Integrated Solutions for Water, Energy and Land

Technical Meeting, 16 April 2019, UNIDO headquarters

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Michiel van Dijk
“Integrated Solutions for Water, Energy, and Land” (ISWEL) Project

2017-2019

Develop tools and capacities that can support the management of the water-energy-land nexus at global and regional scales

Partners: IIASA, GEF, UNIDO

GEF Contract Agreement: 6993
Context

• Up to 2 billion more people by 2050
• Need to produce 70 percent more food
• For access to energy to be universal energy generation needs to double
• With increasing energy and food needs water demands are expected to rise by 55 percent
• Up to 40 percent of the world's population will live in severe water stressed regions
• The development of this very uneven in different geographies and different development trajectories
• This all set in context of increasing variability from CC
Population and Development continues

Middle of the Road scenario

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

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Population in billions, GDP in 1000 billion US$ per year, and GDP per capita in 1000 US$ per capita per year.
NEXUS THINKING

Food/Land Use System
- Preparing land
- Growing crops
- Raising livestock
- Harvesting produce
- Drying, processing
- Storing food products
- Transport, distribution
- Preparing food

Energy System
- Extracting resources
- Harnessing hydro, wind, solar, biomass energy
- Generating and transmitting electricity
- Production, refinement and distribution of transport fuels
- Storing, buffering

Hydropower, power plant cooling, extraction, (bio)fuels

Water System
- Manage renewable surface- and groundwater resources
- Distribute water supply for human consumption
- Collect sewage
- Treat wastewater to protect human and ecological health
- Transfer between basins
- Desalination

Water pumping, delivery, water treatment, energy for desalination

- Fertilizer, irrigation, fuel, processing, transportation

- Irrigation, food processing, sanitation, health risk

- Runoff, pollution, storage, purification, flood protection

Energy/Food/Water Nexus
Nexus model Integration towards SDGs

Improved analysis feedbacks

- Technical innovation
- Electricity production
- Energy futures/options

MESSAGE

Energy

GLOBIOM

Env.

Community Water Model

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

- Available water
- river discharge
- groundwater
- risk/variability
- soil moisture
- impacts of use

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

- Technical innovation
- Electricity production
- Energy futures/options
Multiple scenarios: Developing narratives of the future

SSP1: The world is moving toward sustainability

SSP characteristics
- Improved resource use efficiency
- More stringent environmental regulations
- Rapid technological change is directed toward environmentally friendly processes
- Management of global commons improves.

Implications for Manufacturing Water Use:
- Manufacturing industries with efficient water use and low environmental impacts are favored.
- Enhanced treatment, reuse of water, and water-saving technologies;
- Widespread application of water-saving technologies in industry.
ISWEL Timeline

Development System Analysis Tool

Exploring Nexus Solutions

Engagement, Capacity Building & Dissemination

Project Management

Co-design of Scenarios and Development Pathways

Methods & Tools

2 Basin nexus tools

Fast-track assessment

Global Solutions for SD6

Identification Nexus issues

Case Studies

Indus 1RM

Stakeholder Engagement & Capacity Building

Zambezi 1RM

20 Scientific Conferences

5 HLP

20 Scientific Conferences

8 HLP

1 Policy Brief

6 peer review papers

1 YSSP & 2 VR 2019

1 YSSP & 2 VR 2019

1 Policy Brief

6 peer review papers

PR 1

PR 2

PR 3

FR

Identification Nexus issues

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PR 1

PR 2

PR 3

FR

Abbreviations:
RM: Stakeholder regional meeting
CB: Capacity Building
PSC M: PSC meeting
Outcomes, outputs and synergies

**Basins**
- IBKF
- Zamcom WEF strategy
- (SA, SADC, AMCOW)

**Globally**
- IPCC
- Int. Waters GEF
- World Bank

**Knowledge base and capacity building**
- Research meetings/conferences: 20
- Research papers: 6
- Training events: 4
Insights and messages for implementation

At global level
  • Spatial concentration and driven by socio economic drivers
  • Reducing exposure / vulnerability = inequality / poverty

