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Knowledge Forum on Water Security and Climate Change: Innovative solutions for sustainable water resources management

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Middle of the Road scenario

- 33% more people by 2050 compared to 2010 globally (6.8 billion to 9.1 billion)

Population in [billion]
GDP [1000 billion US$/yr]
GDP per cap (PPP) in [1000US$/cap/yr]

Africa
Pop: 1.0 to 2.0  2 times more
GDP: 2.8 to 19.2  7 times more
GDP pc: 2.7 to 9.5  3.5 times more

Asia
Pop: 4.1 to 5.1  1.3 times more
GDP: 26 to 123  5 times more
GDP pc: 6.2 to 24.1  4 times more
Water demand in Asia region, by sector (km³/yr).

Asian total water demand in the 2010s is about 2410 km³/year and will be 3170 - 3460 km³/year (increase 30 - 40%) under the three scenarios.

Satoh et al. (2017; Earth’s Future)
UN SDGs and Water-Food-Energy Nexus

Dalin, Wada et al. (2017; Nature)
The Nexus Challenge

What are sustainable and synergistic solution portfolios that fulfill both human and environmental resource needs under global change?
Nexus Integration towards SDGs

Enhanced water assessments

- Land use/cover
- Crop area/type
- Irrigation area
- LAI
  (・Shadow price of water ?)

Improved analysis feedbacks

- Electricity production
- Energy futures/options
  - Technical innovation
    - Temperature?
    - Quality?

Available water
- river discharge
- Variability/Risk
  - Supply costs
    - impacts

- river discharge
- groundwater
- risk/variability
  - soil moisture
  - impacts of use
Innovative Resource Analysis
IIASA Community Water Model
Innovative water supply analysis
High resolution hydrological modeling with local calibration
Future Groundwater Sustainability – how much pumping unsustainable [Fraction; 0.5 = 50%]

Current (left) vs Future SSP2 with Climate Change (below)
Energy intensity of water supply options

Global hotspots analysis

- Preliminary analysis

- Final analysis
We present six strategies, or water-stress wedges, that collectively lead to a reduction in the population affected by water stress by 2050, despite an increasing population.

- Water productivity – crop per drop
- Irrigation efficiency – decrease losses
- Water use intensity – industry and domestic
- Population
- Reservoir storage
- Desalination

Wada et al. (2014), Nature Geoscience
Hydro-Economic framework for investment options

Key features represented in the model:

**Drivers:** Demand growth; Resource availability; Climate change; etc.

**Processes:** Reservoir management; Irrigation use; Electricity generation; Water pumping; End-use efficiency; Wastewater treatment; etc.

**Impacts:** Prices; Demands; Emissions; Water quality; Environmental flow; Groundwater depletion; Resource security; etc.

**Decisions:** Extract resources; Operate infrastructure; Expand infrastructure; Trade resources
### Assessment of adaptation measures: technical potential and costs

<table>
<thead>
<tr>
<th>Supply enhancement</th>
<th>Demand management</th>
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<tbody>
<tr>
<td>- Build/enlarge dams</td>
<td>- Efficient irrigation technologies</td>
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<tr>
<td>- Rainwater harvesting</td>
<td>- Efficient domestic water appliances</td>
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<tr>
<td>- Drill/improve wells</td>
<td>- Energy cooling technologies</td>
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<tr>
<td>- Reuse of wastewater</td>
<td>- Better crop management</td>
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<tr>
<td>- Desalination</td>
<td>- Diet change</td>
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<tr>
<td>- Reprogram reservoir operation</td>
<td>- Food loss reduction</td>
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<td>- Inter-basin transfer</td>
<td>- Improving education</td>
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<td>- Controlling population growth</td>
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Inclusive development & climate policies are key to reduce risk of hunger for simultaneous achievement of SDG 2 (hunger) and 13 (climate).
Policy scenarios

Three policy scenarios:

1/ Business as usual (BAU): SSP2-RCP6.0 + no constraint on groundwater use

2/ Sustainable groundwater use policy (SGW): limiting groundwater use to renewable resources by 2050

3/ Sustainable groundwater use and virtual water trade policy (TRADE): limiting groundwater use to renewable resources by 2050 and substituting 5% of domestic production of crops by food imports

Case study area

Test case: Mediterranean South Coast basin

Water scarcity and Groundwater depletion problem: pumping in 2010 ≈ 6 km³, renewable resources ≈ 4.8 km³ (depletion ≈ 1.2 km³/year)
Optimal allocation of resources under each scenario

Preliminary results

Groundwater use (Km³)

GW policy

Preliminary results
Adaptation: Cost implications

NPV of costs (Billion $)

-6% with +5% Trade

0.5 billion $/year
≈ 0.1% of GDP
Next steps: Scenario analysis of adaptation pathways

Quantitative SDG targets

- Population with improved access and treatment
- Increase water efficiency
- Reduce population living in water scarcity

Basin-scale assessment tools

Infrastructure pathways and investments
How to bridge the gap?

Scenario Developers

Scenario Users
IIASA - RESEARCH FOR A CHANGING WORLD