

# Co-developing integrative water-energy-food-ecosystems (WEF+) nexus scenarios

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Workshop on Accelerating Progress on the WEF E Nexus in Sub-Saharan Africa

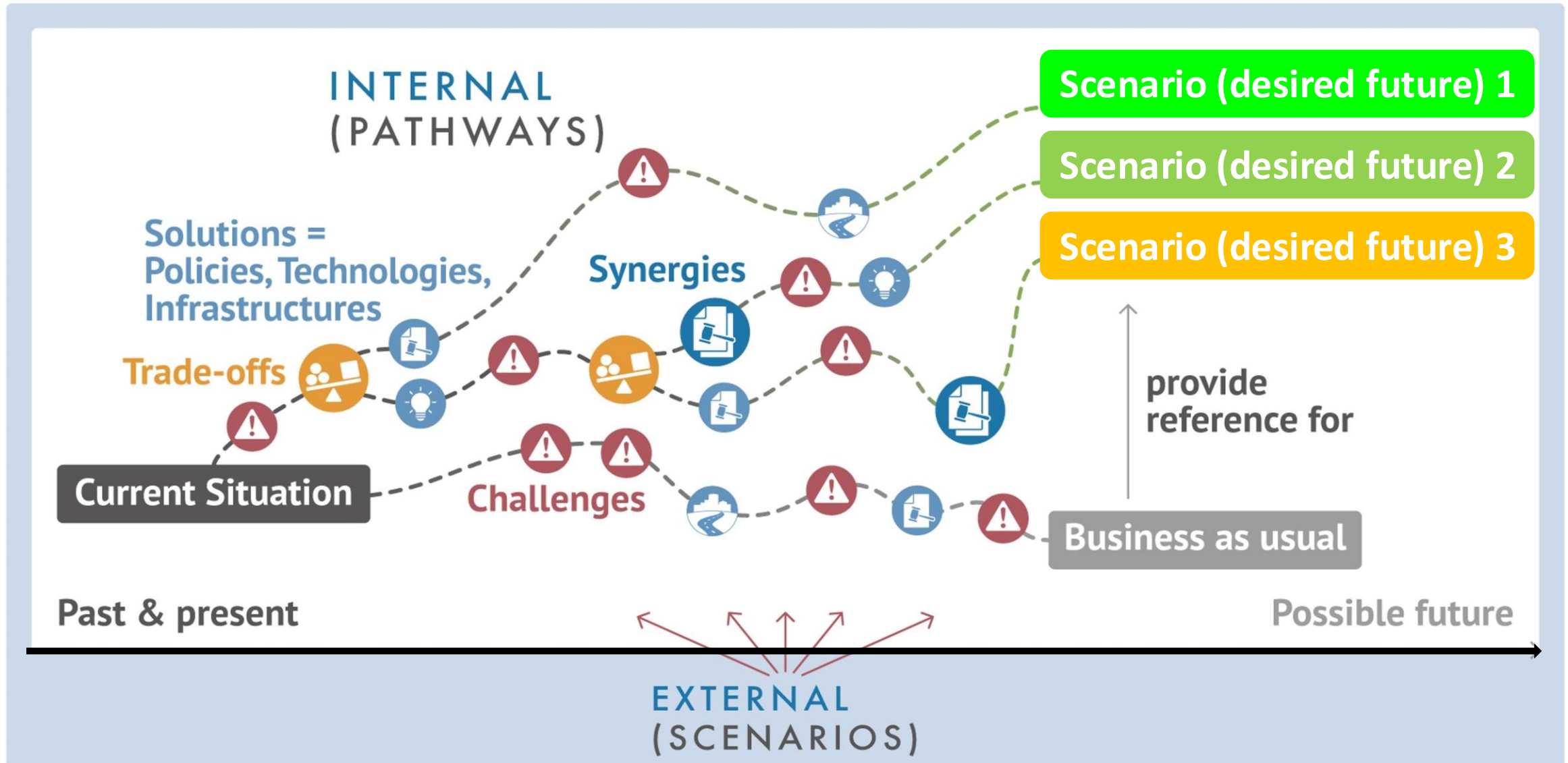
# Research Outline

- ❑ WEF+ nexus scenario planning: Background
- ❑ Planning WEF+ nexus scenarios: Framework and guidelines
- ❑ Decisions informed by WEF+ nexus scenarios

# WEF+ nexus scenario planning: Visioning the future

- ❑ **Scenarios** – coherent combinations of quantitative **pathways** and qualitative **storylines** of the possible future (alternative) state of the world.
- ❑ **Pathways** – trajectories of future conditions that describe a single component, for example alternative strategies.

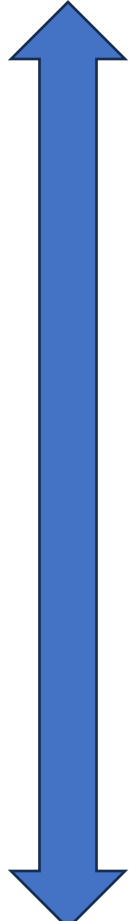
# Scenarios & pathways (IIASA)



# Scenario typologies vs. principal questions about the future

Principal questions	Scenario typologies
What will happen?	<ul style="list-style-type: none"><li>• Predictive scenarios: eliciting probable futures.</li><li>• Based on current trends or ongoing changes.</li></ul>
What can happen?	<ul style="list-style-type: none"><li>• Explorative scenarios: situations of significant uncertainty.</li><li>• Creative thinking and 'out of the box': imagine possible surprises.</li></ul>
How can we get there?	<ul style="list-style-type: none"><li>• Normative scenarios: achievement of a vision - targets to be achieved, outcomes to be avoided, impacts to be reduced.</li><li>• Usually in the centre of interest for most stakeholders.</li></ul>

