

Water consumption and availability

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Water consumption

Definition:

“Water consumption denotes the part of the freshwater which is not released back to the original watershed; primarily due to evaporation and product integration” (Pfister, 2011)

Differentiation needed between “*withdrawal*” and “*consumption*”

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'The Nexus'

Food

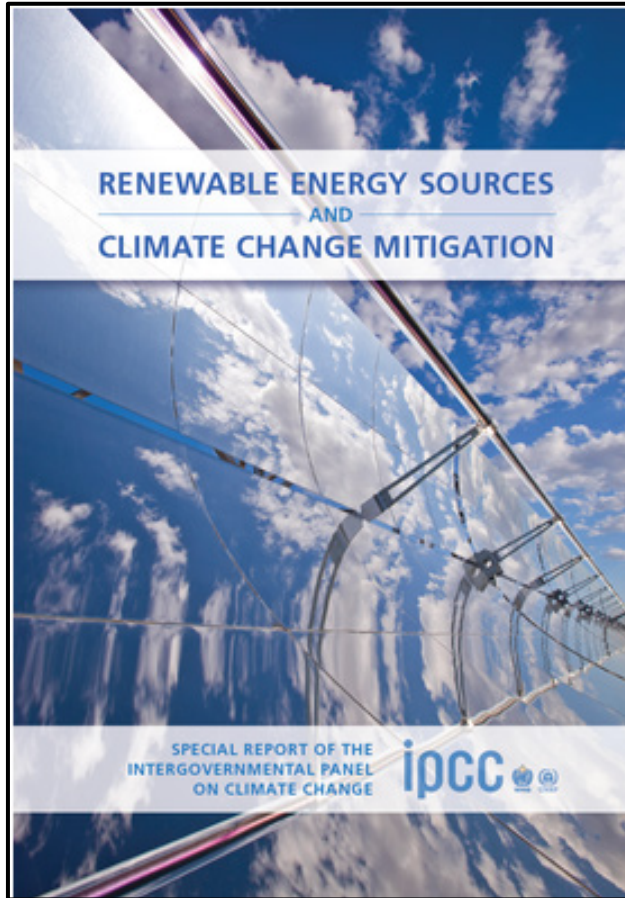
Climate

WATER & ENERGY

Water and energy systems are interdependent.

Water is used in all phases of energy production. Energy is required to extract, pump and deliver water for use by humans, and to treat wastewater so it can be safely returned to the environment.

IPCC (2011) raised water consumption into the energy sector

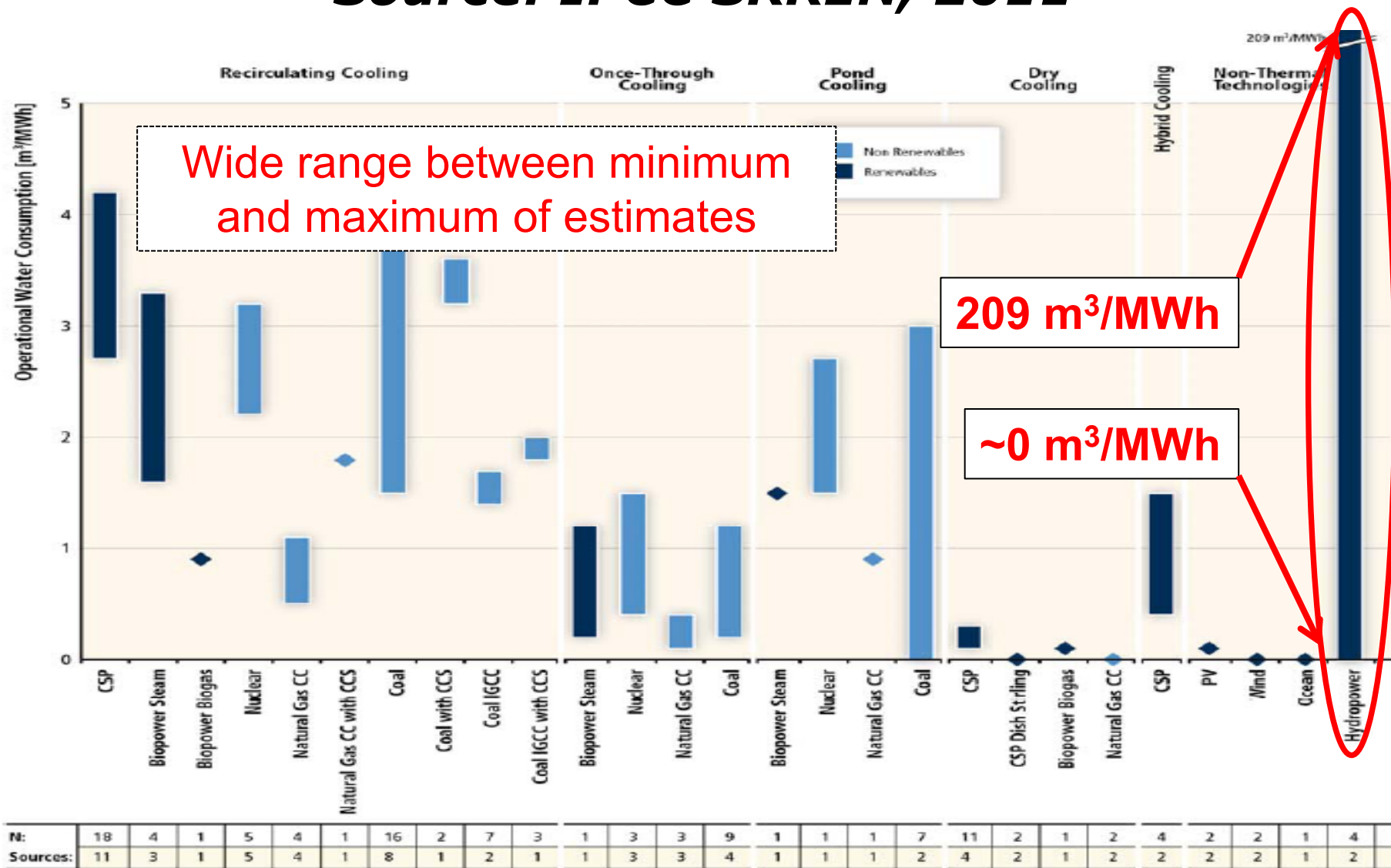


IPCC Special Report on Renewable Energy (2011):

- What is the potential for renewable sources to replace fossil-based fuels?
- The different technologies benchmarked with respect to various criteria, including 'water needed to produced 1 MWh electricity (*water consumption*)'

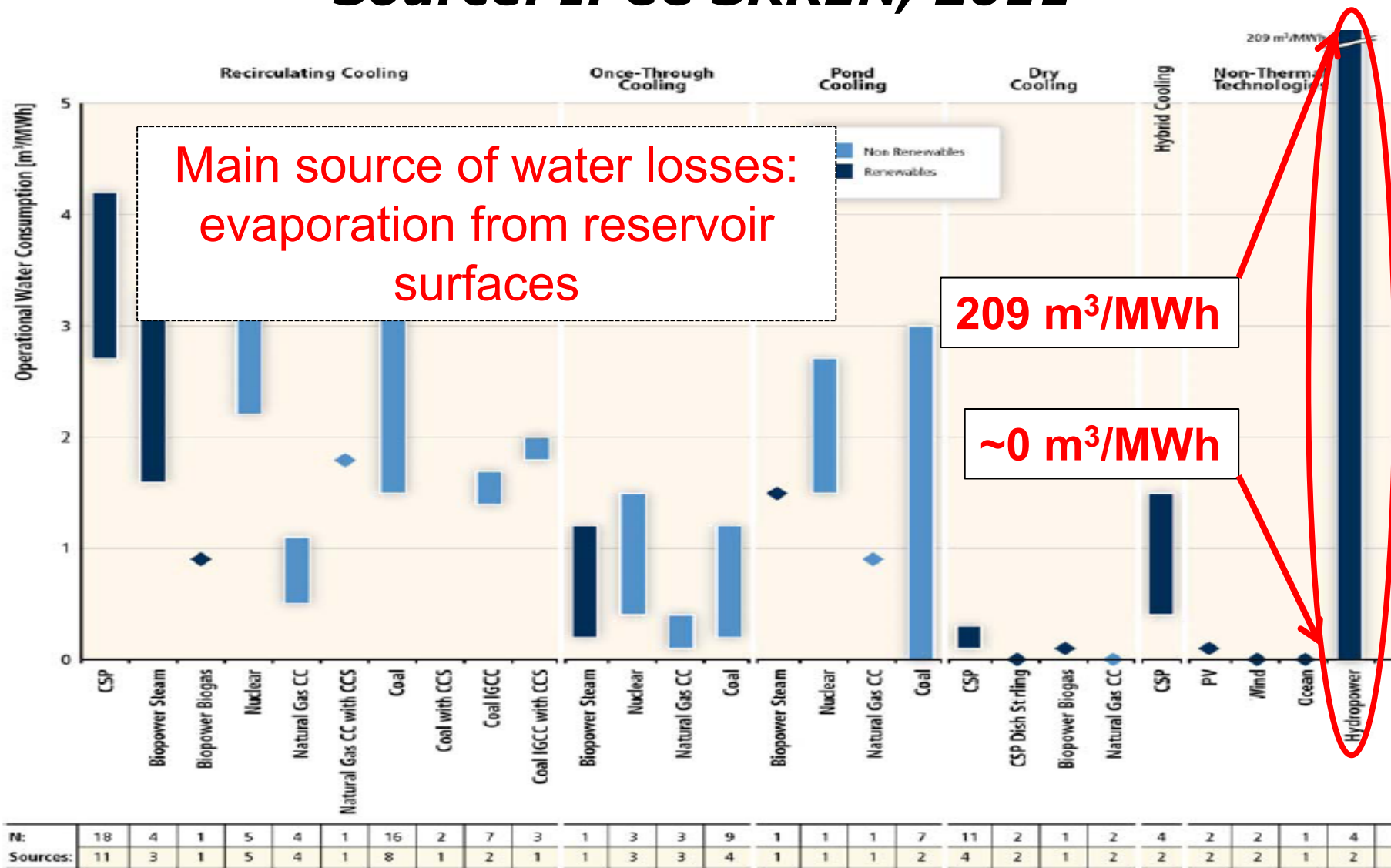
Water consumption from electricity generation:

