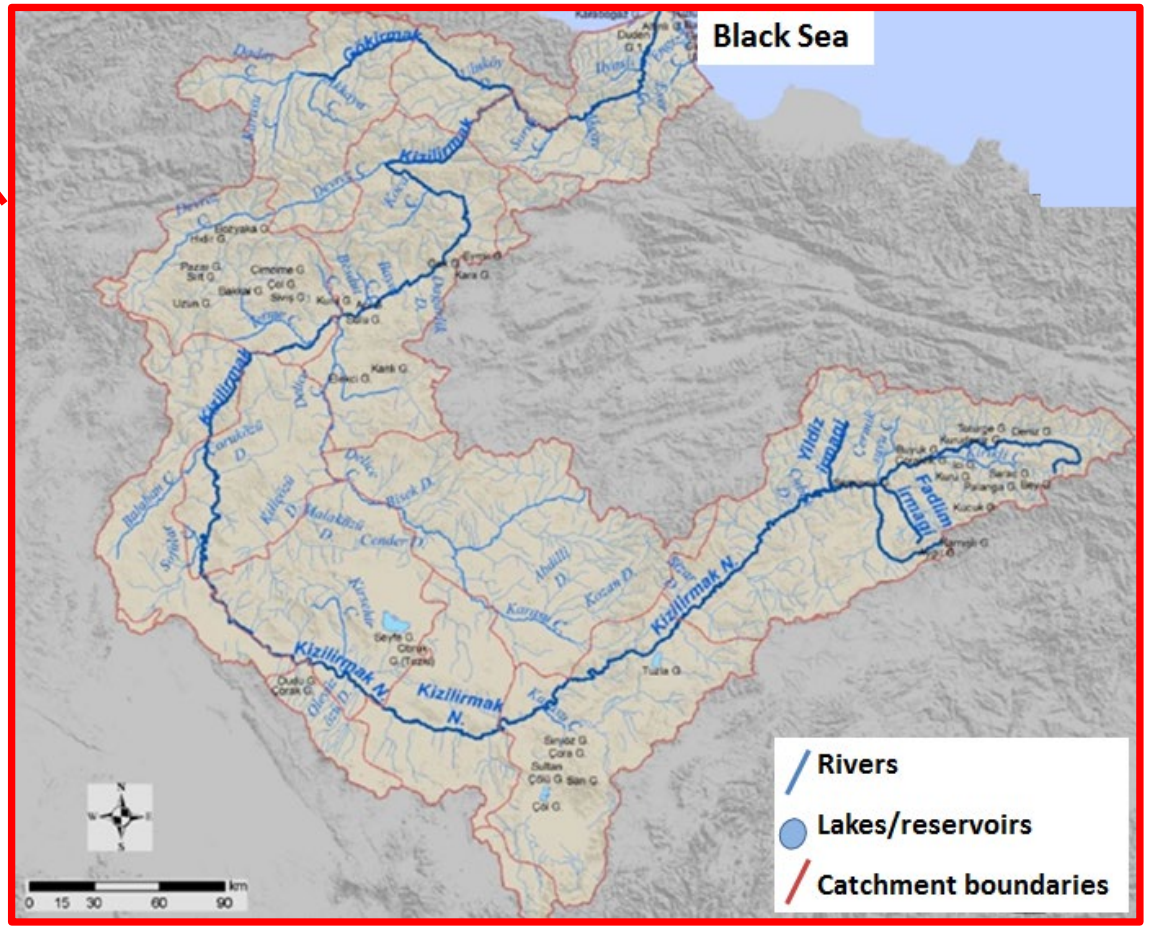
Concerns

How much water will be available for use in the mid- and long-term horizon?