At basin level
  • Trade-offs between sectors and risks under diff. SSP
  • Frameworks needed to build pathways and capacity
  • Stakeholder scenario development tool provides method to identify specific issues and ownership
  • Significant interest other basins for tools and methods
Global hotspots assessment and explorer tool
A flexible global vulnerability hotspots framework

Understanding the underlying challenges
i. multiple development-climate pressures across multiple sectors
ii. Impacting vulnerable people, and/or large populations
iii. i + ii = vulnerability hotspots

...from multiple perspectives
Global
IPCC regions
River basins
Countries

Dissemination, building capacity and increasing impact
• Development funders and knowledge institutions
• Practitioners and stakeholders
• From scientist... to student

• Answering diverse questions
• Sectoral assessment and comparison
  • Subset indicators and sectors
• Low income, high vulnerability and the low-latitude nexus
• Climate extremes and hydroclimate complexity
• Rural and urban, drivers of migration
• MEAs (SDGs, Sendai, Paris, etc.)
ISWEL: Global analysis of vulnerability hotspots

Need 1.5°C to minimize risks to all

Need targeted poverty reduction to reduce vulnerability

Byers et al. (2018, ERL)
IPCC (2018, Ch3.)
Avoided impacts of 1.5°C*

* In the 2050s

Byers et al. (2018, Environmental Research Letters)

But climate and development scenario uncertainties are considerable... and vary from place to place
Hotspots basin analysis

Large distributional differences across the world

Zambezi river basin

Indus river basin
Basin & country scale exposure

Which **basins** have most people exposed and vulnerable, *in absolute numbers*?

Which **countries** would benefit most from targeted poverty and vulnerability reduction and adaptation assistance?

**Top 20 basins exposed and vulnerable in 2050**

**Top 15 countries exposed and vulnerable in 2050**

*Poverty & vulnerability reduction (SSP1 ↔ SSP3)*

Ranked by **E&V 2.0**

Ranked by Δ SSP 3-1
Break-out example: South Africa

Water risks already prominent (1/3rd of population)

Higher global warming:
• exposes most of the population to energy risks (cooling & heat stress)
• Up to 2/3rds population exposed to water risks
Dissemination and impact

Published outputs and reach

- Paper in Environmental Research Letters (7000+ downloads)
- IIASA Annual Report, Options Magazine
- IIASA press releases & social media
- Policy Brief

Interactive impacts of climate change at 1.5°C, 2.0°C and beyond

Conferences & events

Scientific conferences
- Impacts World 2017
- Integrated Assessment Modelling Consortium 2017, 2018
- International Energy Workshop 2018
- European Geosciences Union 2018, 2019
- American Geophysical Union 2018 (x2 invited talks)
- Asian Energy Modelling Workshop 2018 (invited)
- Scenarios Forum 2019

Science-policy fora
- COP 23
- World Water Forum 2018
- GEF 6th Assembly STAP
- GEF/ World Bank seminar
- US Department of Energy / EU JRC workshop
Global hotspots explorer

- State-of-the-art online data exploration tool
- Easy to use with layered complexity – from scientist to student
- Dynamic with range of perspectives (zoom global to basin)
- Pop-out data selection, comparison and export
- Customizable dashboards and maps
- Education and dissemination
  - Indicator, sectoral and multi-sector analysis
  - Global, regional and basin comparisons
  - Socioeconomic scenario comparison

Global hotspots explorer

Explorer view primarily defined by only being able to see one scenario at a time...
Two recent similar examples

Gridded Dataset for Electrification in sub-Saharan Africa

IAMC 1.5°C Scenario Explorer

https://data.ene.iiasa.ac.at/kolp/GDESSA/gdessaDataset.html

(draft – do not distribute)

https://data.ene.iiasa.ac.at/iamc-1.5c-explorer
Next steps for 2019

Global Hotspots Explorer website
Publications on:
• Hotspots & river basins
• Hotspots and extreme vulnerabilities
• Climate-development sensitivities and uncertainties

Questions?!