Source: IPCC SRREN, 2011



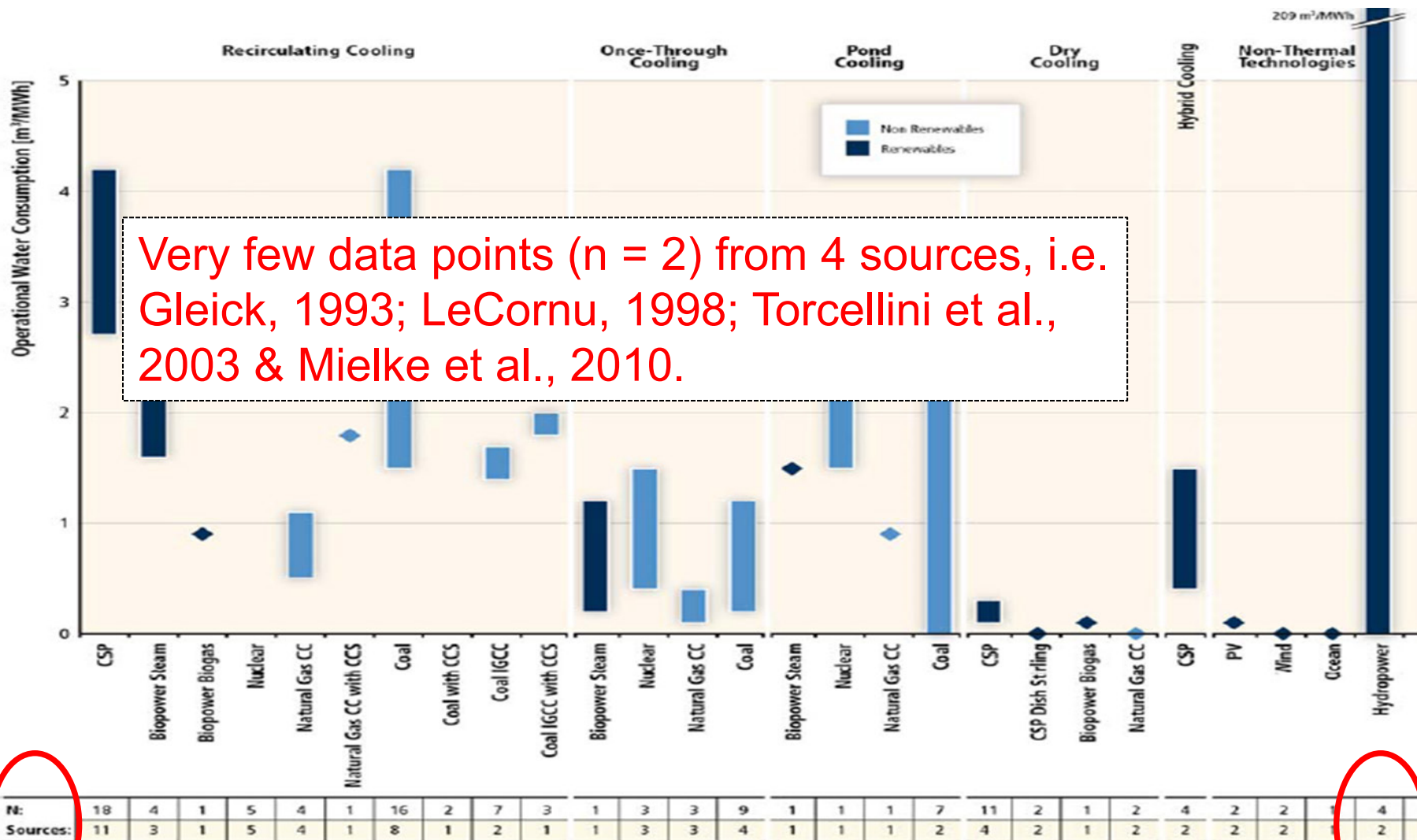
Water consumption from electricity generation:

Source: IPCC SRREN, 2011



Water consumption from electricity generation:

Source: IPCC SRREN, 2011



IPCC SRREN (2011) states

- *Upper values for hydropower result from few studies measuring gross evaporation values, and may not be representative.*
- *Allocation schemes for determining water consumption from various reservoir uses in the case of multipurpose reservoirs can significantly influence reported water consumption values.*

The concern in the hydropower sector

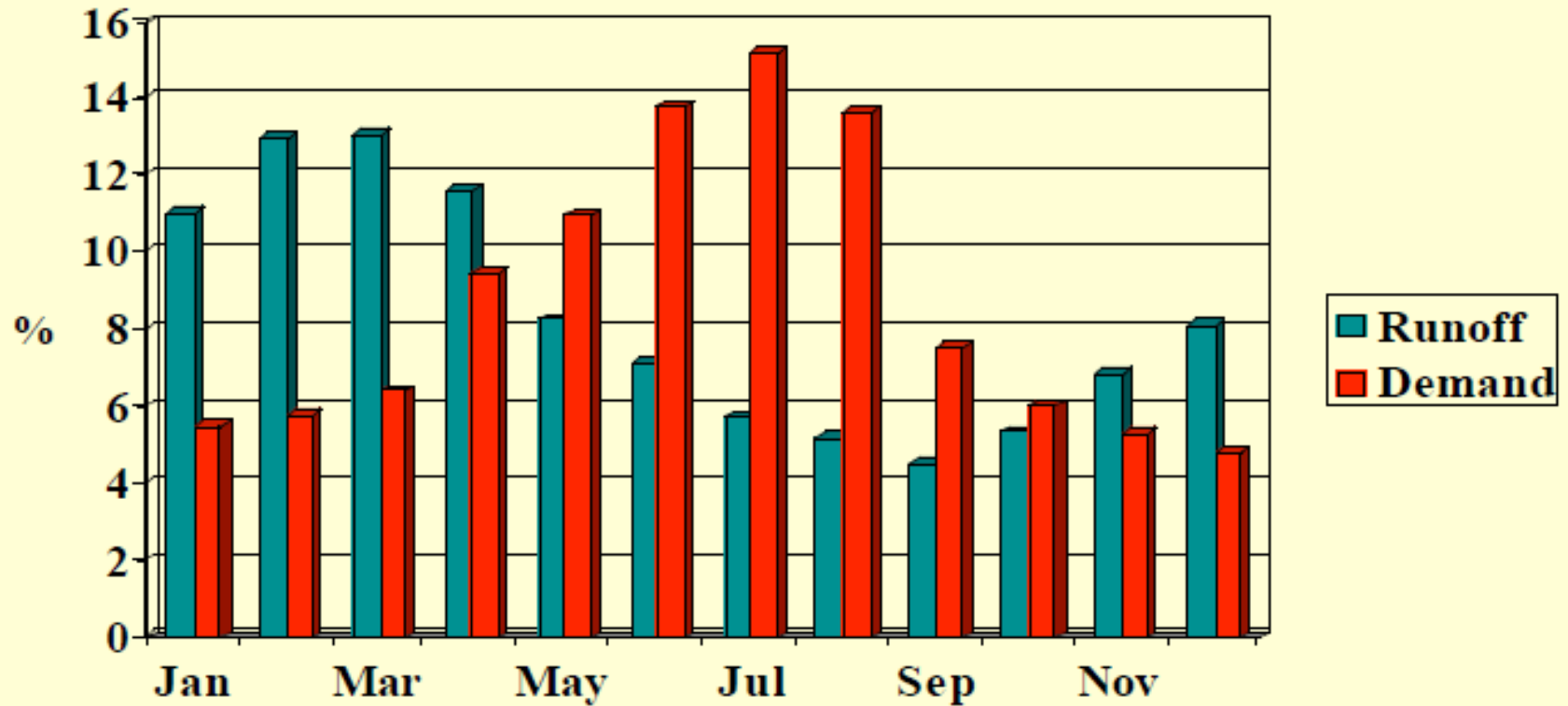
- A fear that the high numbers can be taken as ‘typical water footprint of hydropower’
- Potentially a large reputational and business risk
- Might disqualify hydropower based on an unfair methodological basis
- The water footprint methodology seems to gain an increasing foothold (ISO Water Footprint 14046)
- Does not take into account the increased water availability introduced by reservoirs