- **Climate change**
- **Land use changes/irrigation practice**

Case study: Kizilirmak River Basin, Turkey

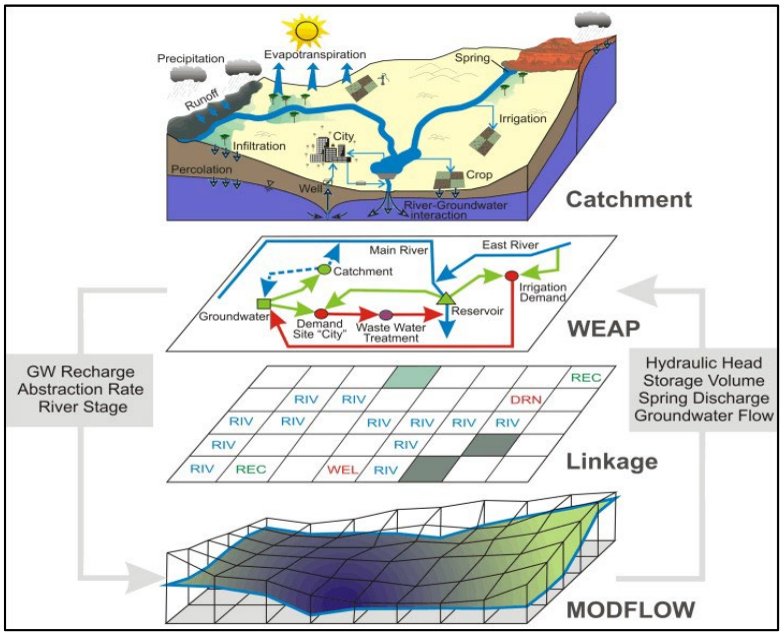


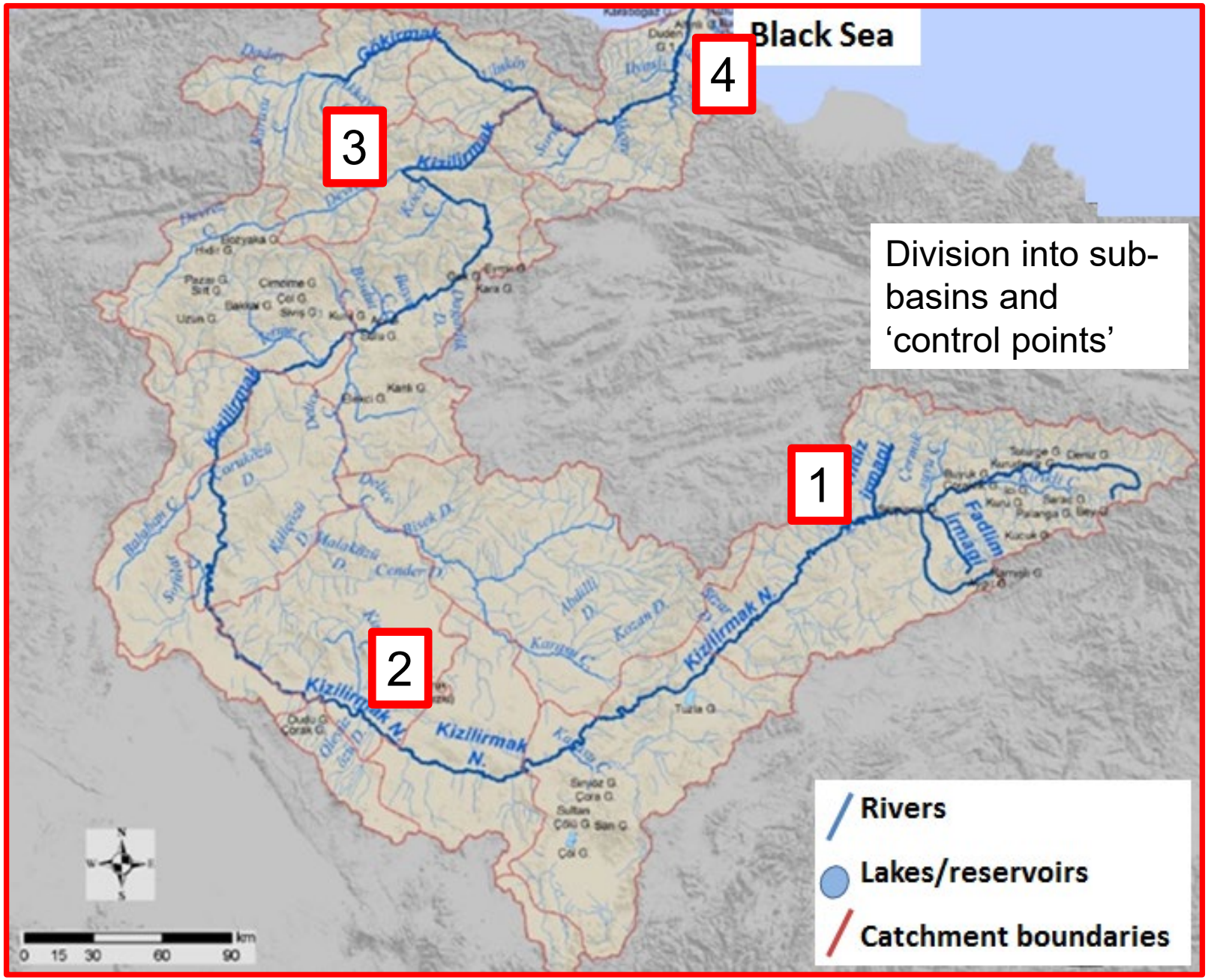
- Several hydropower projects
- Intense agricultural production (to be extended)
- Source of drinking water