Global exposure and vulnerability to multi-sector development and climate change hotspots


http://www.iiasa.ac.at/web/home/resources/publications/IIASAPolicyBriefs/pb21-web.pdf
Basin Assessment
Outputs and outcomes

- Two types of tools to address WEL nexus development challenges
  - Regional basin planning model (policy optimization IAM)
  - Policy exercise to develop stakeholder visions and pathways
- Stakeholder informed scenarios
- Enhanced capacities for nexus management and research
Stakeholder Engagement

Barbara Willaarts, Project Officer & Research Scholar
Stakeholders

INDUS

ZAMBEZI

Republic of Angola
Ministério da Energia e Águas

Malawi Government
Ministry of Agriculture
A Smart And Value-Centered Public Service

Ministry of Land Reform

Republic of Pakistan
Ministry of Science and Technology

IDRC

CRDI

ICIMOD

Ministry of Energy & Water

WAPDA

Water and Power Development Authority

Pakistan Business Council

The Pakistan Business Council

US Agency for International Development

USAID

Pakistan Institute of Engineering and Applied Sciences

CRIC

LEAD Pakistan
Inspiring leadership for a sustainable world

TIFAC

Technology Innovation Fund

Government of Khyber Pakhtunkhwa

Government of Pakistan

Ministry of Planning and Reform

Planning and Development Department

Ministry of Land Reform

Ministry of Energy and Water Development

Malawi Government

Ministry of Agriculture
A Smart And Value-Centered Public Service

Republic of Zambia

Ministry of Energy and Water Development

Ministry of Land Reform

Republic of Zambia

Ministério da Energia e Águas

Republic of Angola
Participatory Scenario Development process
HOW TO BRIDGE THE GAP?

MODELs SCENARIO DEVELOPERS SCENARIO USERS DECISIONs
Stakeholder visions and pathways
Scenario Elements

Map

Cards

Indicators

- Runoff
- Precipitation
- Evapo-transpiration
- Water outflow (from the area)
- Land availability and demand
- Food production and demand
- Energy production and demand
- Population
Current Situation

STEP 1

- **Outflow**
- **Runoff**

INDUS RIVER BASIN

ELEVATIONS IN METERS:
- 4000
- 2000
- 1000
- 500
- 200

NATIONAL CAPITALS

CONFLICTS

WATERLOGGING

WATER STRESS

HABITAT DEGRADATION
STEP 2

Business as Usual Pathway

2018

2050
Indus visions and pathways

Economy pathway  Society pathway  Environment pathway
## From pathways to basin scenarios

<table>
<thead>
<tr>
<th>Sector(s)</th>
<th>Policy</th>
<th>Target (Economy)</th>
<th>Target (Society)</th>
<th>Target (Environment)</th>
<th>Model Represent.</th>
<th>Model Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to water clean water</td>
<td>100% in 2050</td>
<td>100% in 2030</td>
<td>100% in 2030</td>
<td></td>
<td>people connected to pipes</td>
<td>infrastructure costs and urban water demand</td>
</tr>
<tr>
<td>Water storage and supply</td>
<td>Development of large storage dams and interbasin transfers</td>
<td>Strategic large storage dams combined with small scale storage</td>
<td>Strategic storage dams; develop groundwater potential</td>
<td>Storage capacity</td>
<td>total storage capacity, min, max and actual level of reservoirs, storage investment costs</td>
<td></td>
</tr>
<tr>
<td>Conservation of water-related ecosystems</td>
<td>Economic water uses attended first</td>
<td>Securing environmental flows</td>
<td>Securing environmental flows + conservation of sensitive wetlands</td>
<td>Allocation prioritization, Restrict land use changes</td>
<td>Volumetric flow by sector (km^3), Share of wetlands protected (%)</td>
<td></td>
</tr>
<tr>
<td>Ensuring water quality</td>
<td>At least primary treatment of industrial and urban water</td>
<td>At least primary treatment of industrial and urban water</td>
<td>Secondary wastewater treatment and recycling; wastewater treatment and water pollutants</td>
<td>Investments in clean water technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood and drought management</td>
<td>Multipurpose-dam management; Joint surface and groundwater management</td>
<td>Multipurpose-dam management + Transboundary cooperation strategy</td>
<td>Multi-purpose dam management and NBS</td>
<td>Maximum river flows</td>
<td>Activity of river, canals and level of reservoir</td>
<td></td>
</tr>
</tbody>
</table>
Research design & progress