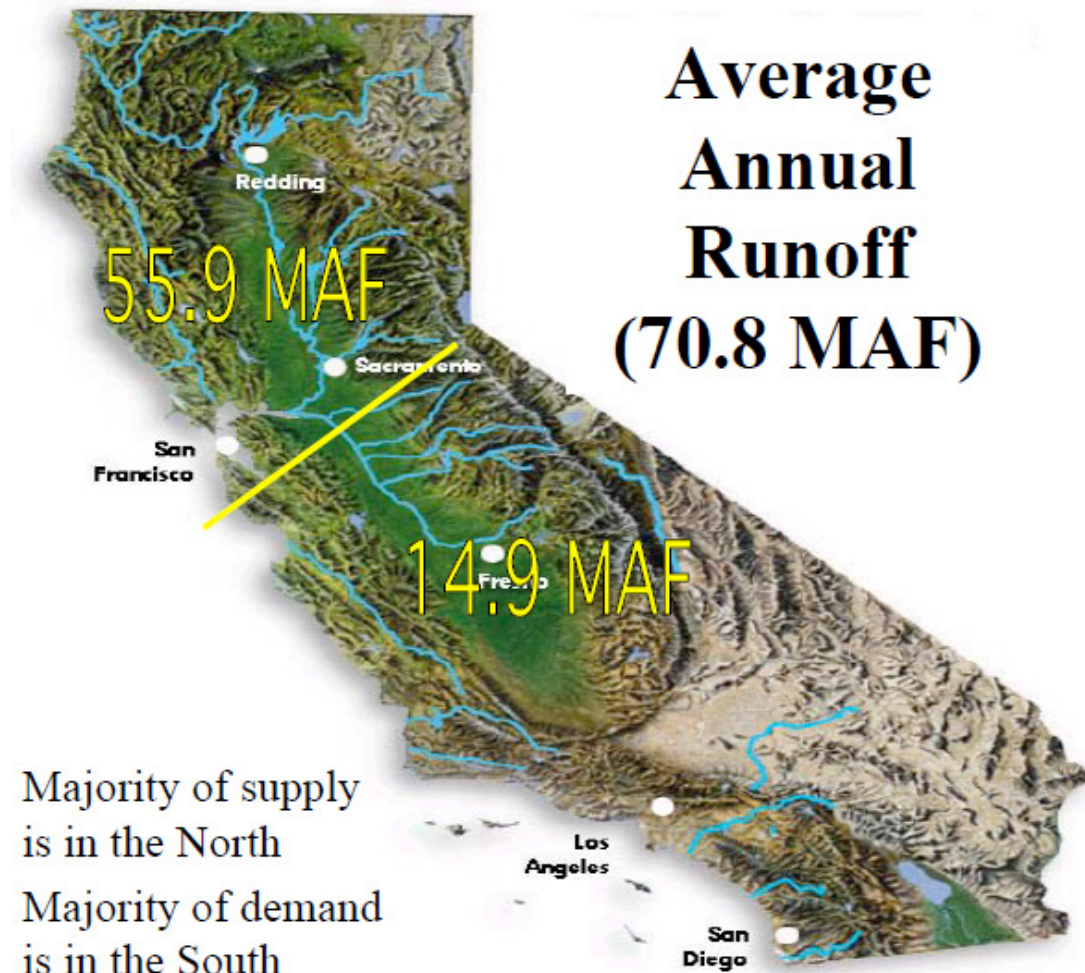
On-going scientific debate

- “The methodology is immature”
- “Hydropower is a large water consumer”
- “High water consumption in water stressed regions, but reservoirs needed”
- “Reservoirs needed to mitigate climate change”
- “Water security”