Irrigation dams are
huge infrastructure

WEAP as a modelling tool

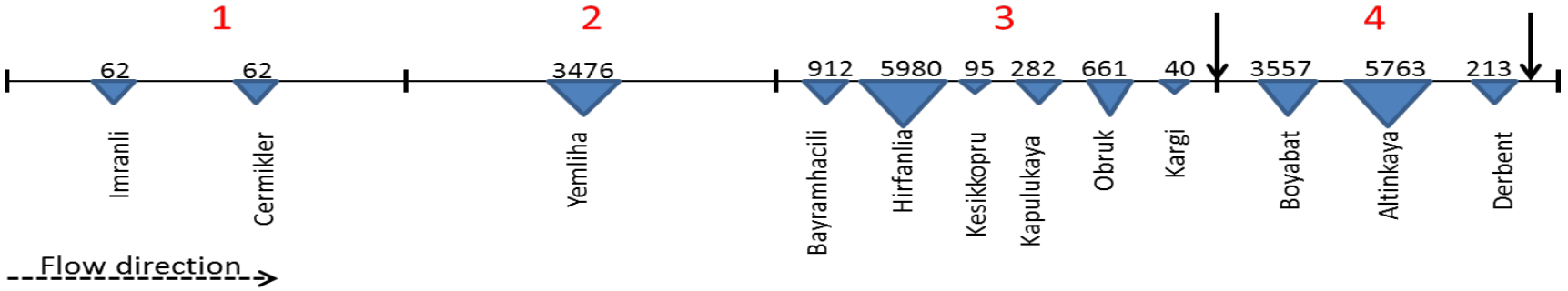
- Hydrological module as the basis for supply calculations
- Incorporates human consumption and use of water, and the effect of water infrastructure
- Supports analysis of the effects of policy scenarios on the water resources (e.g. changes in priorities of water use, land management practice, etc.)
- Supports long-term analysis of available water resources (e.g. climate change)
- Supports dynamic linking to other tools, scripting




Black Sea
4
3
2
1
Division into sub-basins and 'control points'
Kizilirmak
Kizilirmak N.
Gökirmak
Delice
Rivers
Lakes/reservoirs
Catchment boundaries
0 15 30 60 90
km