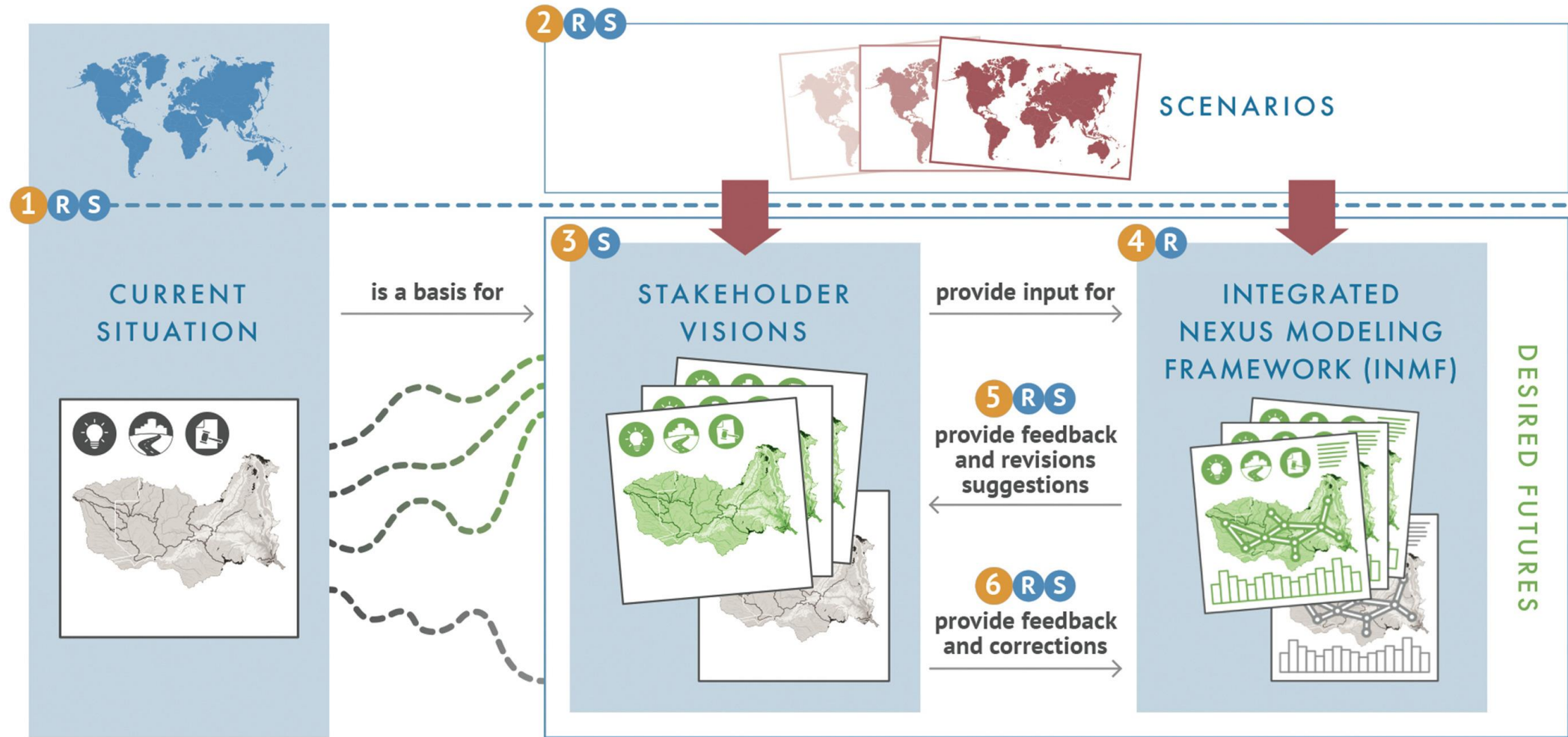
Potentialities



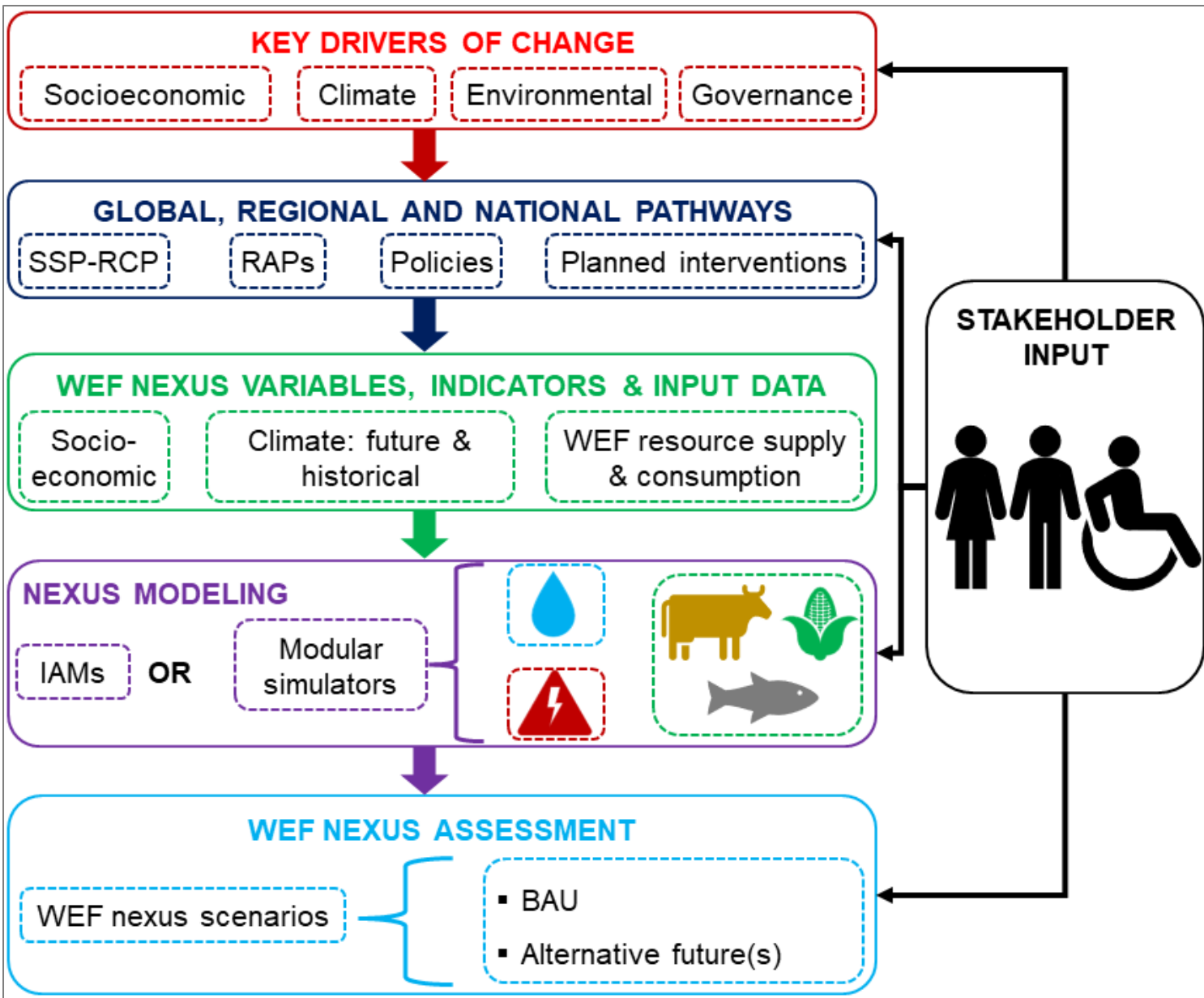
Setting a positive direction

# Co-planning WEF+ nexus scenarios (IIASA)

R Researchers  
S Stakeholders

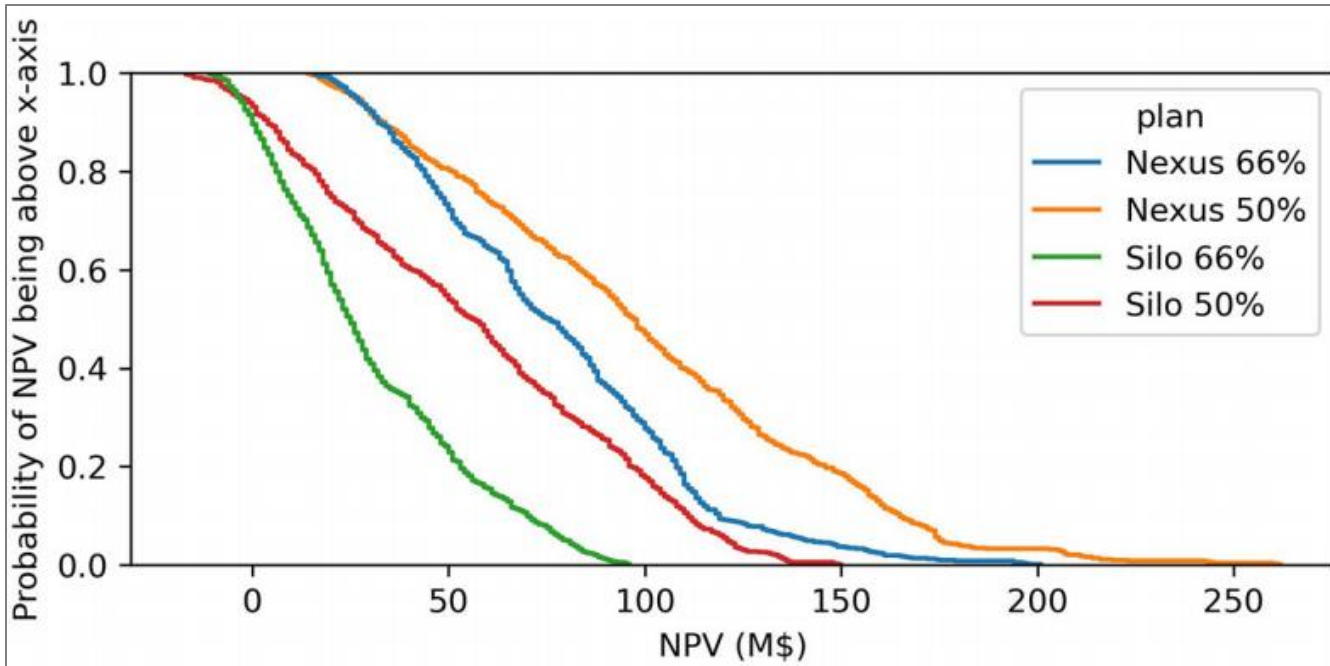


# A generic people-centred and data-driven methodological framework for co-planning integrative WEF nexus scenarios



# Scenario planning: WEF+ investment planning (e.g., infrastructure) under uncertainty

(Payet-Burin et al., 2021) [Zambezi River Basin]