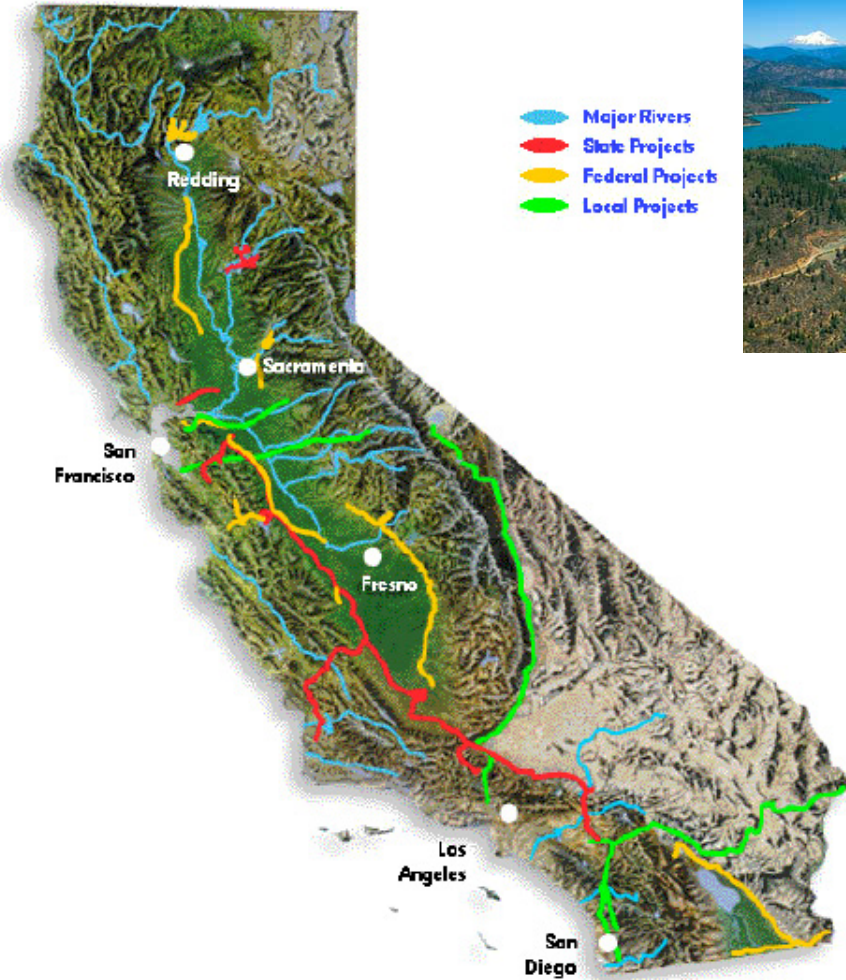
Imbalance in time



Imbalance in space

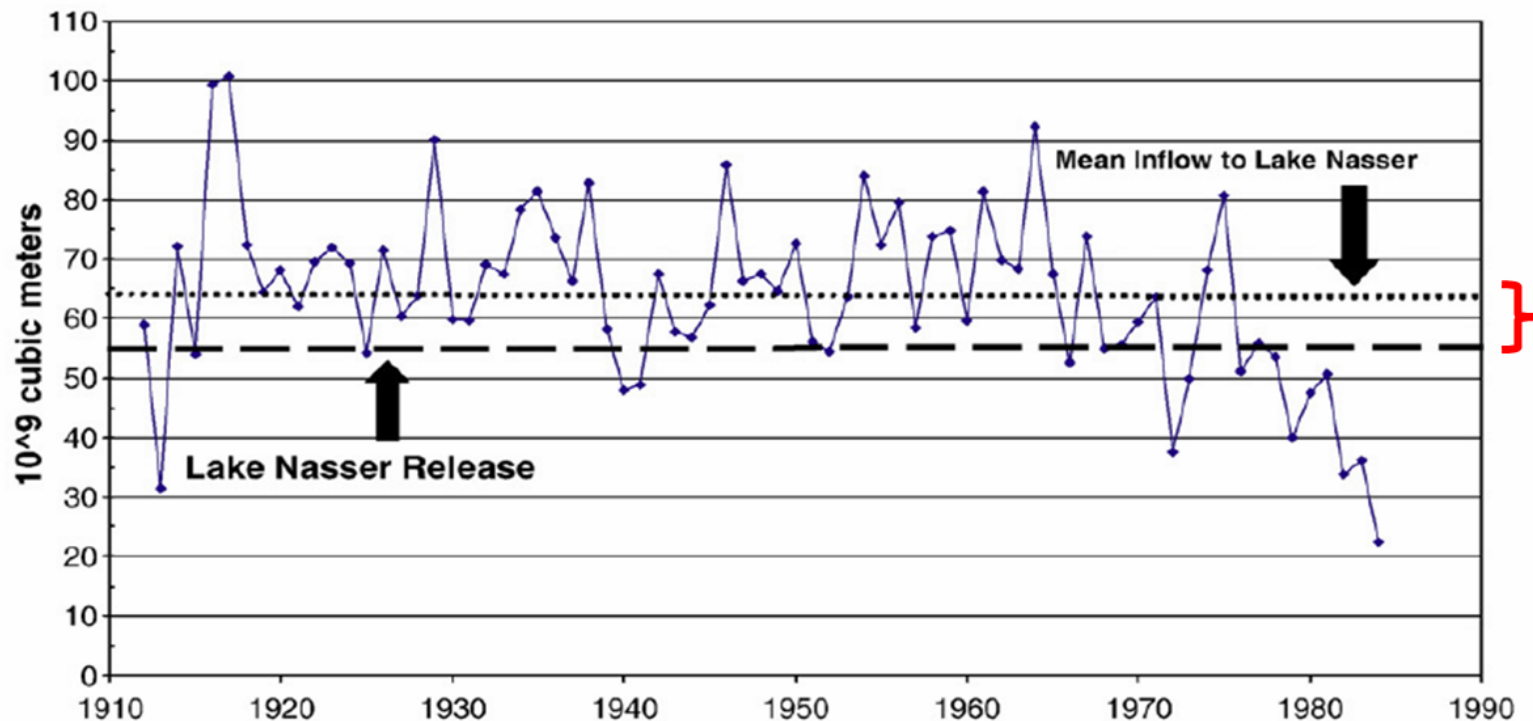


The engineering solution



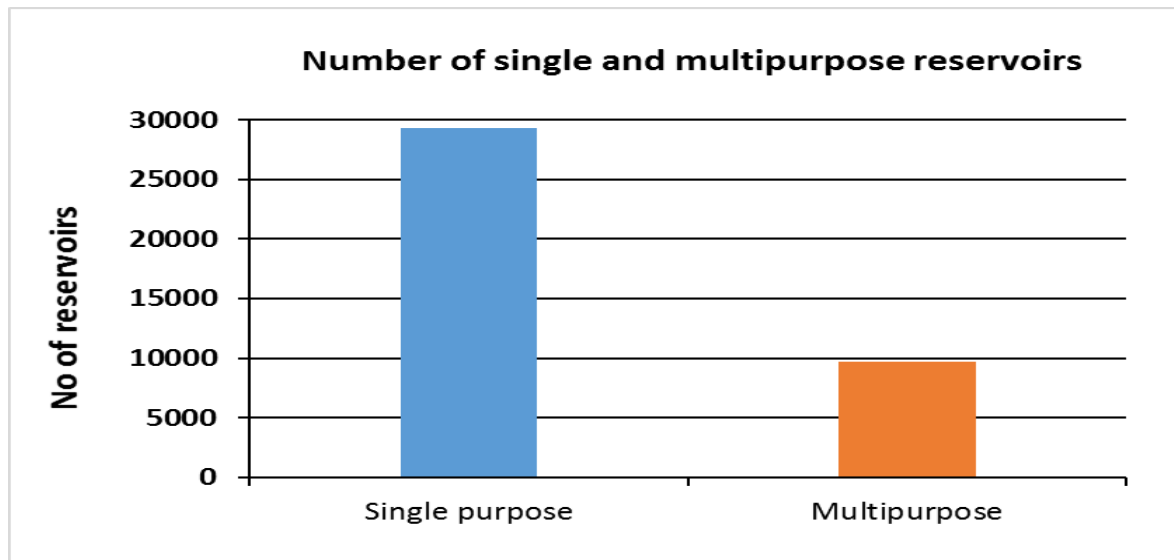
The trade-offs – Case Egypt

**Trade-off: Increased availability
versus reduced annual volumes**



Source: Strzepek et al., 2008

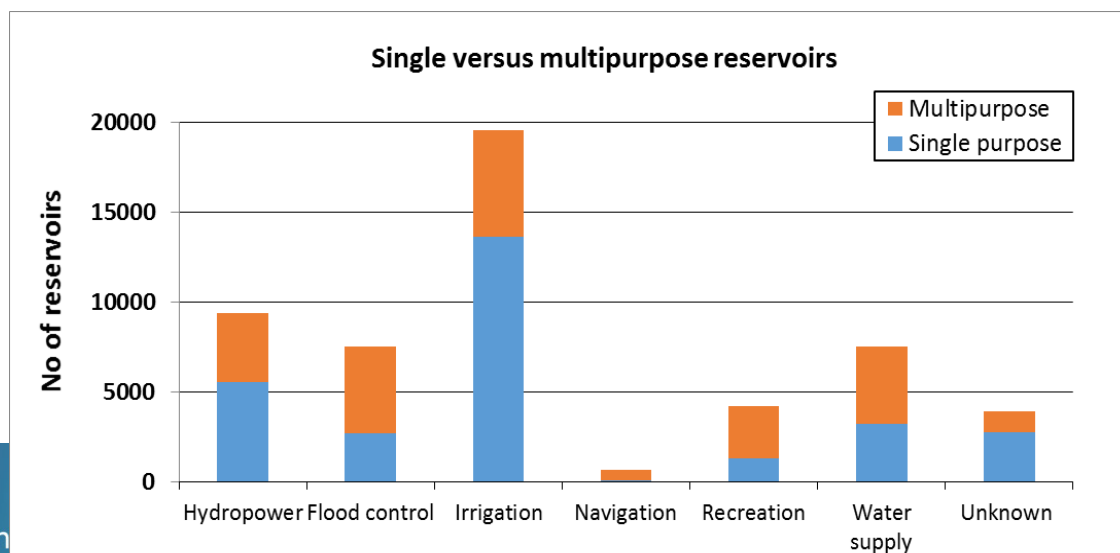
What reservoirs are used for



~25% of the reservoirs are multi-purpose

Many of the reservoirs used for a specific purpose also has another function

Source: ICOLD database, 2014



Multipurpose projects – their functions

Hydropower has a limited role in multipurpose projects in parts of the world, which might mean:

- New projects complex
- Potential for retrofitting with HP

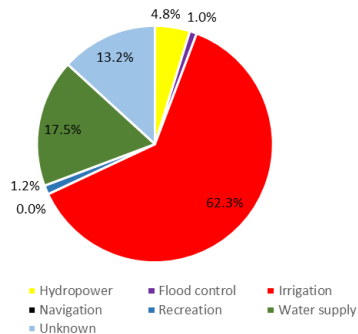
Africa



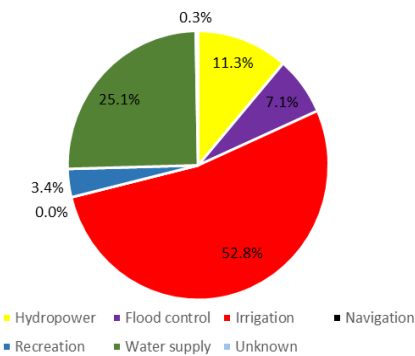
Hydropower

Asia

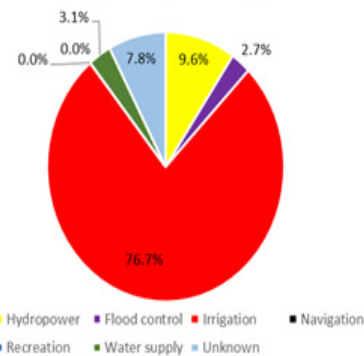
Single purpose Africa (n=1859)



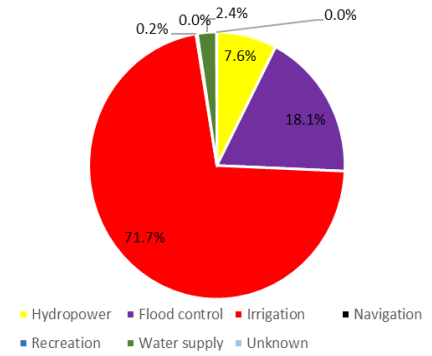
Multipurpose Africa (n=354)



Single Asia (n=12541)