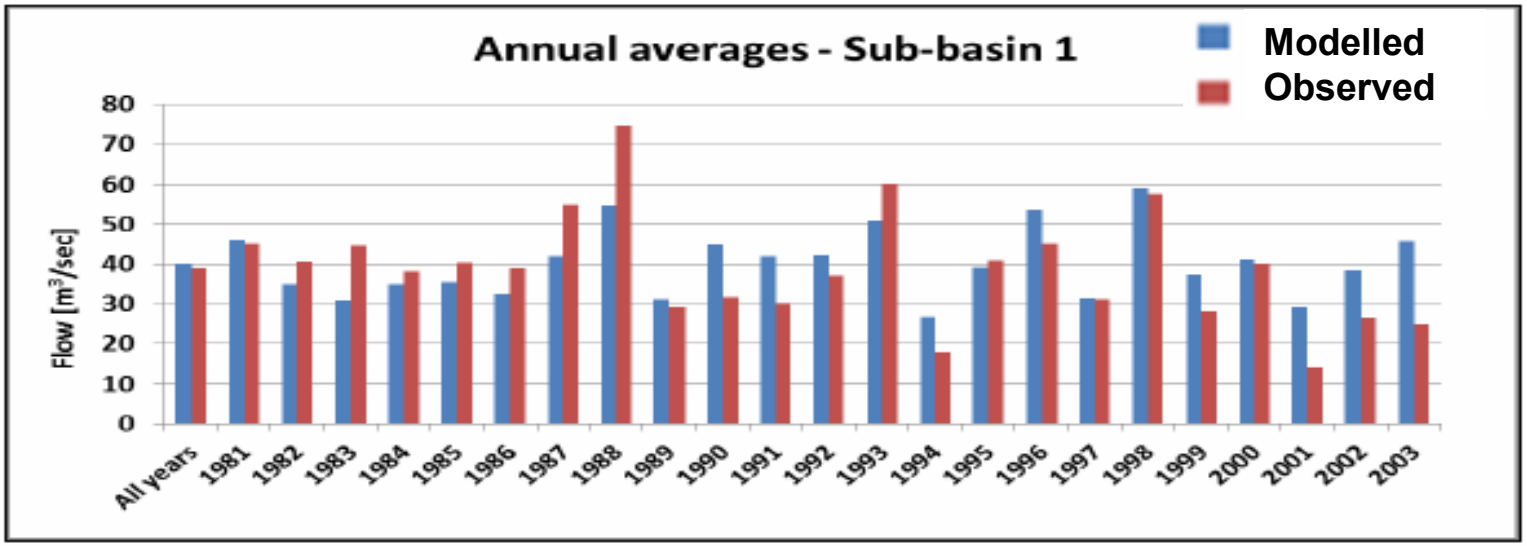
WEAP Model setup

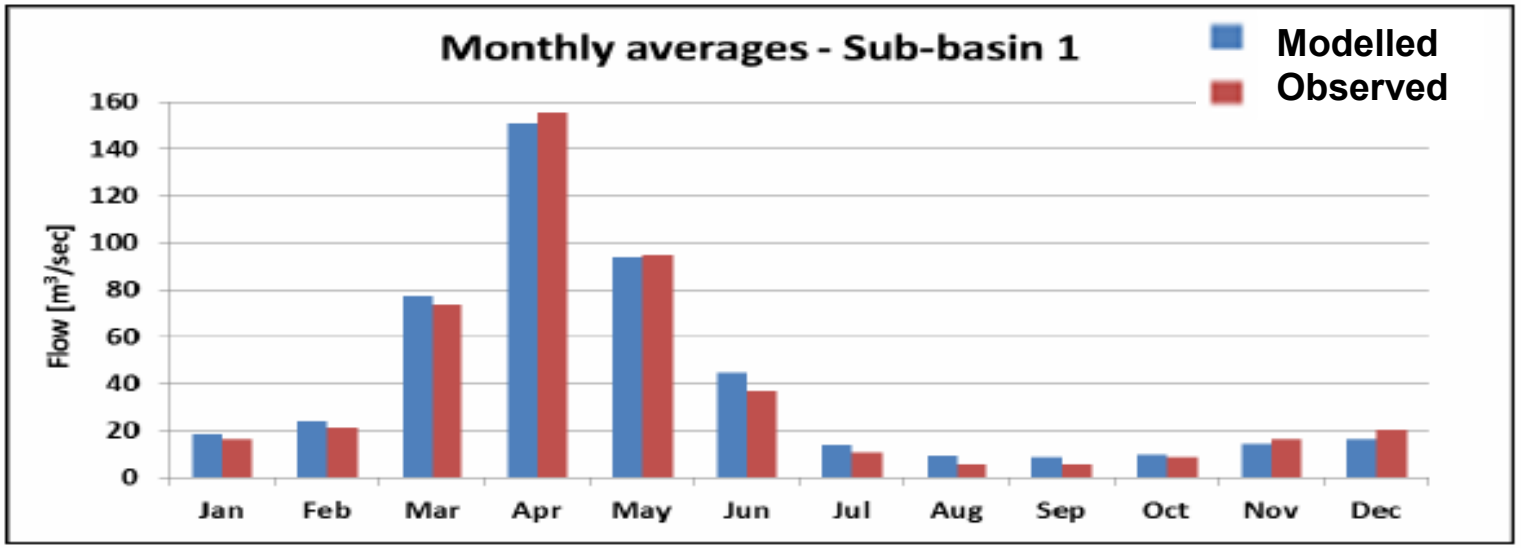
The river basin schematically presented