1. CURRENT SITUATION

2. SCENARIOS

3. STAKEHOLDER VISIONS
   - provide input for research models & analysis
   - provide feedback and revisions suggestions

4. RESEARCH MODELS & ANALYSIS
   - provide feedback and corrections

5. DESIRED FUTURES

R Researchers
S Stakeholders
Benefits of the policy tool

1. Well received by stakeholders (great buy-in)
2. Very flexible, can be adapted to explore a wide range of different challenges and pathways
3. It allows to generate sets of regional scenarios that are coherent with global storylines. Inter-comparability
4. Combined with IAMs, suitable for policy issue identification and measure development
Zambezi VIDEO
The Nexus Game

LUMS, Lahore, March 2018
IIASA Young Scientists Summer Program (YSSP)

Each year: 50 international students working under the supervision of IIASA staff

- 1 June - 31 August, in Laxenburg, Austria
- Open to advanced PhD. students whose research interests correspond to IIASA’s research
- Goal: publishable journal article
- Funding available from IIASA’s National Member Organizations
- On-line application (Oct – Jan) www.iiasa.ac.at/yssp
A framework for charting water-energy-land nexus solutions for the Indus basin

Adriano Vinca, Simon Parkinson, Edward Byers, Peter Burek and colleagues
UNIDO, Vienna, April 16 2019
International Institute for Applied Systems Analysis (IIASA)
Laxenburg, Austria
Water stress and other challenges

Challenges

Water and land
- Complex canal and irrigation system
- Groundwater depletion and water storage
- Very little flow reaches the sea
- Lack of wastewater treatment
- Food self-dependence
- Burning of crops leads to air pollution

Energy systems
- Electricity can be unreliable
- Air pollution and GHGs increasing
- Hydropower generation

Combined indicator of vulnerability hotspots in water, energy and land

Byers el al. (2018), ERL
Stakeholder engagement

First round of meetings (2018)
• Identifying challenges
• Collecting regional data
• Generating scenarios
• Capacity building to PhD students

Second round of meetings (later this year)
• Round of results checking and discussion
• Capacity building
The core model

NExus Solutions Tools (NEST)
Distributed Hydrology
Community Water Model (CWaTM)
(Burek et al., 2018)

Infrastructure Planning
MESSAGEix
(Huppmann et al., 2018)

Downscaling
Water and land-use

Upscaling
Potential ET
Effective precipitations
Runoff availability

Minimize total system cost
Vinca et al., (forthcoming)
Best practice

What can the model do and its limitations

• Optimal new system transformations required to achieve certain objectives

• Explore different climate and socioeconomic pathways (SSP, RCP)

• Assess proper management of resources (energy-water-land) under stressed conditions

• Focus on sub-areas or on monthly variations (i.e. water storage)

• The model does not predict the future

• Cross-national borders

• Increasing spatial resolution it’s possible, but increase the complexity and solution time
Data flexibility

**General Information**
- Exclusion Zones
- Roads

**Energy System**
- Renewable Capacity Factor
- Existing Power plant capacity
- Transmission Lines
- Fuel Production Capacity

**Water System**
- Water Availability
- Freshwater Extraction
- Water Table Depth
- Storage
- Water Supply Technologies

**Land System**
- Available Land
- Crop efficiency
- Irrigation Technologies

**Demands**
- Energy
  - Electricity
  - Fuels
- Water
- Food

**Complexity**
- 187
- 86
- 21
Water

Water distribution

Pumping
Desalination
Water diversion

Water demand

Urban* (and industrial)
Rural*
Energy sector
Land sector

Return flows*

Urban
Rural

wastewater treatment and recycle

Electrical

Return flows from energy sector

wastewater

Data:

• SSP-RCP water demand scenarios
• Surface water availability
• Current river flow, canals
• Fossil groundwater, aquifer recharge
• Storage, current and planned reservoir capacity
• Water supply, diversion and treatment technologies
• Indus water treaty allocations

* exogenous
+ limits are imposed based on information from hydrologic model
**Data:**

- Solar, wind and hydropower potential
- SSP electricity sectoral demand
- Transmission and distribution networks
- Power and cooling technology

* exogenous

^ crop residues can be transported as solid biomass or converted in ethanol, technologies not represented here
Land

Data:
- Land use/ availability maps
- SSP-RCP crop yields
- SSP crop products demand
- Irrigation technologies

* exogenous.
§ total available area for agriculture based on historical data
Integrated Policy Analysis

How to strike a balance between objectives and challenges? ...

and at what cost?