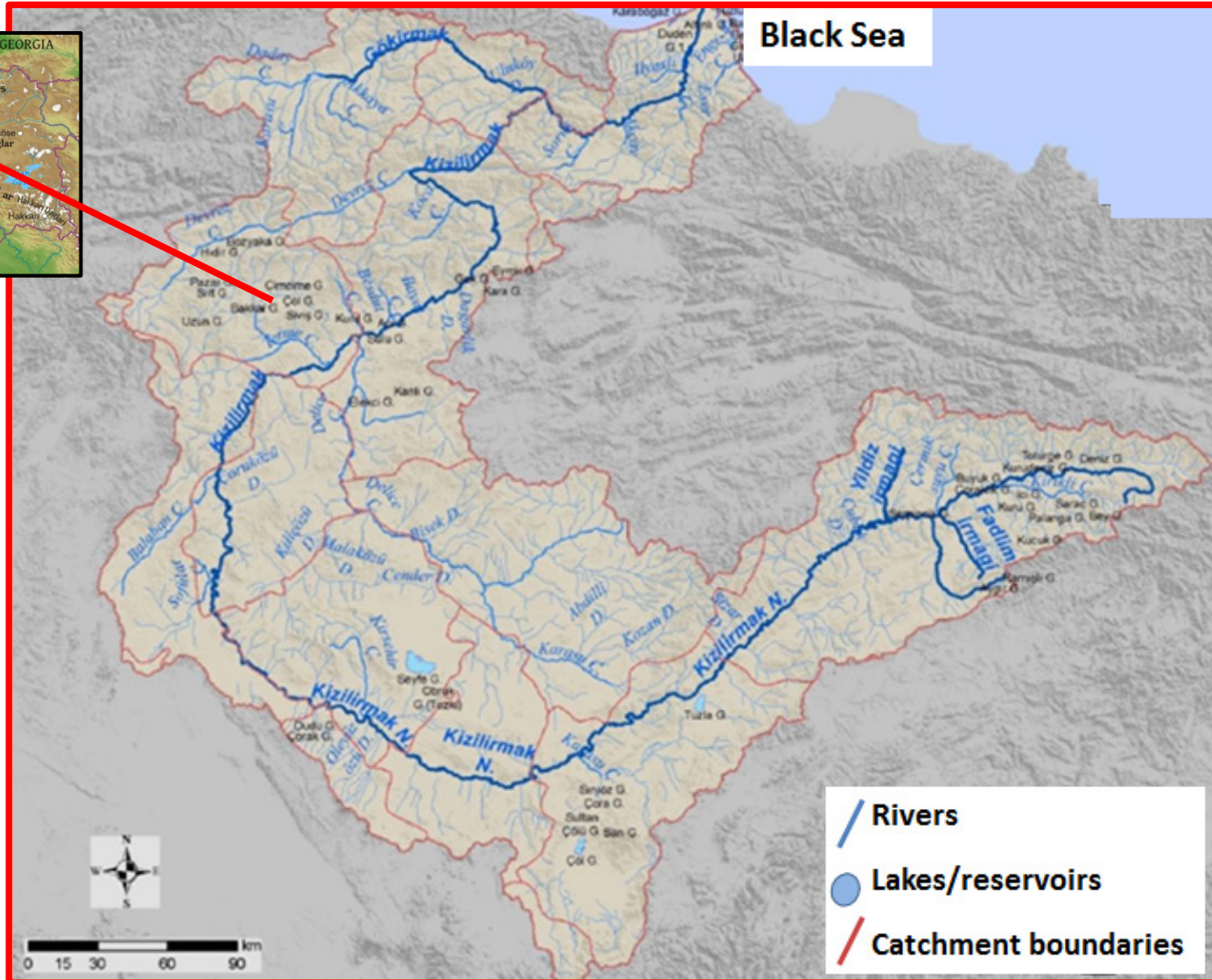
Multipurpose Asia (n=4102)



Source: ICOLD database, 2014


The role of reservoirs:

Case study Kizilirmak River Basin, Turkey



Concerns

How much water will be available for use in the future?

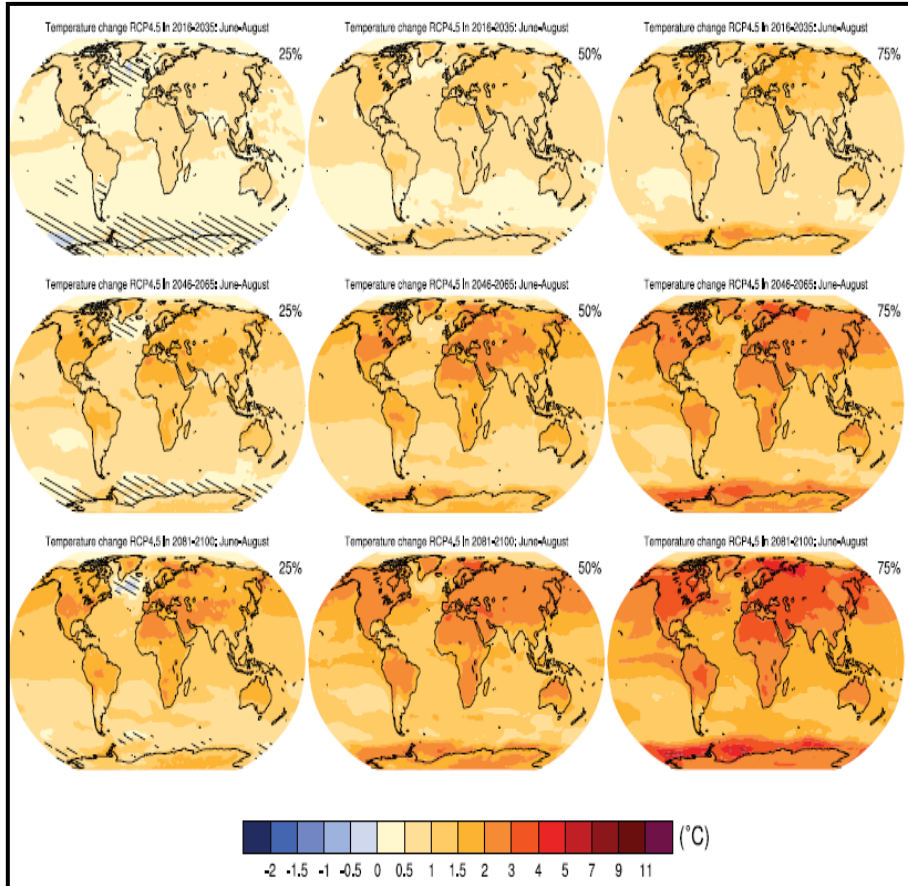
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- A wide, calm river flows through a rural landscape. The river is bordered by lush green vegetation on both sides. In the background, there are rolling hills and a small town with red-roofed buildings. The sky is blue with scattered white clouds.
- 1. Climate change**
 - 2. Land use changes/irrigation practice**
 - 3. Effects of reservoirs on downstream use**