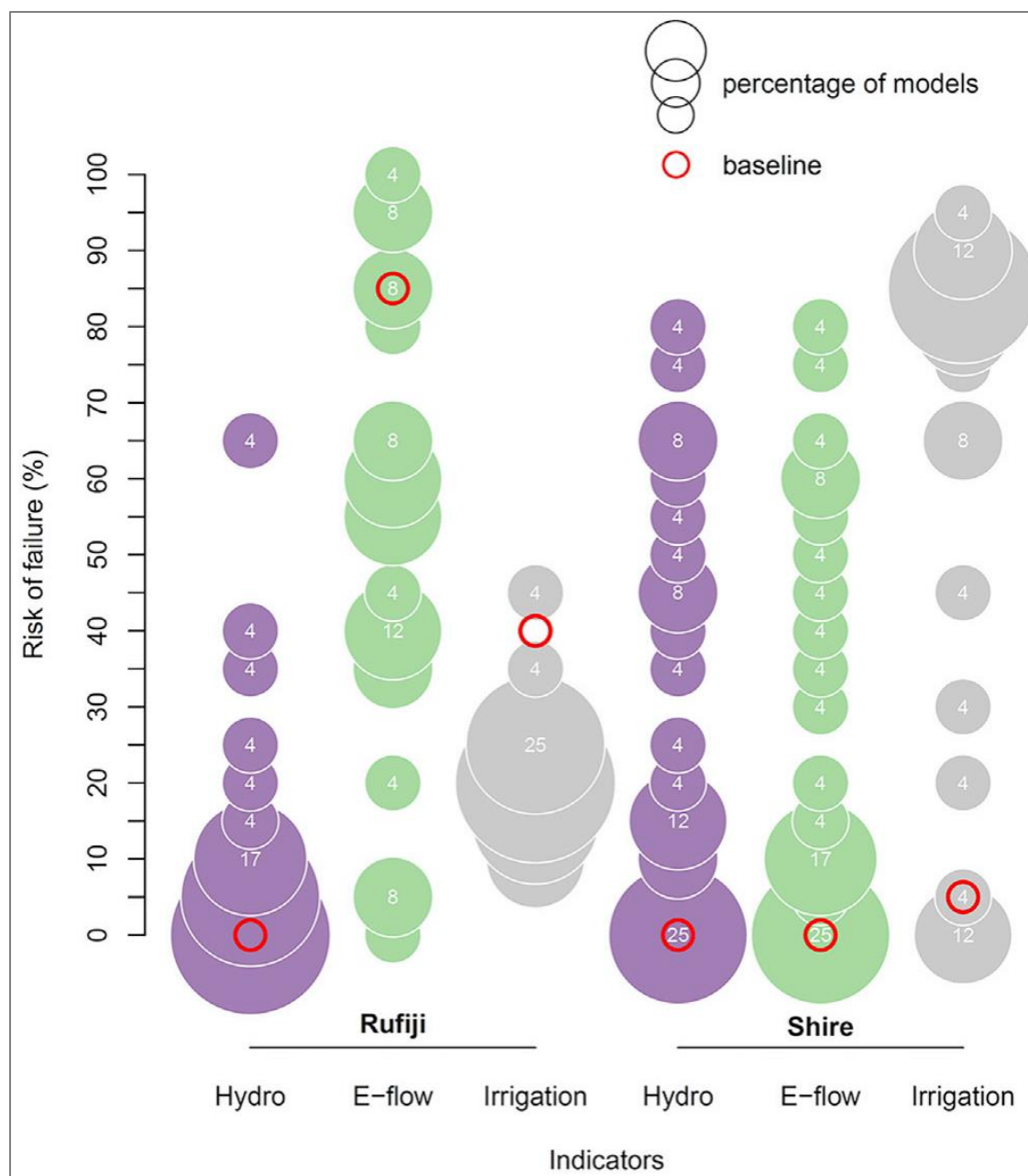
Aggregated investment	Nexus	Silo	Difference
Irrigation (1,000 ha)	670	819	22%
Reservoir (Mm <sup>3</sup> )	4,326	4,632	7%
Hydropower (MW)	3,190	3,426	7%
Transmission (MW)	3,857	3,889	1%
Renewable (MW)	26,680	26,453	-1%
Thermal (MW)	4,607	4,365	-5%
Renewable SA (MW)	72,226	72,339	0%
Thermal SA (MW)	8,035	8,067	0%

*SA stands for South Africa and is differentiated from the other countries.*



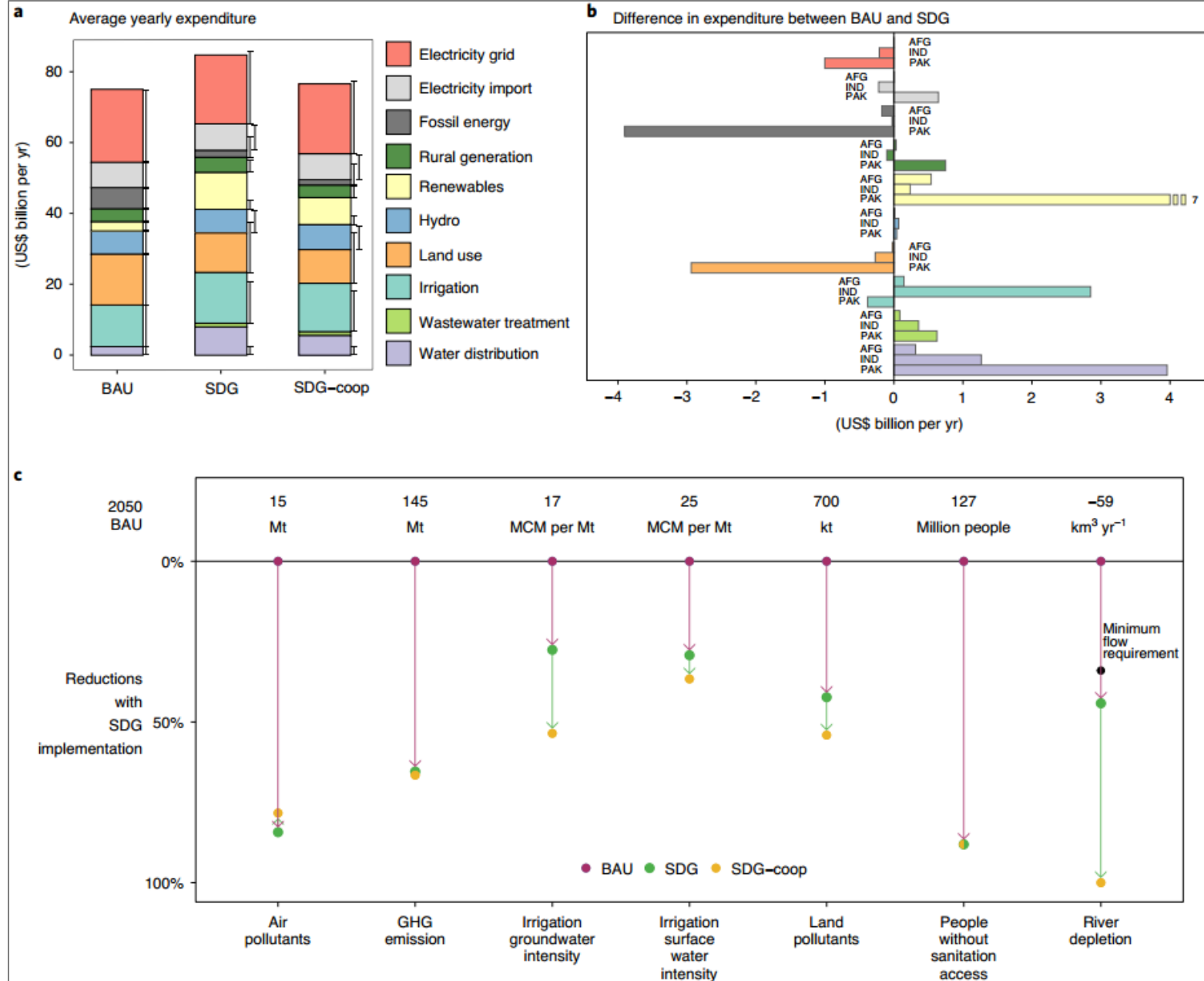
# Scenario planning: Developing robust and resilient WEF+ infrastructure under climate change