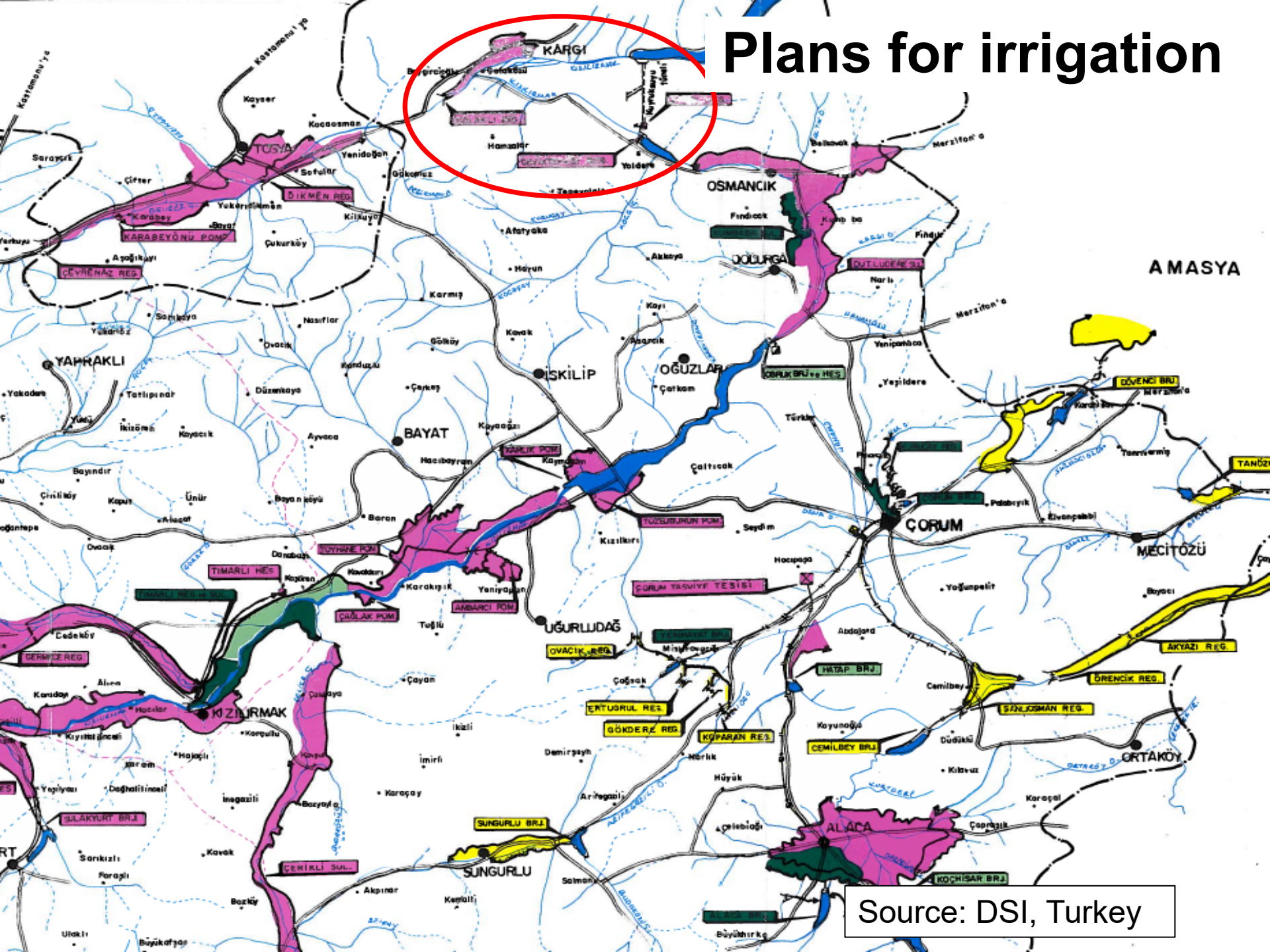
- Red numbers on top: sub-basin numbering
- Black numbers: volume of reservoirs in mill. m^3