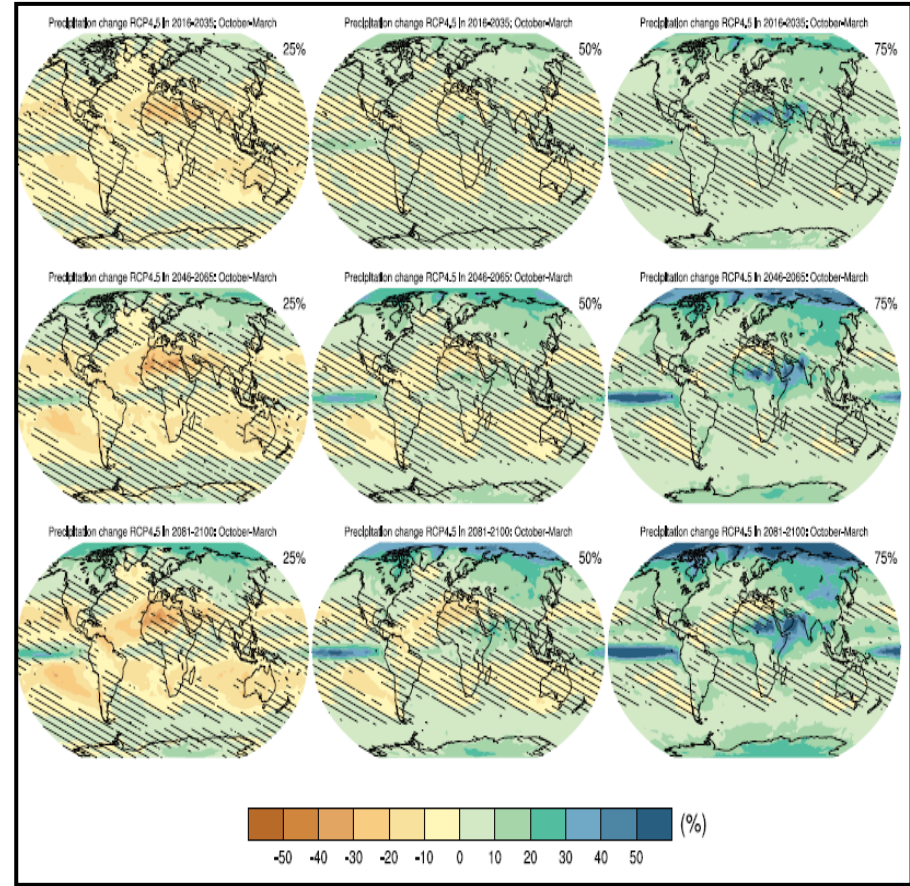


Climate change

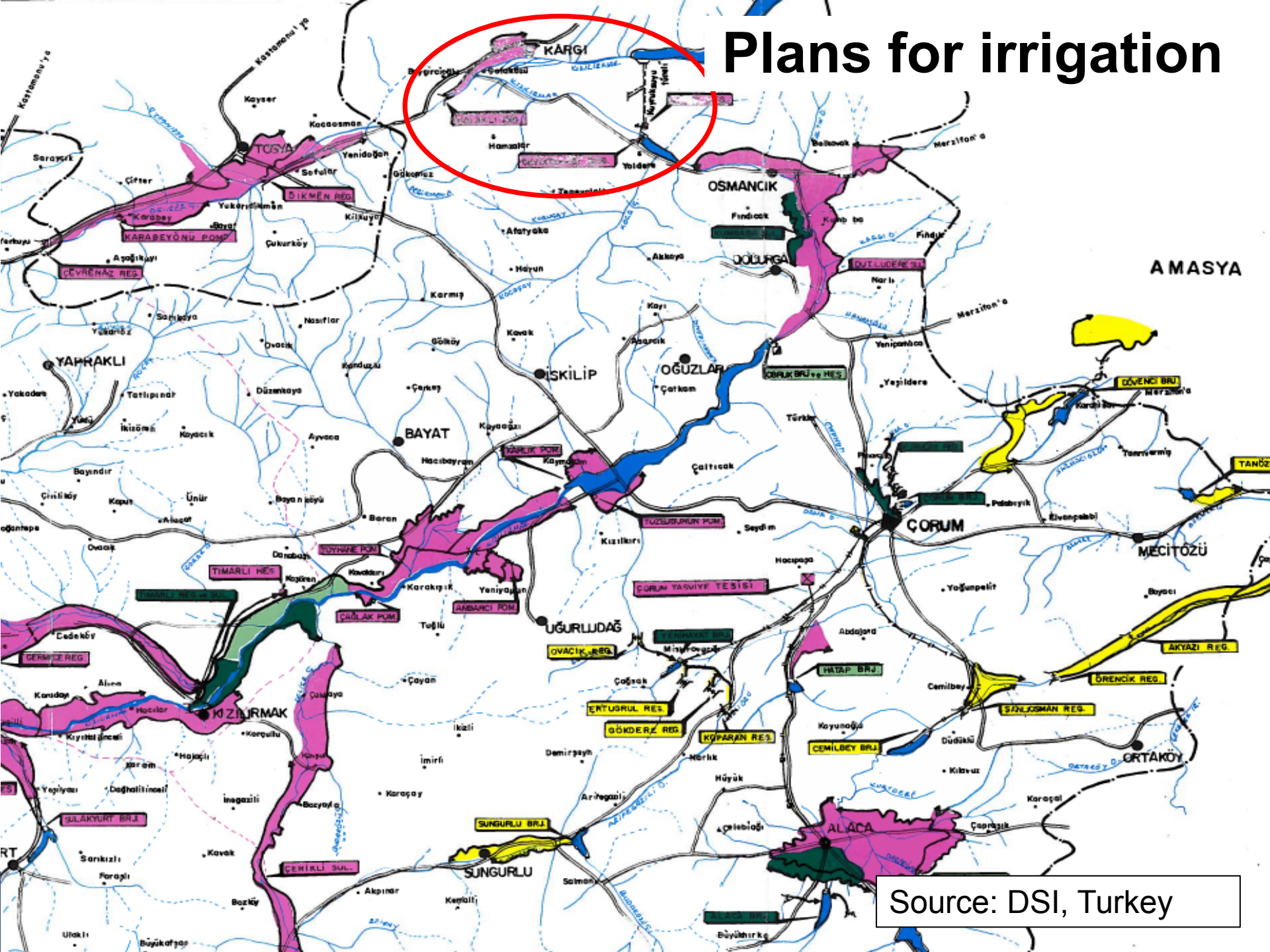
Temperature



Precipitation



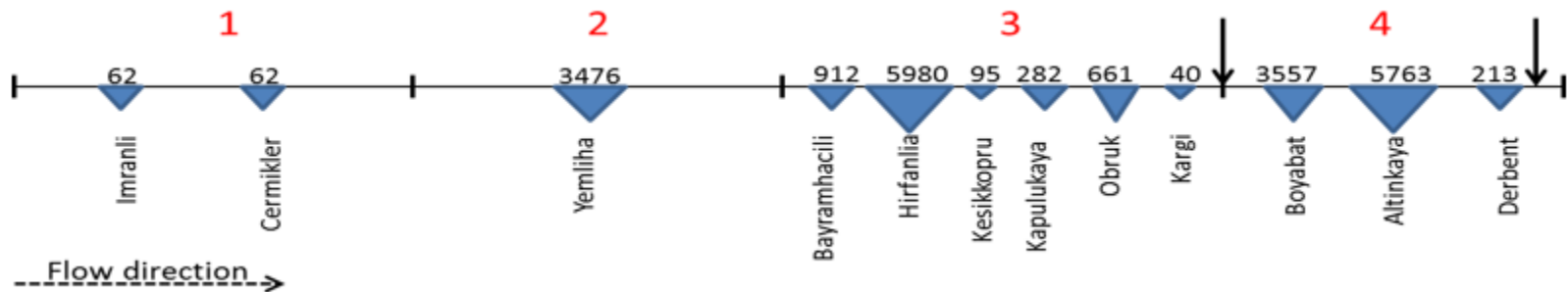
Source: IPCC, 2013: Annex I



Source: DSI, Turkey

WEAP - Model tool applied

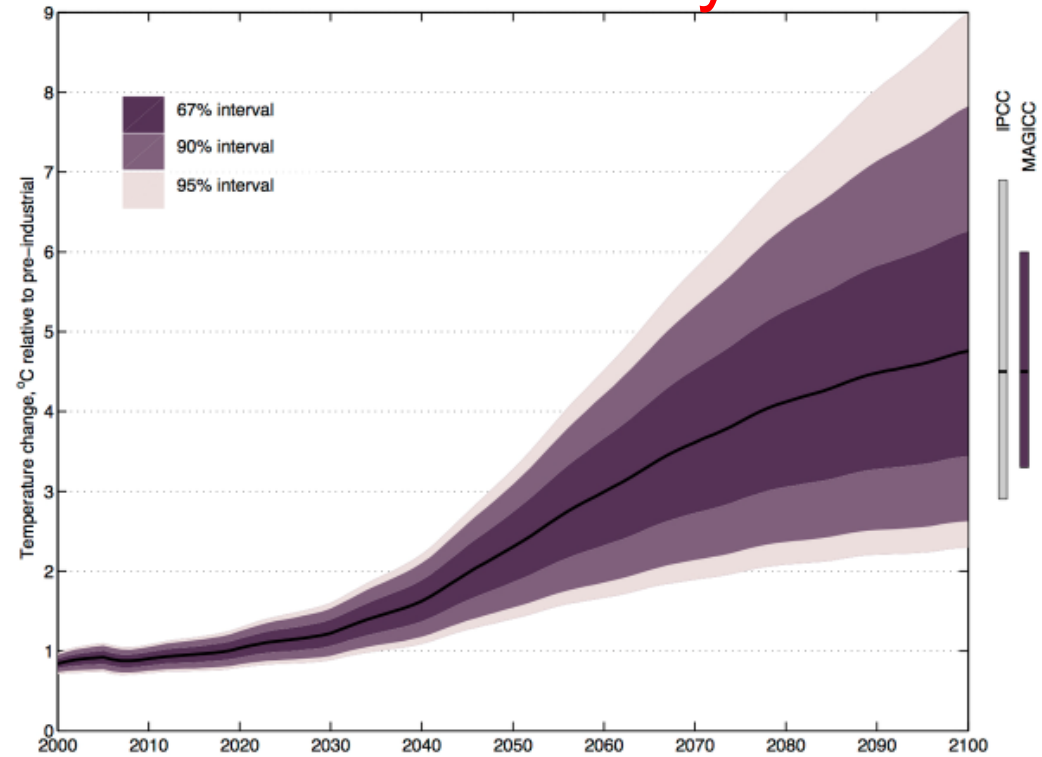
- WEAP – Water evaluation and planning tool
- Supports long-term analysis of available water resources (e.g. climate change)
- Supports the effects of policy scenarios on the water resources (e.g. changes in priorities of water use, land management practice, etc.)