(Siderius et al., 2021) [Rufiji River in Tanzania and Lake Malawi-Shire River Basin in Malawi]



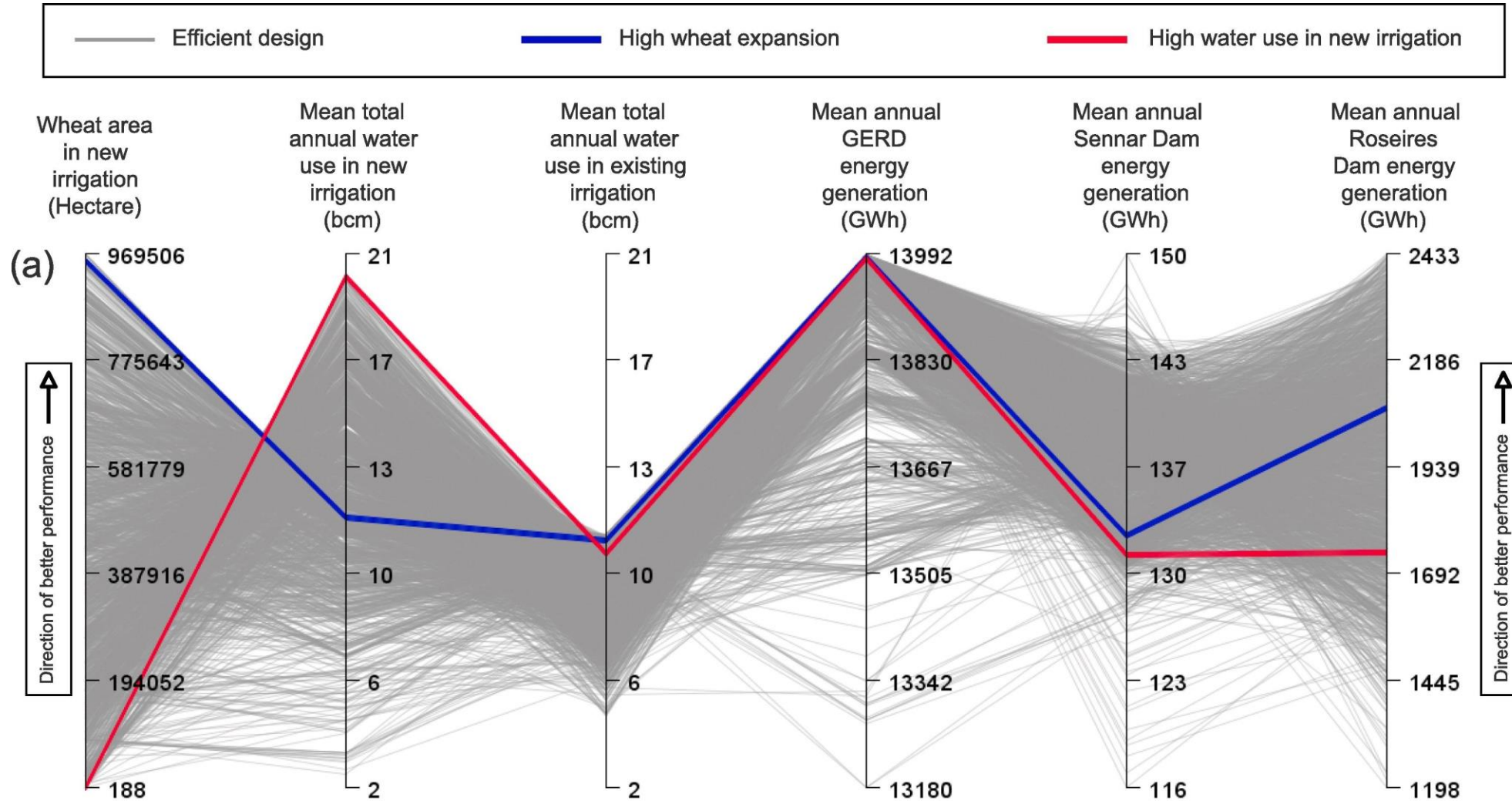
# Scenario planning: Optimising WEF+ multi-sectoral and cross-country investments in transboundary basins

- ❑ Integrated international cooperative WEF planning in Indus Basin (Afghanistan, Pakistan, India) could:
  - lower costs for development,
  - reduce soil pollution,
  - water stress,
  - accrue economic gains (Wada et al., 2019; Vinca et al., 2020; Vinca et al., 2021).

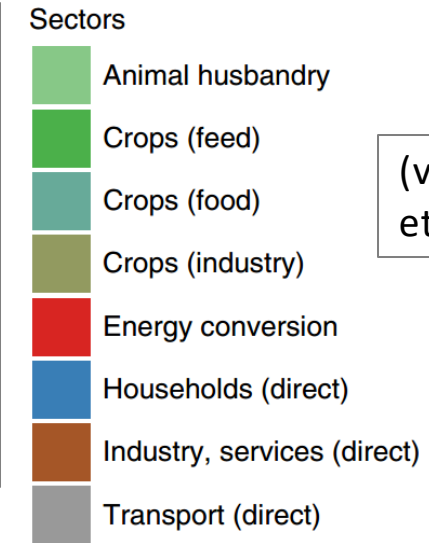
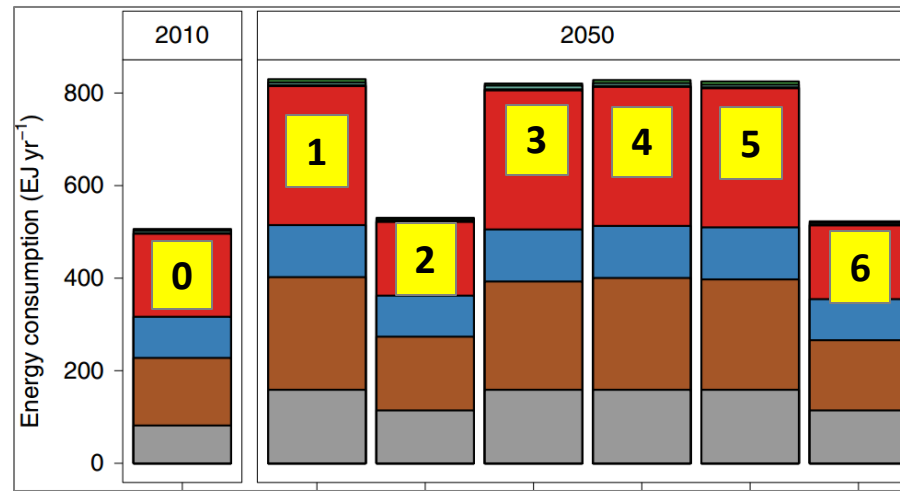
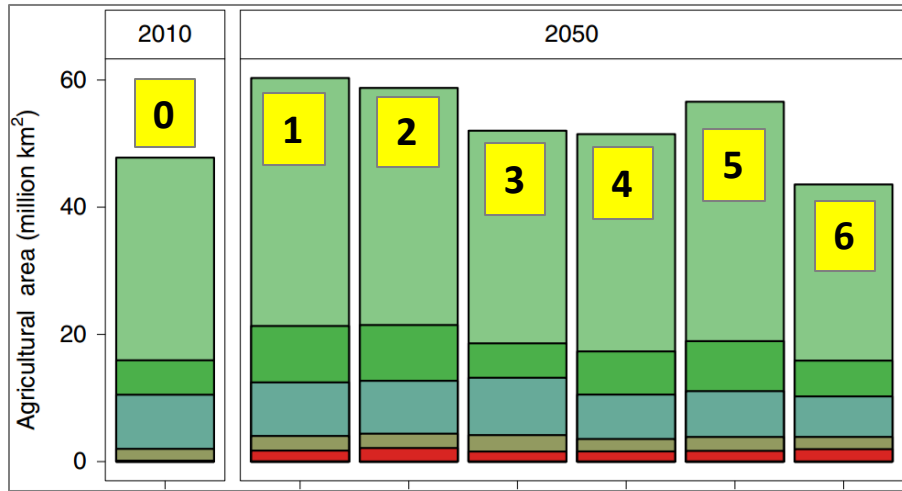


# Scenario planning: Optimising shared **WEF+** benefits through cooperation in transboundary basins under resource competition