SDGs

2 ZERO HUNGER

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

13 CLIMATE ACTION

Transboundary Agreements

India

Pakistan

Afghanistan
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common assumptions to all scenarios</td>
<td>SSP2. RCP 6.0. Indus Water Treaty allocations. Planned hydropower projects in 2030. Current renewable energy policies. Maximum electricity imports fixed to baseline. Limited fossil groundwater extraction.</td>
<td>Set of different constraints, present also in the baseline (with the exception of those that refer to the baseline)</td>
</tr>
<tr>
<td>SDG 2, Achieve food security and promote sustainable agriculture scenarios</td>
<td>SDG 2.4 By 2030, 100% implementation of modern so-called smart irrigation technologies that increase productivity and production relative to 2015.</td>
<td>SDG 2.4: No flood irrigation (except for rice) after 2030. Smart irrigation is available. <strong>Baseline:</strong> no smart irrigation technologies adopted before 2030.</td>
</tr>
<tr>
<td>SDG 6 Water sector development scenarios</td>
<td>SDG 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. SDG 6.3 By 2030, improve water quality by reducing pollution, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.</td>
<td>SDG 6.6 Minimum of 20% of natural flow left in rivers and aquifers by 2030. SDG 6.3 Treat half of return flows treated by 2030, recycle one quarter of return flows. <strong>Baseline:</strong> no targets.</td>
</tr>
<tr>
<td>SDG 7 Clean and Affordable Energy Development Scenarios</td>
<td>SDG 7.2 By 2030, 50% By 2030 the share of renewable energy in the global energy mix = 50%. SDG 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all.</td>
<td>SDG 7.2 Target on share of renewables (wind, solar, geothermal). Phase out of coal. SDG 7.b Phase out of once-through cooling, imposing capacity constraint. <strong>Baseline:</strong> no targets.</td>
</tr>
<tr>
<td>SDG 13 Climate action</td>
<td>SDG 13.a Implement the commitment undertaken by the United Nations Framework Convention on Climate Change.</td>
<td>SDG 13.a Ghg emission budget and climate scenario accordingly. <strong>Baseline:</strong> no emission targets.</td>
</tr>
</tbody>
</table>
Preliminary results

Comparing baseline with preliminary SDG 2+ 6 + 7 + 13 scenario

Low carbon tech and wastewater distribution and treatment.
Use of more efficient, but costly irrigation technologies.
Higher land requirements.

Less water used in agriculture.
Much more energy required for pumping, treating, water infrastructure, power plants.

Average yearly costs for the entire basin (2020-2050)

Average yearly cross-sectoral energy, water and biomass flows
Single SDG, multi sector

If positive:

Sum (cost, emissions, energy) or average (others) between 2020 and 2050

SDG2: no significant changes

SDG6: water constraints, more fossil fuel than in baseline
higher cost for water distribution

SDG7 and 13 similar even though targets are different
• Less water available for various uses, more groundwater

• Rain-fed agriculture, where land is available

• Land sector more stressed when multiple SDG are achieved (nuclear water consumption)
Results explorer dashboard

- High dimensionality of outputs
- Database available for stakeholders
- Compare and explore scenarios:
  - Time
  - Sub-catchments or country
  - Sectors
  - Technologies
  - Policies & scenarios

Example of new installed hydropower in the baseline scenario, including the Indus Treaty
Conclusions

• Environmental flow constraint strongly affect available surface water for energy and agriculture.

• SDG7 and 13 have a clear overlap as mitigation strategy, although different costs and advantages.

• Rain-fed agriculture to adapt to water scarcity, more efficient irrigation technologies when the available land is limited.