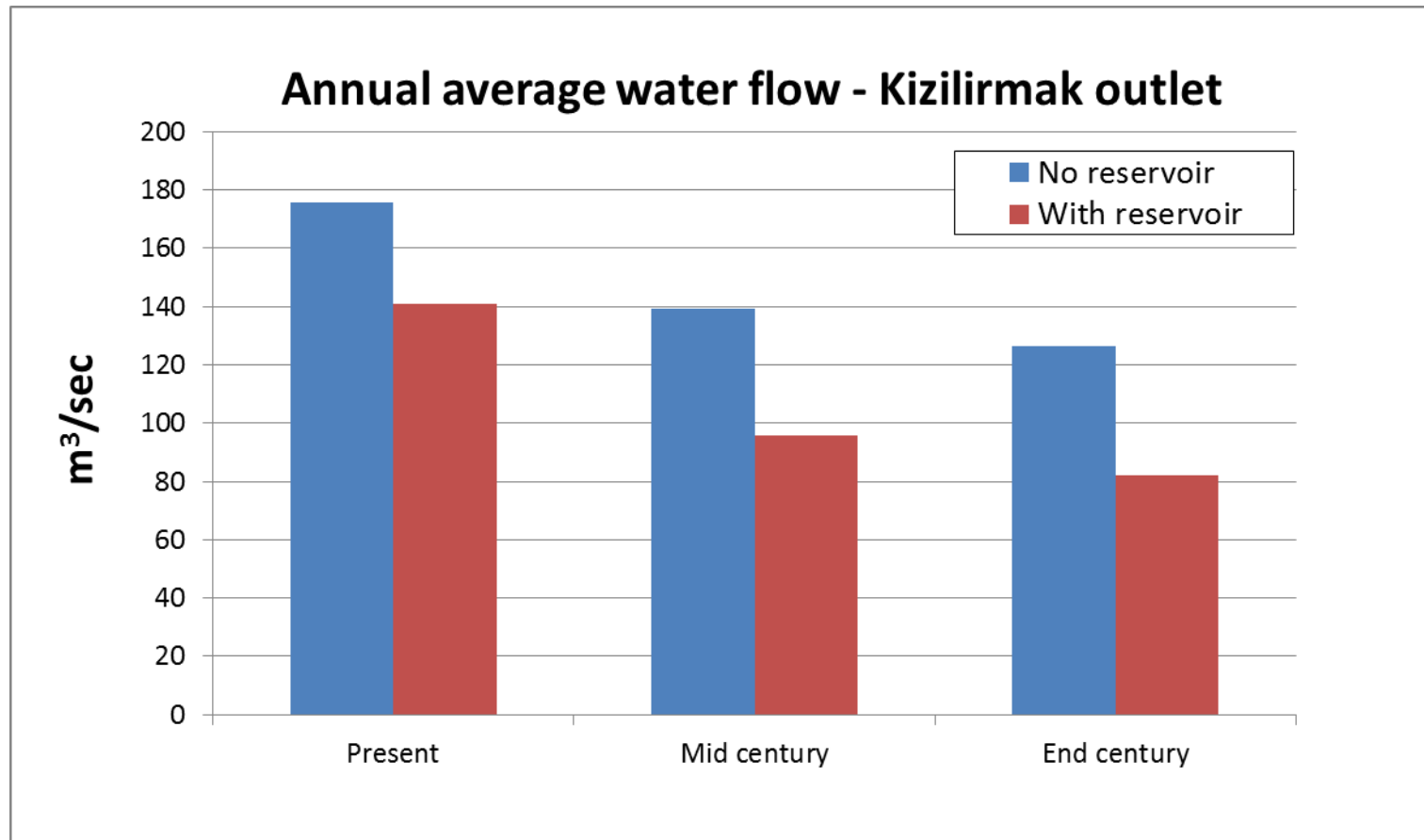
The art of modelling

1. Input data – what is available and not available?
2. Model parameters and representation
3. What we do not know

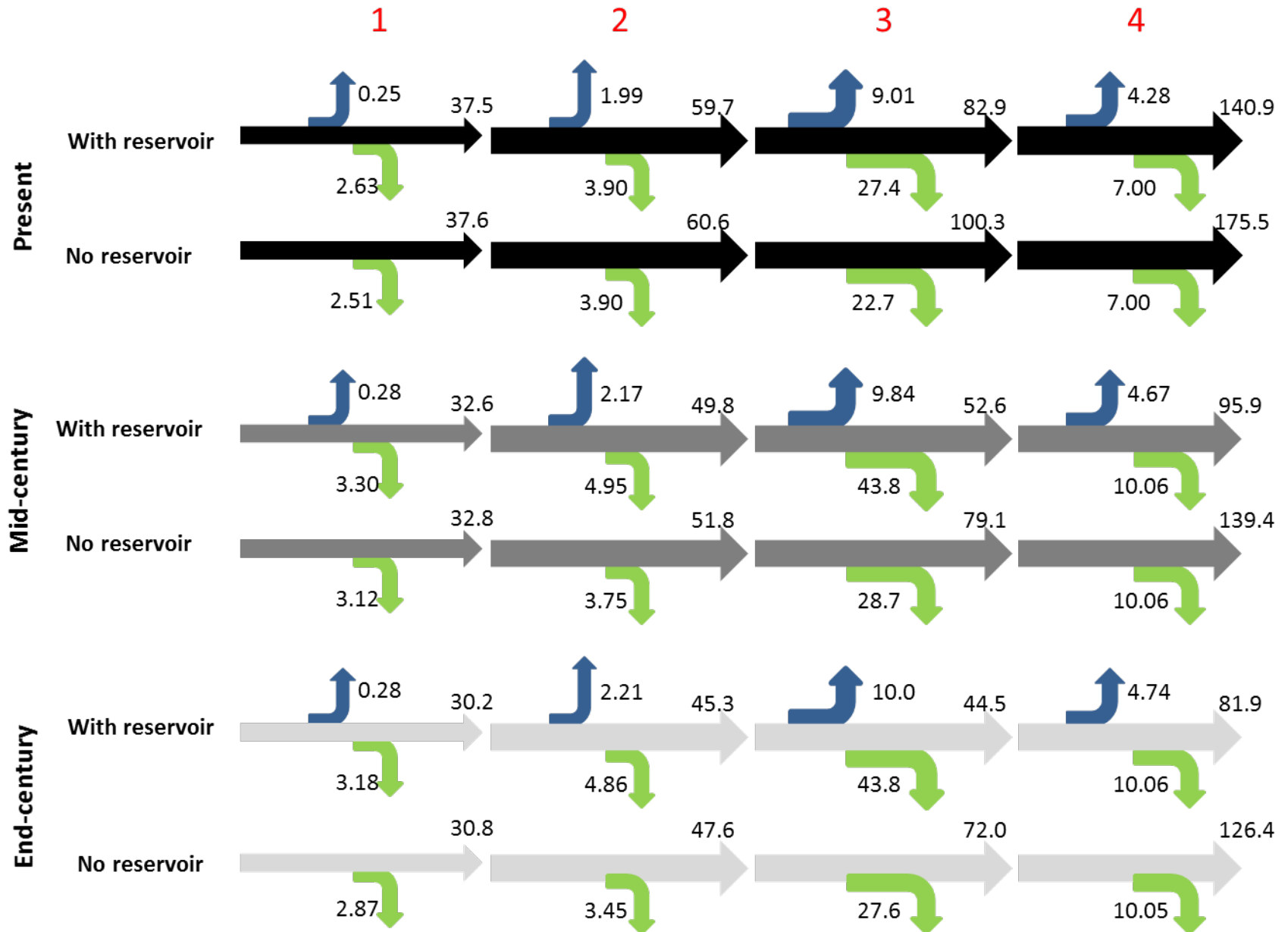
Uncertainty!



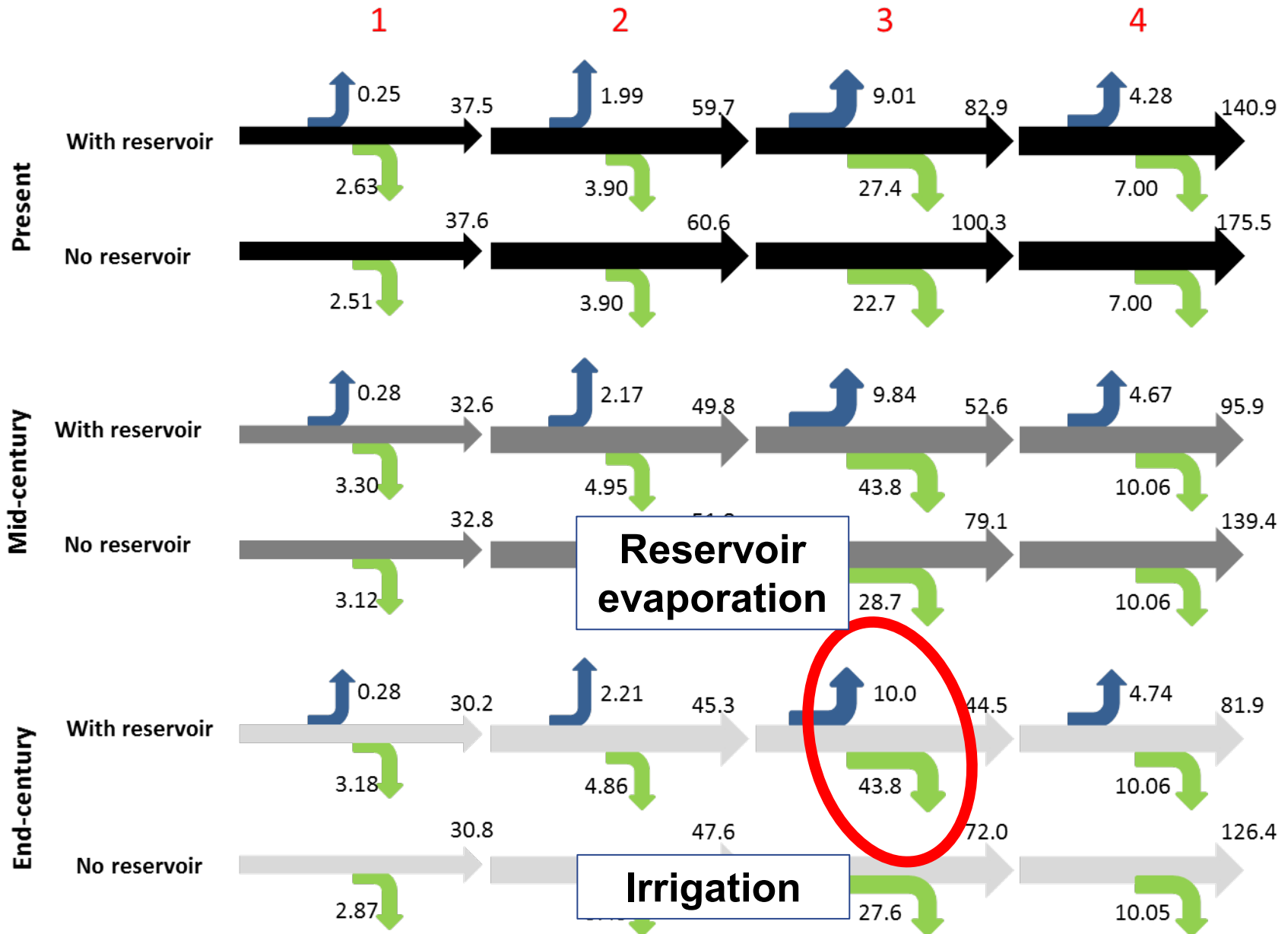
Effect of climate change, irrigation and reservoirs