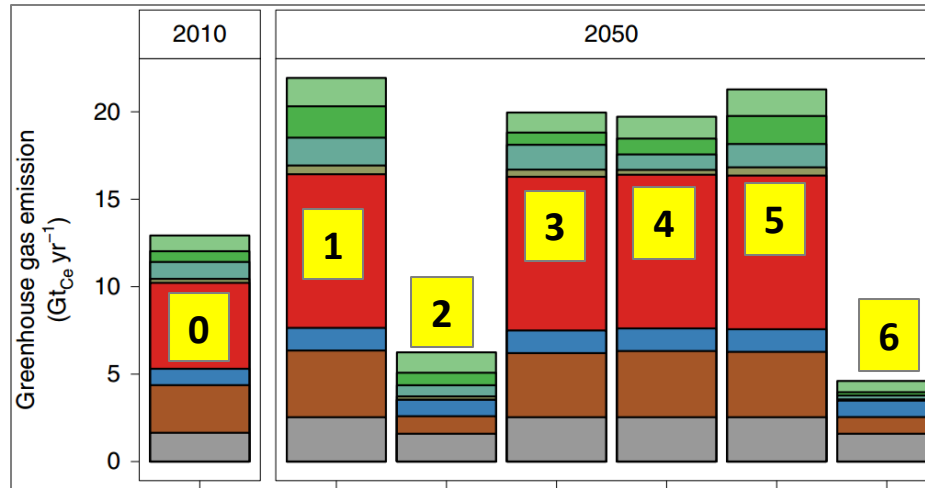
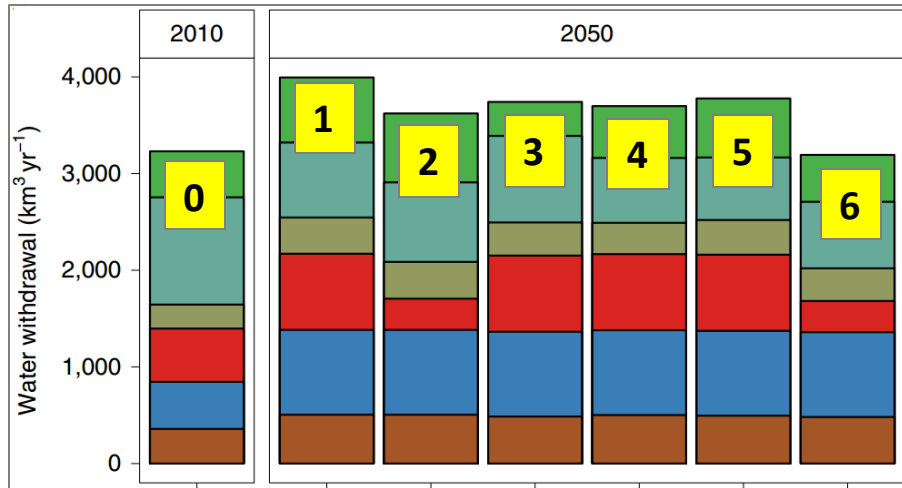
► Designing efficient **agricultural (irrigation)** and **dam operation (Grand Ethiopian Renaissance Dam [GERD], Sennar and Roseires)** portfolios considering national (**Ethiopia, Sudan**) and sectoral priorities in Blue Nile Basin (Basheer et al., 2024)



# Scenario planning: Formulating WEF+ response strategies and policies



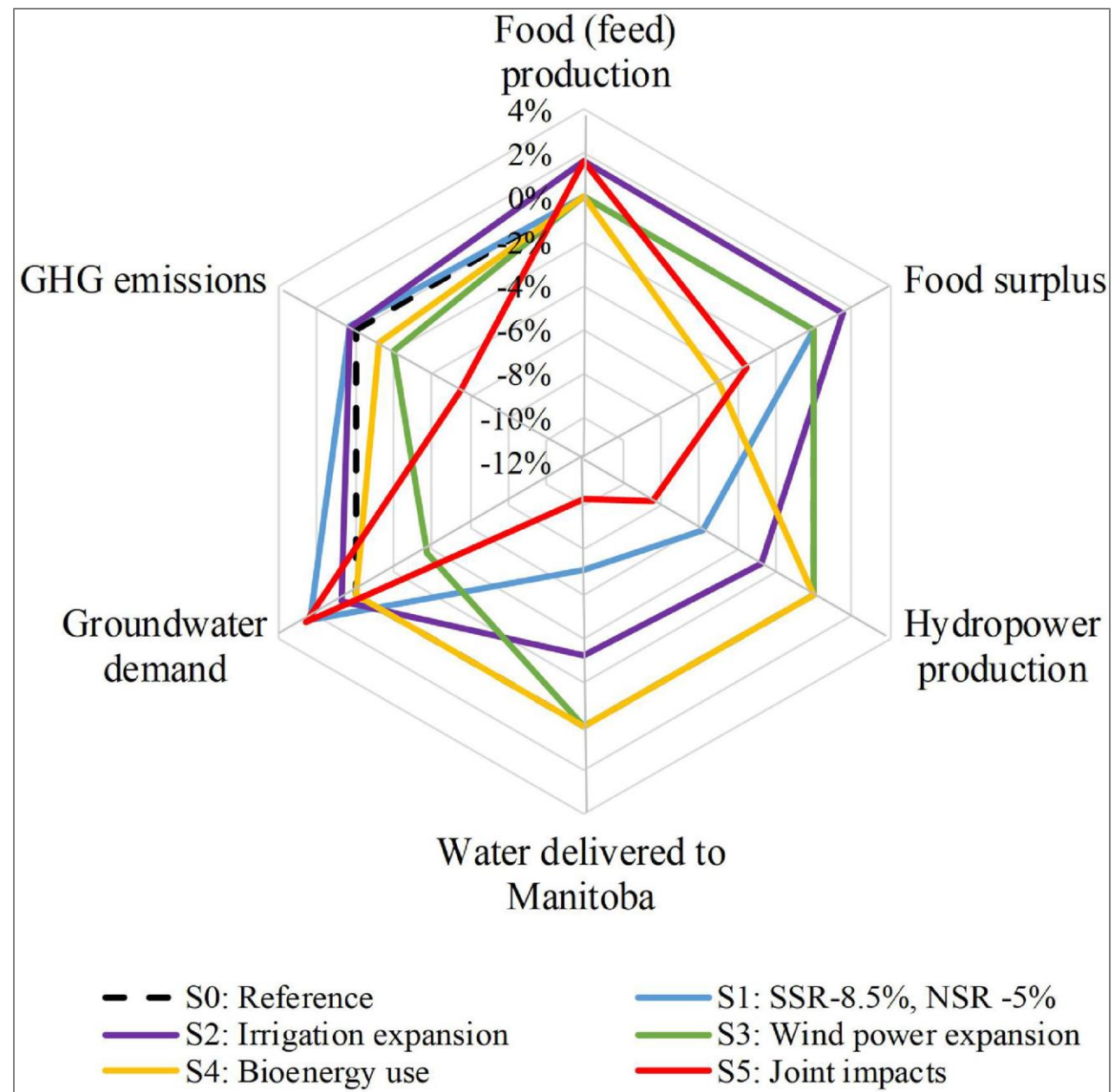
(van Vuuren et al., 2019)