Next steps:

• Re-discussing critical assumptions with stakeholders (i.e. groundwater, environmental flows, demand projections)

• Multi-criteria optimization

• Exploring different scenarios and questions: national interests, reservoir expansion, hydropower

SDG insights:
An integrated modeling framework for assessing water-energy-food nexus solutions: Application to the Zambezi transboundary river basin

Michiel van Dijk
Ecosystems Services and Management (ESM), IIASA

ISWEL UNIDO meeting, 16 April, 2019

With input from the ISWEL ZAMBEZI team
Study area: Zambezi Basin

- One of the largest river basins in Africa, covering an area of 1.4 million km² and home to around 40 million people.

- A transboundary basin spanning over eight countries and 21 subbasins.

- Existing governance structure: ZAMCOM

- Growing population and economy

- Considerable potential for agriculture and hydropower development
Zambezi nexus: Literature review & stakeholder input

Climate change

Forest Degradation due to increasing use of charcoal caused by limited access to electricity

Decrease in water availability due to upstream irrigation expansion

Regional development of hydropower increases energy access but might threaten ecosystems

Variations across countries and sub-basins

Food/Land Use System

Energy System

Water System
Harmonized input data
Scenario assumptions (e.g. population and GDP growth) and base year data (e.g. subbasin and land use maps)

NEXUS scenario outcomes
Energy, water and land pathways and ecosystem indicators

Nexus Assessment Modeling Framework

- **GLOBIOM**
  - Ground and surface water supply, environmental flow, domestic and industrial water demand
  - Land use change, irrigated area, irrigation water demand

- **CWaT-M**
  - Annual runoff, Natural and actual river discharge
  - Ground and surface water supply, environmental flow; domestic and industrial water demand; effective precipitation, Pot. Evaporation,

- **MESSAGE-Access**
  - Household energy demand for charcoal; Water demand for hydropower
  - Crop yields, crop prices, land prices, production costs, irrigated area by systems, irrigation water demand

- **MARINA**
  - Sub-basin hydro-economic network of water available for beneficial use for hydropower, domestic, industrial and irrigation; reservoir evaporation

- **ECHO**
  - Annual or seasonal mean concentration
  - Water demand for hydropower

Scenario assumptions (e.g. population and GDP growth) and base year data (e.g. subbasin and land use maps)
Using regional data sources

Irrigation and hydropower

Household surveys
Scenario analysis preliminary

1. Business As Usual (BAU): SSP2+RCP4.5 (hydropower capacity and irrigated area are fixed at 2010 level)

2. Hydropower expansion (HP) (from 4,870 in 2010 to 7,780 MW in 2020-2050)

3. Hydropower and irrigation expansion (HP+IR) (from 215,000 in 2010 to 600,000 in 2030 (planned), and 2 Mha in 2050 (potential))

4. Hydropower and irrigation expansion under reduced water availability of 10% (HP+IR+CC)

Source: FHReD, Zarfl et al. 2015
Source: MSIOA, World Bank 2010
Preliminary results for BAU: Crop production and irrigated area

Note: 2000-2010 change
Preliminary results for BAU: Land use change

Cropland

Short rotation Plantations

Grassland

Primary Forest

Managed Forest

Other natural land
Preliminary results for BAU: Household energy demand and forest area eq.

Household energy demand projections (GJ)

Forest area equivalent (ha)
Preliminary Results
Irrigated area expansion and investment costs

Irrigated area under pressurized systems (1000 ha)

- BAU
- HP
- HP+IR
- HP+IR+CC

×6 175-180 M$/yr

18-23 M$/yr

+3-17%
Preliminary Results
Hydropower production

The impact on HPP of a drier climate is much stronger than irrigation expansion
Scenario results show tradeoffs and synergies that decision-makers have to consider.
Next steps

• Run scenarios using fully integrated model framework
• Incorporate stakeholder scenarios and present at event (end of May)
• Address ‘other’ nexus elements
  • charcoal-deforestation/forest degradation
  • Hydropower-ecosystems
• Make results available to stakeholders by means of graphical user interface
• Prepare policy briefs with key results
Thanks