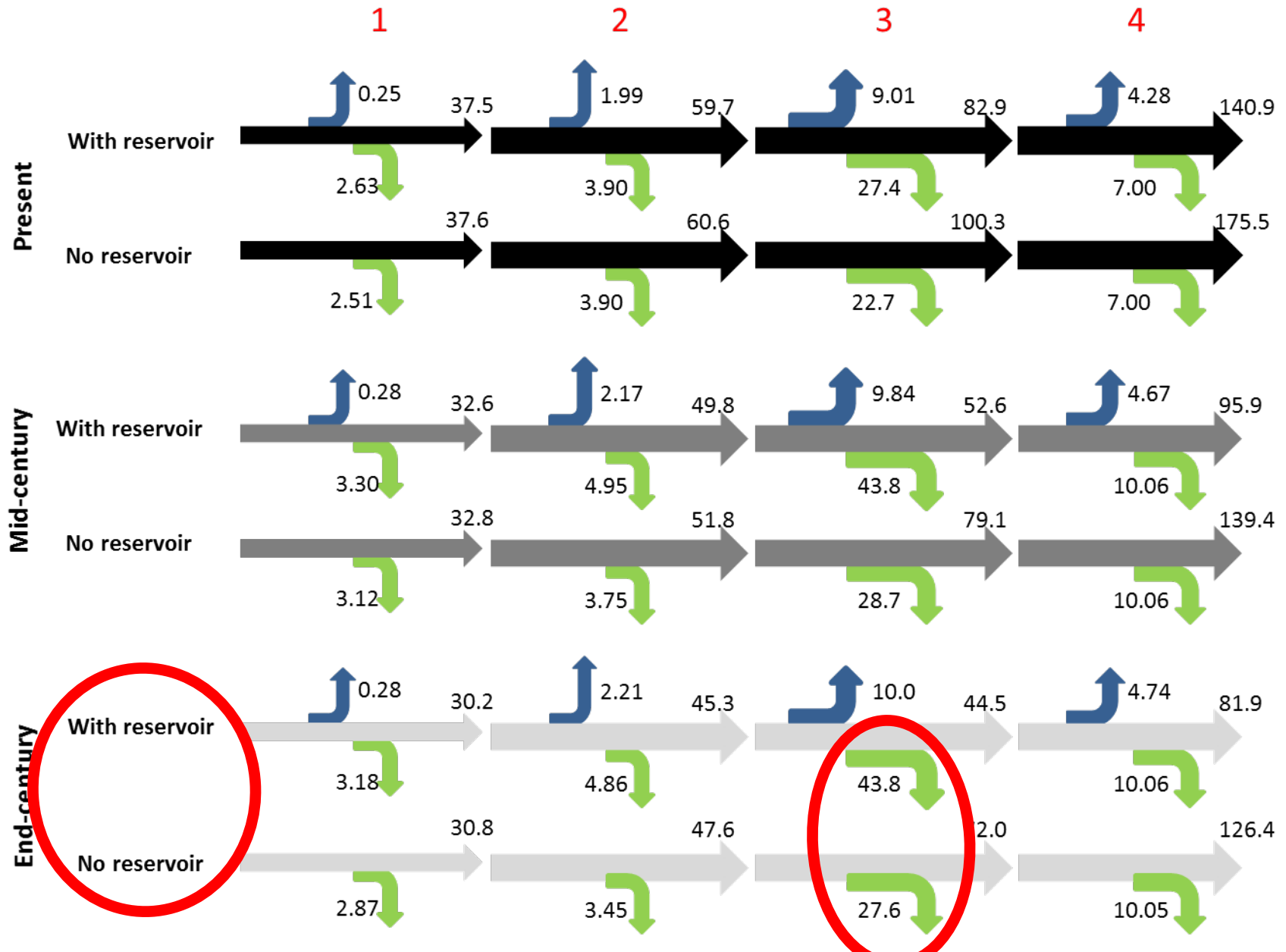
The water use, Kizilirmak



The water use, Kizilirmak



The water use, Kizilirmak



Reflections on future hydropower development & planning

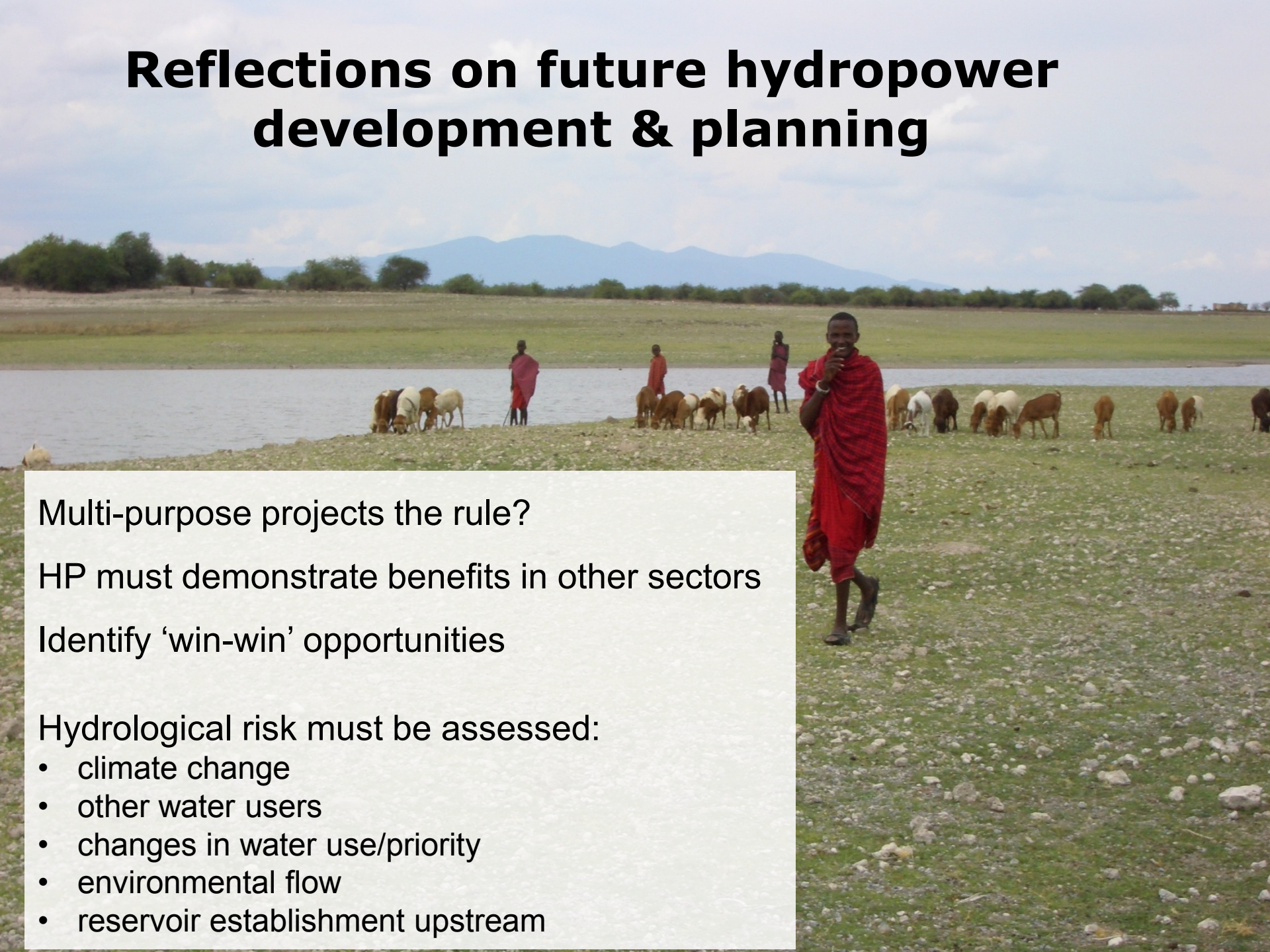
Multi-purpose projects the rule?

HP must demonstrate benefits in other sectors

Identify 'win-win' opportunities

Hydrological risk must be assessed:

- climate change
- other water users
- changes in water use/priority
- environmental flow
- reservoir establishment upstream





Planning the water resources:

**A challenge with many and big
uncertainties**

**Robust Methodologies & Tools
needed**

**Owens Lake,
California**