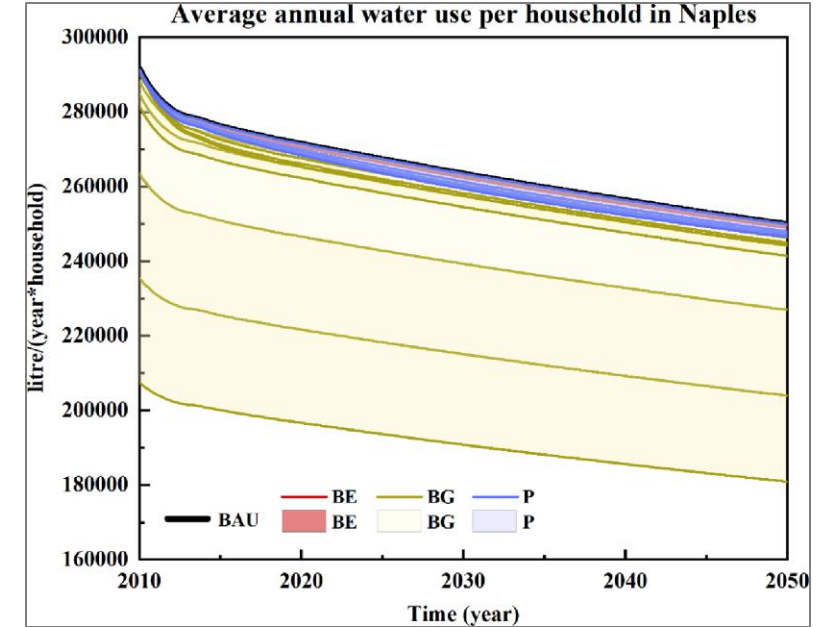
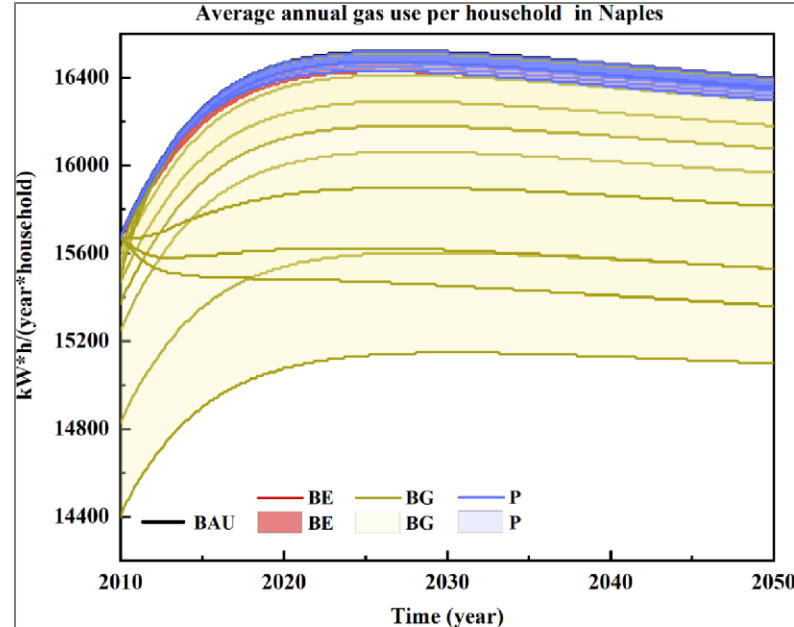
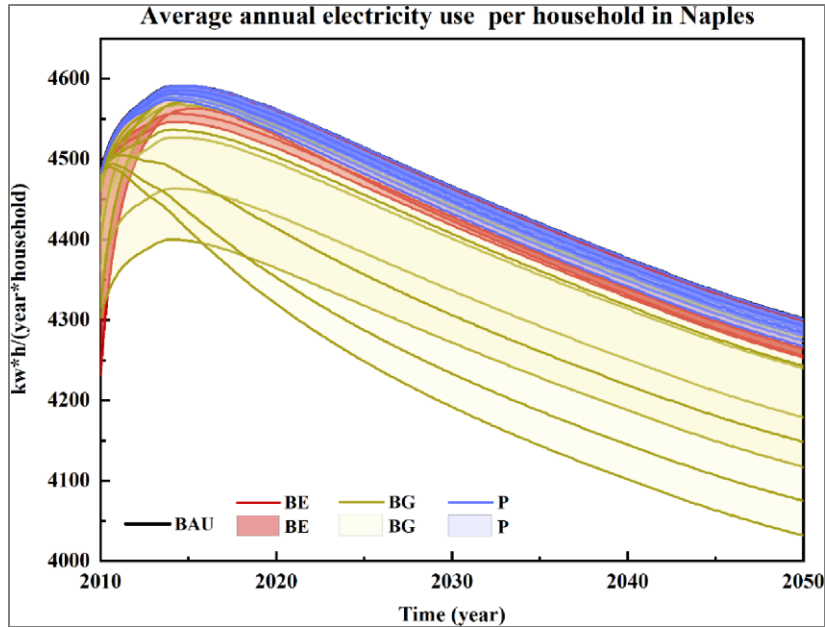
- 0. Reference scenario.
- 1. Reference scenario.
- 2. Climate policy only.
- 3. Less meat-intensive diets.
- 4. Increased yields and feed efficiency.
- 5. Food waste reduction.
- 6. Illustrative response scenario

# Scenario planning: Exploring WEF+ technical adaptation and mitigation strategies

(Wu et al., 2021) [Saskatchewan, Canada]

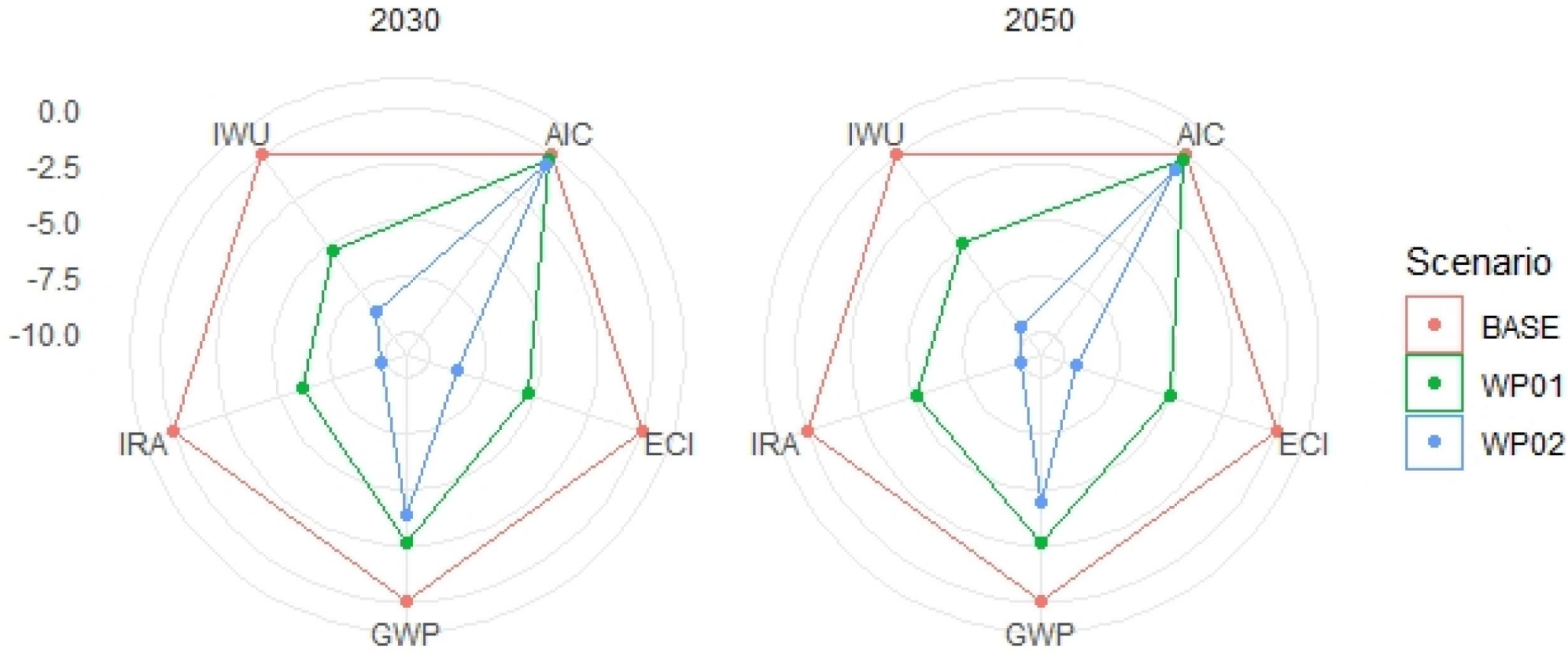


# Scenario planning: Managing **WEF+** resource consumption through policies and strategies: pricing, communication and education



(Casazza et al., 2021) [Napoli, Italy]