Model calibration – an important first step





Plans for irrigation



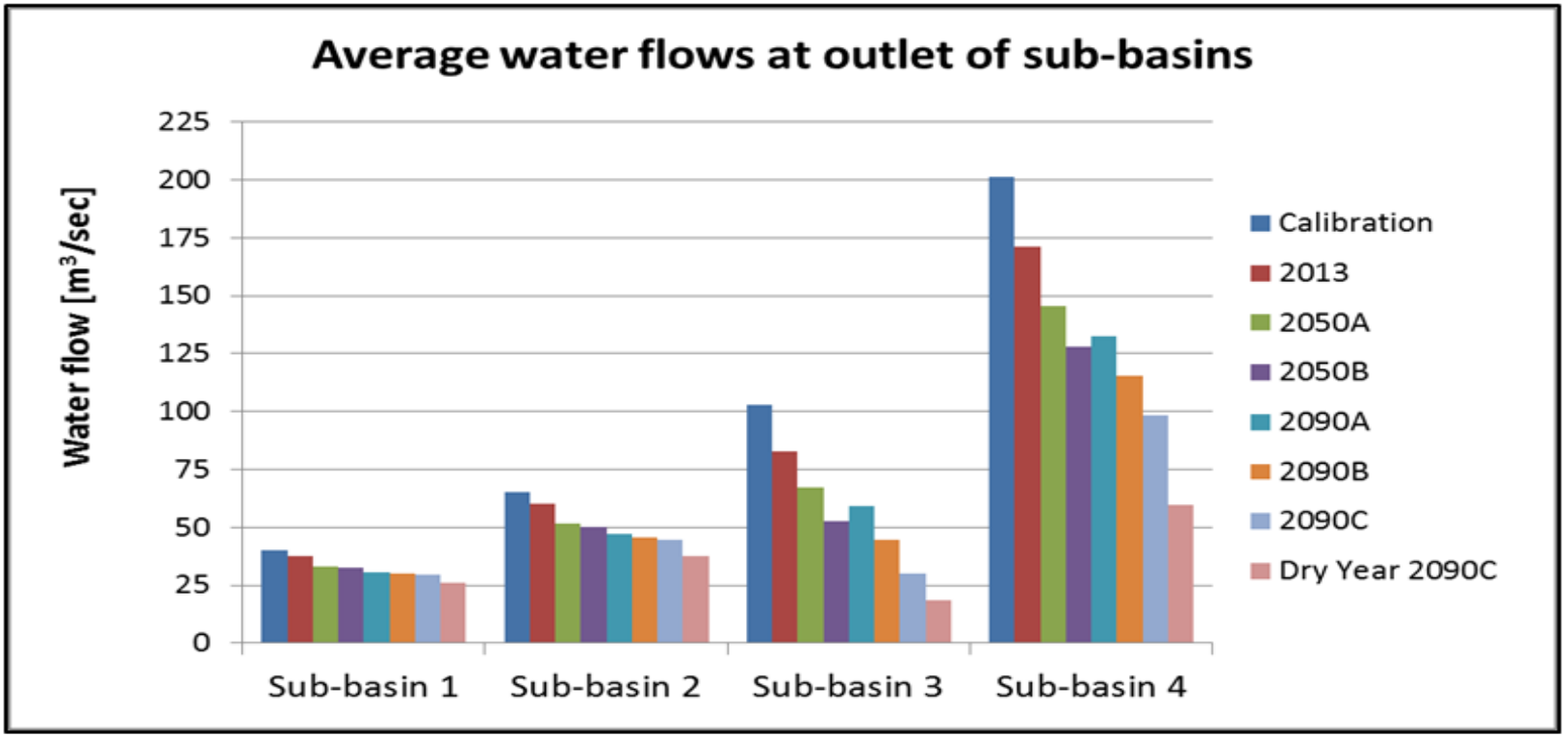
Scenario definition (based on RCP4.5)

	Scenario name	Temperature Summer/Winter [° C]	Precipitation Summer/Winter	Irrigation
	Year 2013	Observed	Observed	As built by 2013
2050	Year 2050A	+2.5 / +1.5	-5 % / -2.5 %	No new from 2013
2050	Year 2050B	+2.5 / +1.5	-5 % / -2.5 %	As planned
2090	Year 2090A	+3 / +2	-10 % / -5 %	No new from 2013
2090	Year 2090B	+3 / +2	-10 % / -5 %	As planned
2090	Year 2090C	+3 / +2	-10 % / -5 %	As planned + more
2090	Dry Year 2090C	+3 / +2	-10 % / -5 %	As planned + more

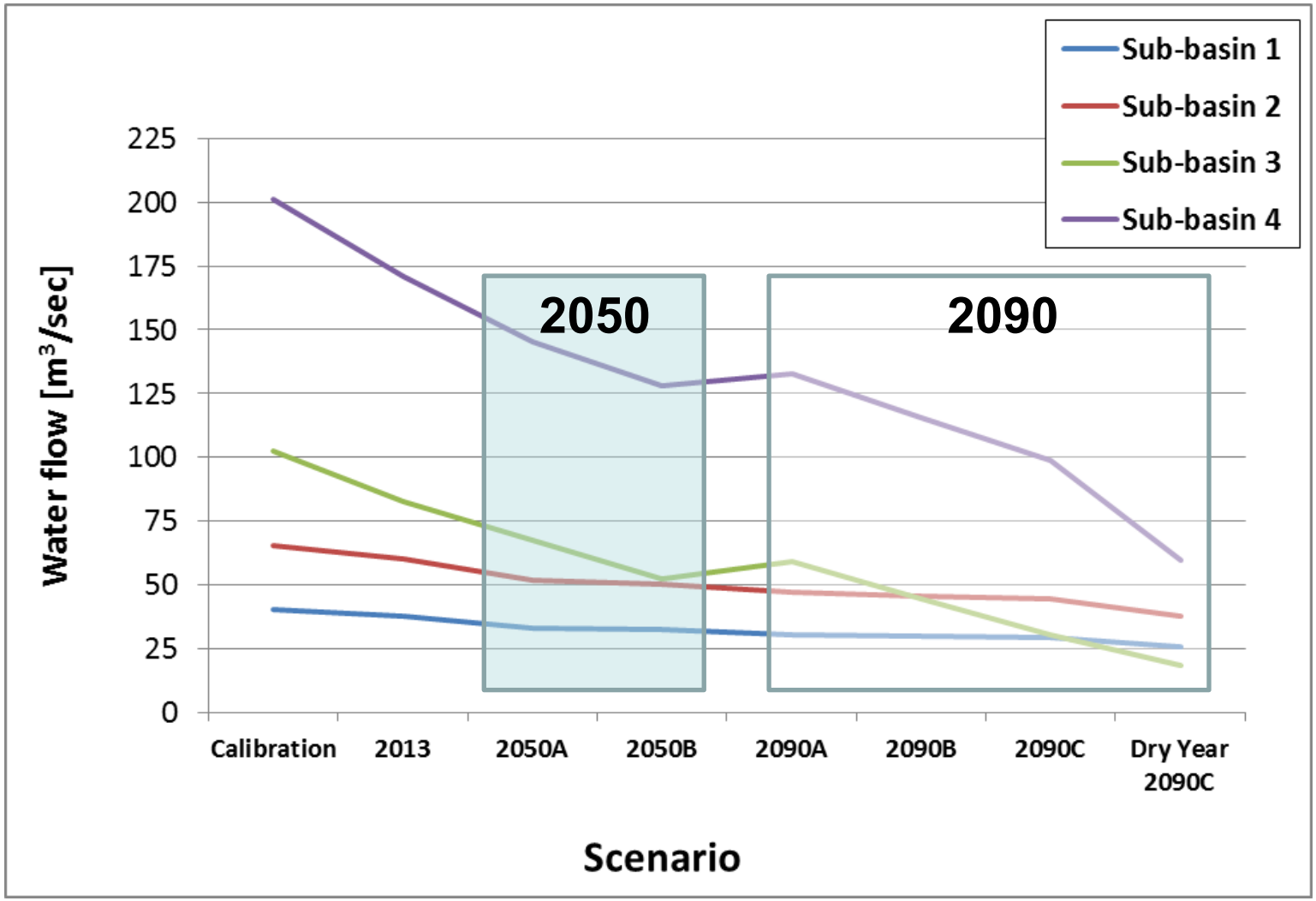
Based on: IPCC, 2013: Annex I

Scenario Results

	Scenario name	Temperature Summer/Winter [° C]	Precipitation Summer/Winter	Irrigation
	Year 2013	Observed	Observed	As built by 2013
2050	Year 2050A	+2.5 / +1.5	-5 % / -2.5 %	No new from 2013
2050	Year 2050B	+2.5 / +1.5	-5 % / -2.5 %	As planned
2090	Year 2090A	+3 / +2	-10 % / -5 %	No new from 2013
2090	Year 2090B	+3 / +2	-10 % / -5 %	As planned
2090	Year 2090C	+3 / +2	-10 % / -5 %	As planned + more
2090	Dry Year 2090C	+3 / +2	-10 % / -5 %	As planned + more