# Scenario planning: Managing WEF+ resource consumption through policies and strategies: pricing

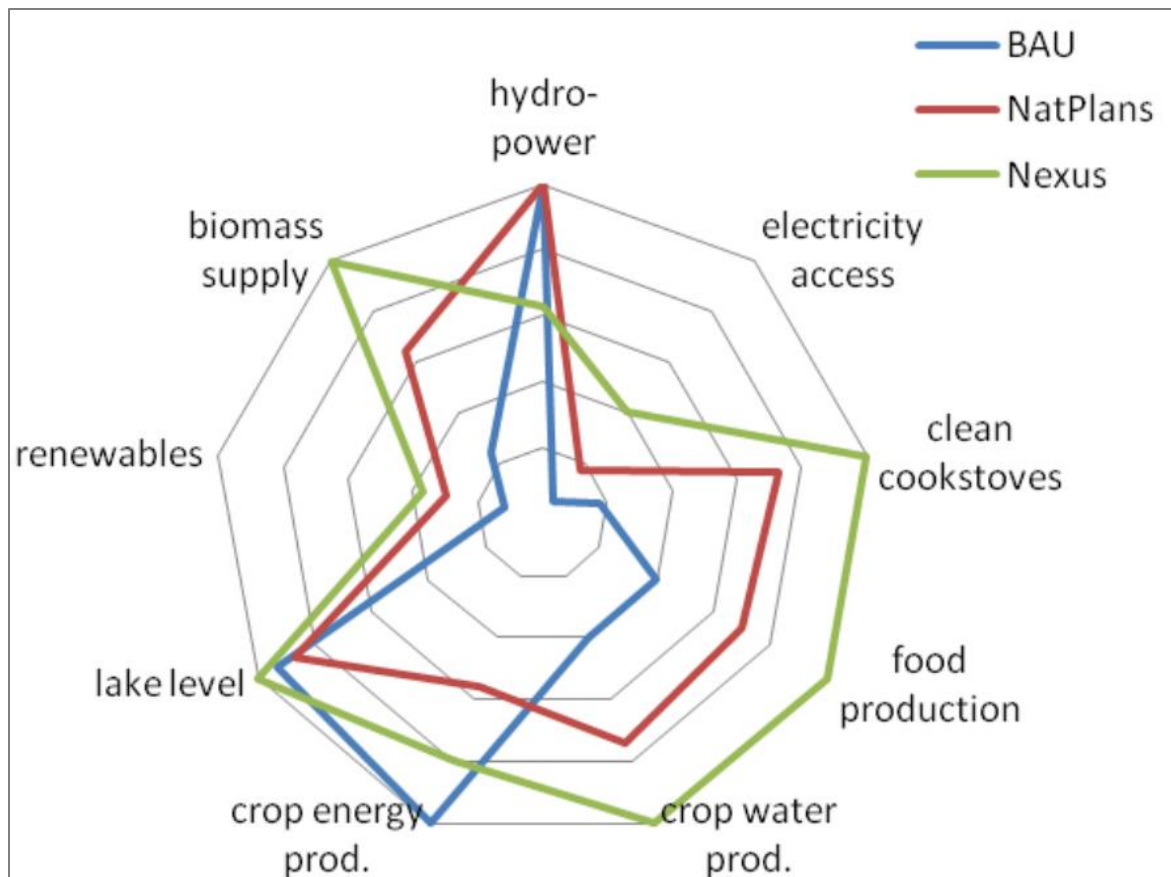


AIC: Average income from crops ECI: Energy consumption in irrigation  
 GWP: Crops global warming potential IRA: Irrigated area IWU: Irrigation water use

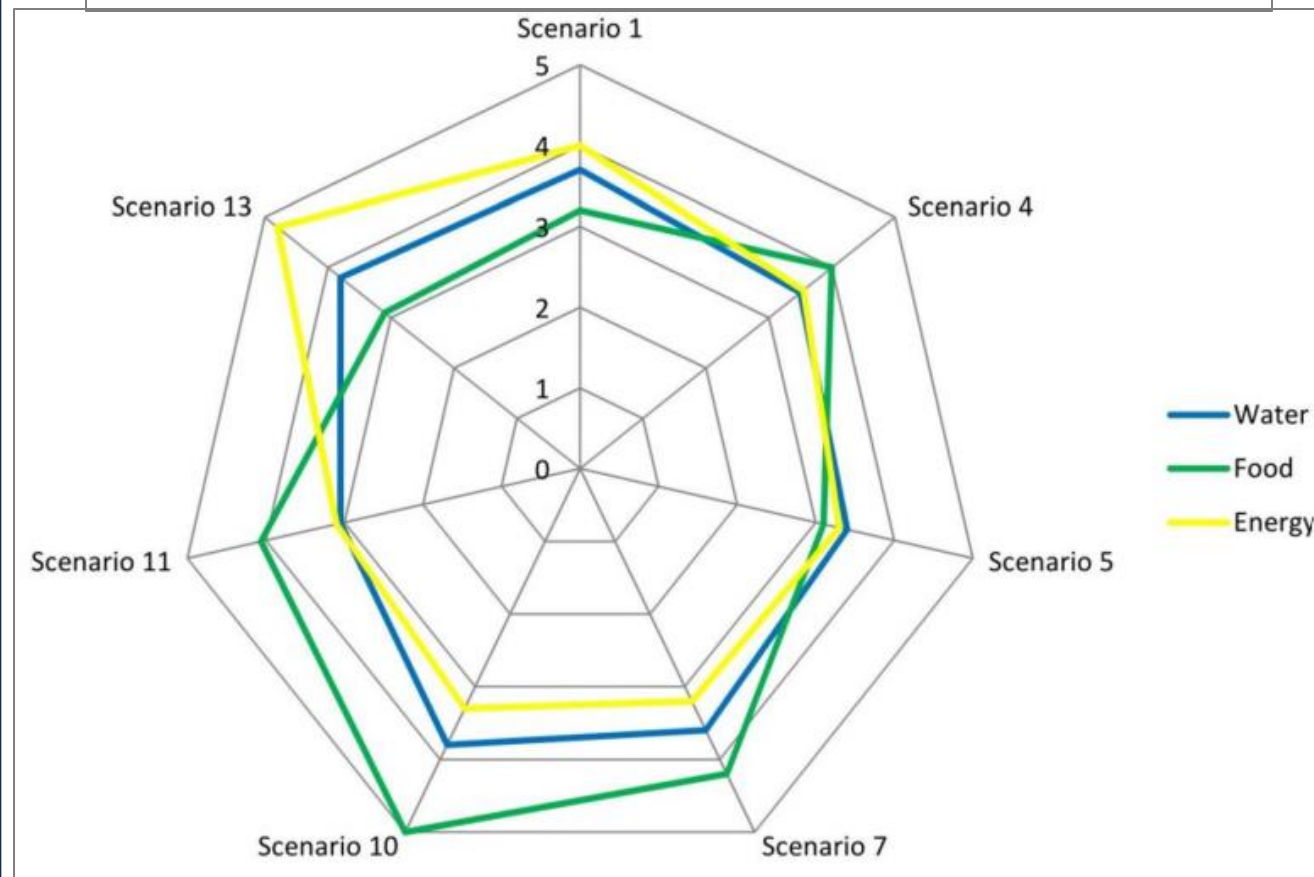
(González-Rosell et al., 2020)  
 [Andalusia, Spain]

# Scenario planning: Testing the effectiveness of implementing WEF+ policies

(Karlberg et al., 2015) [Mediterranean region]

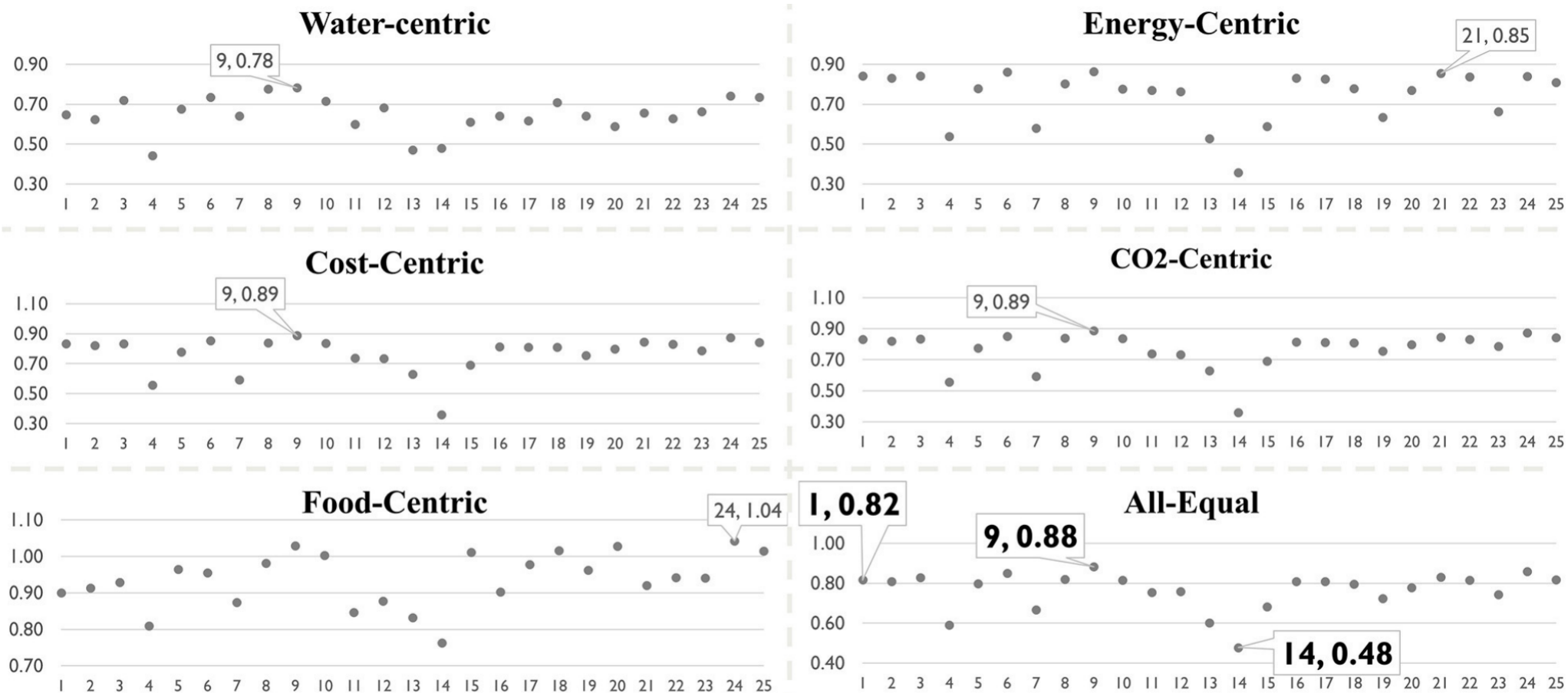


(Ghafoori-Kharanagh et al., 2021) [Yazd-Ardakan aquifer, Kavir-e-Siah Kuh watershed, Iran]





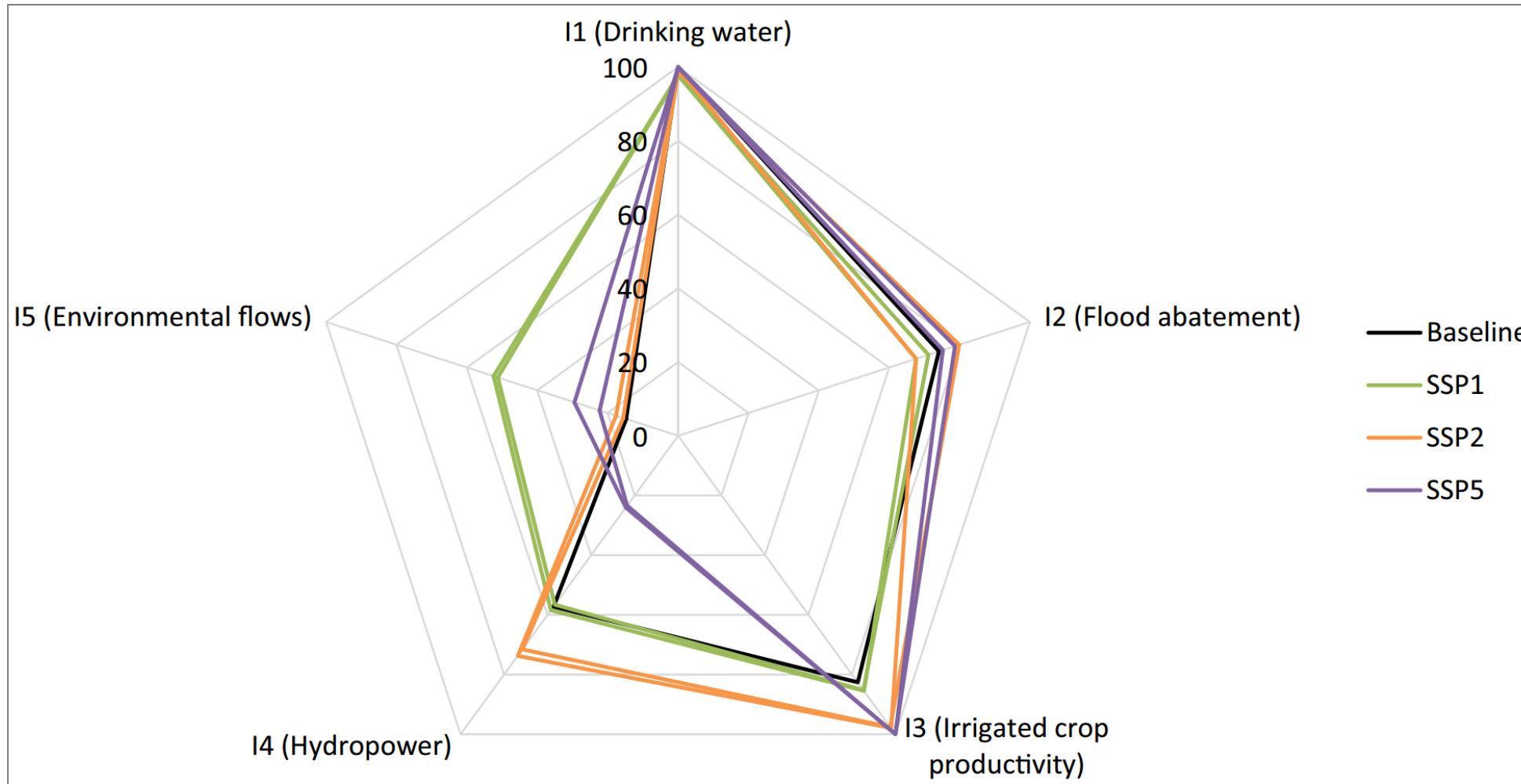
# Scenario planning: Testing WEF+ technology, innovation and investments



*x-axes represent scenarios while y axes are for sustainability indexes*

(Kulat et al., 2019) [Matagorda County, Texas]

# Scenario planning: Developing **WEF+** strategies for climate action and environmental integrity



(Momblanch et al., 2019) [Beas and Sutlej river basins in western Himalayas]

# Scenario planning: Integrated energy transition planning from a WEF+ nexus perspective

	Scenario 1: Reference - 2015	Scenario 2: CPP & Energy Reference - 2030	Scenario 3: No CPP & Energy Reference - 2030
<b>Energy Production</b>	165 Billion Gal <b>Water Consumption</b>	6% <b>Water Consumption</b>	13% <b>Water Consumption</b>
	400 Million Tons <b>Carbon Emissions</b>	35% <b>Carbon Emissions</b>	35% <b>Carbon Emissions</b>
	5,883 km <sup>2</sup> <b>Land Use</b>	4.5% <b>Land Use</b>	4.5% <b>Land Use</b>
	83,218 Million USD <b>Revenue</b>	3% <b>Revenue</b>	3% <b>Revenue</b>
<b>Electricity Generation</b>	105 Billion Gal <b>Water Consumption</b>	5% <b>Water Consumption</b>	16% <b>Water Consumption</b>
	3,678 Billion Gal <b>Water Withdrawal</b>	35% <b>Water Withdrawal</b>	12.5% <b>Water Withdrawal</b>
	179 Million Tons <b>Carbon Emissions</b>	0% <b>Carbon Emissions</b>	20% <b>Carbon Emissions</b>
	85 km <sup>2</sup> <b>Land Use</b>	143% <b>Land Use</b>	58% <b>Land Use</b>
	1,745 Million USD <b>Cost</b>	18% <b>Cost</b>	18% <b>Cost</b>

(Mroue et al., 2019)  
[Texas, USA]

**GREEN** Positive Impact  
**RED** Negative Impact



Thank you!



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