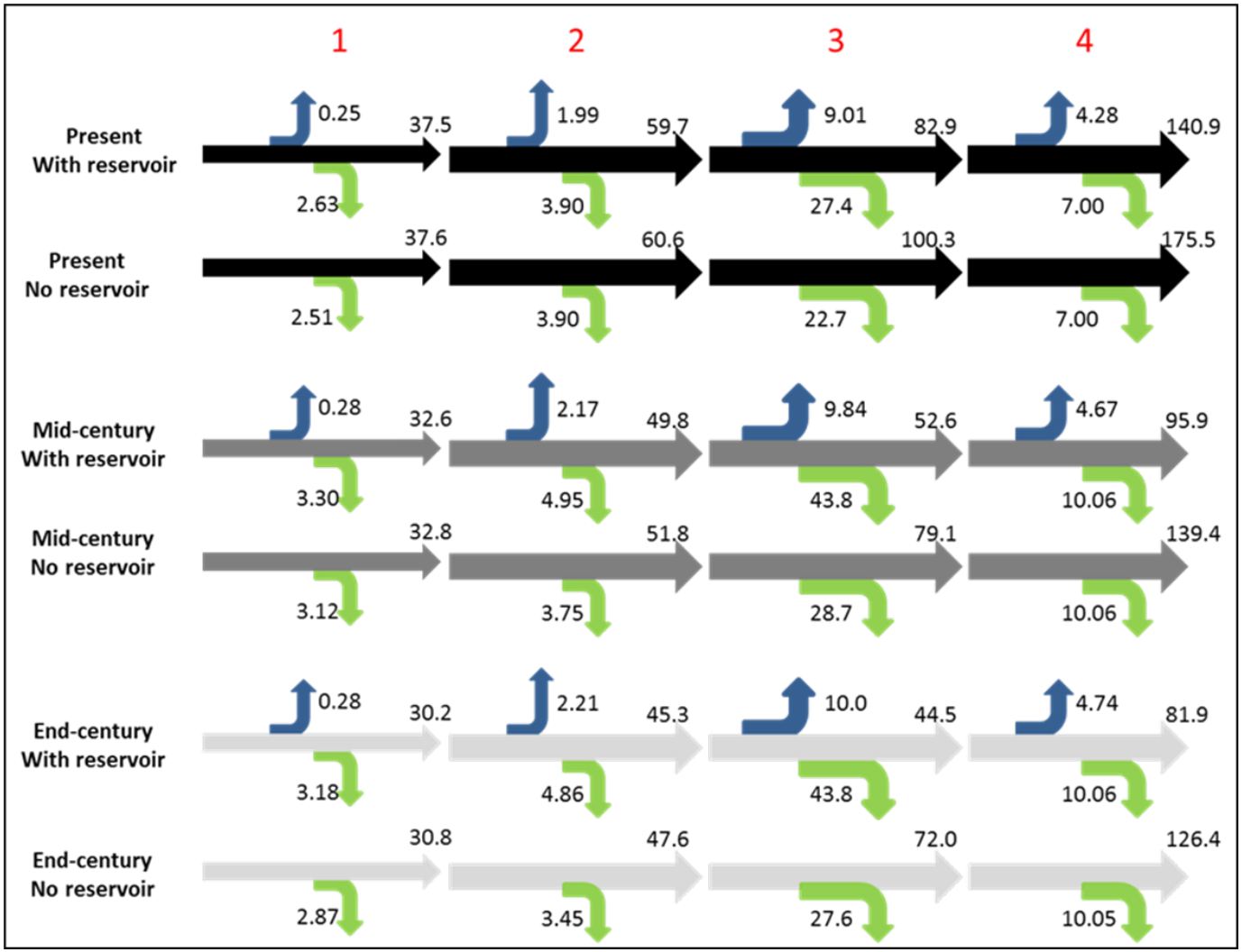


Average flow [m^3/sec]



Analysis: the effect of water losses and demand fulfillment with and without reservoirs

All numbers in m^3/s



Evaporation losses from reservoirs

Irrigation water

Black to grey arrows:

Remaining water in the river

Conclusions Kizilirmak, Turkey

- The effect of climate change and irrigation will reduce the available water resources significantly.
- Small changes in climate will potentially make big changes in runoff when low runoff coefficients (low effective rainfall & high evaporation)
- The effect of climate change is stronger than irrigation in some parts of the basin - opposite in other parts.
- The risk profile of the investment portfolio is to a large extent affected by the location of the prospects in the river basin
- Integrated assessment of the water resources needed in order to plan the mid- and long-term available water resources

Risks of future hydropower developments

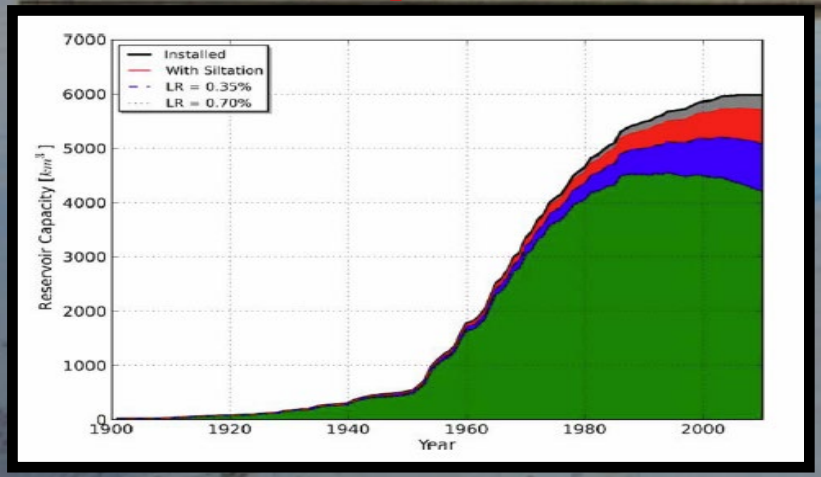
Large uncertainties

Climate change:

- Lower precipitation?
- Higher evaporation?
- More intense short-term prec. events?
- Longer/more frequent droughts?

Changes in use of water/policies:

- Growing population
- More food needed/irrigation
- Environmental requirements
- Multi-purpose reservoirs



Change in storage capacity

Source: Wisser et al., 2013


Planning the water resources:
A challenge with many and big uncertainties
Robust Methodologies & Tools needed
Owens Lake, California