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Integrated solutions for water, energy, and land nexus management the Zambezi Basin: stakeholder engagement and modeling

Palazzo A., van Dijk M., Willaarts B., Magnuszewski P., Mayor-Rodriguez B., Burek P., Kahil T., Tang T., Byers E., Pachauri S., Poblete-Cazenave M., Krisztin T., Riahi K., Krey V., Wada Y., Langan S., Obersteiner M., Havlik P.

3rd Zambezi Basin Stakeholders' Forum: Water-Energy-Food-Ecosystems (WEFE) Nexus for Socio-Economic Benefits in the Zambezi River Basin
8-9 October 2018, Lilongwe, Malawi

Contents

- Background on Water-Energy-Land project
  - ISWEL
- Zambezi River Basin stakeholder engagement
- ISWEL nexus-tools
- Next steps

ISWEL project objective

Develop tools and capacities to support the Water-Energy-Land Nexus management at the global scale and in two transboundary basins: Indus and Zambezi

ISWEL Assessment Areas

1. **Global**
   i. Vulnerability hotspots
   ii. Global solutions and pathways
2. **Basin level assessments (Indus and Zambezi)**
   i. Integrated modeling of WEL
   ii. Stakeholder engagement- identification of basin nexus priorities, and co-design of future pathways
3. **Capacity building and knowledge dissemination**
   i. Trainings for young researchers (e.g. YSSP)
   ii. Online tools and databases
   iii. Scientific publications and policy briefs

Stakeholder Process-ROADMAP

Establish partnerships with entry points: national and basin organizations

Meeting 1:
Warming Up
Identify priority needs from stakeholders
September 2017

Meeting 2:
Scenario and Capacity Development Workshop
July 2018

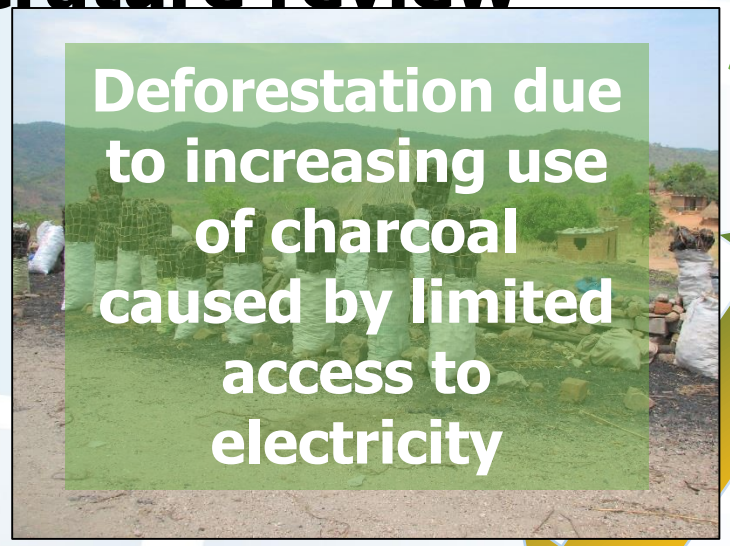
Meeting 3:
Presentation of results and Capacity Development Workshop
March 2019

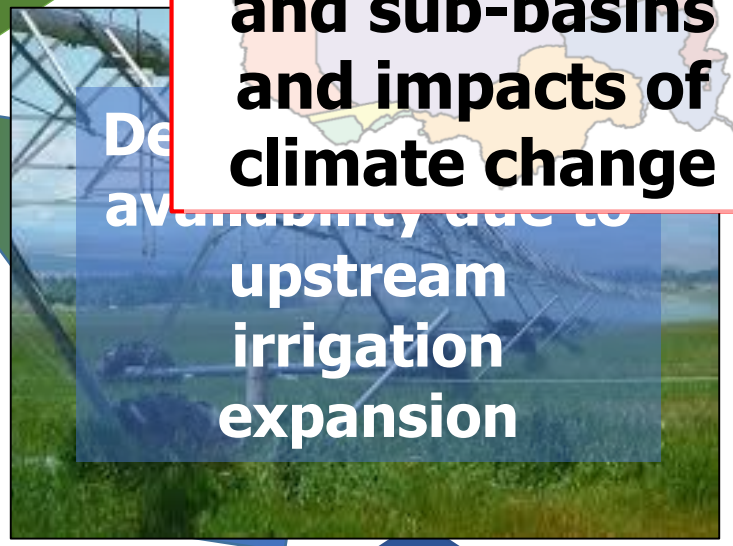
Beyond 2019

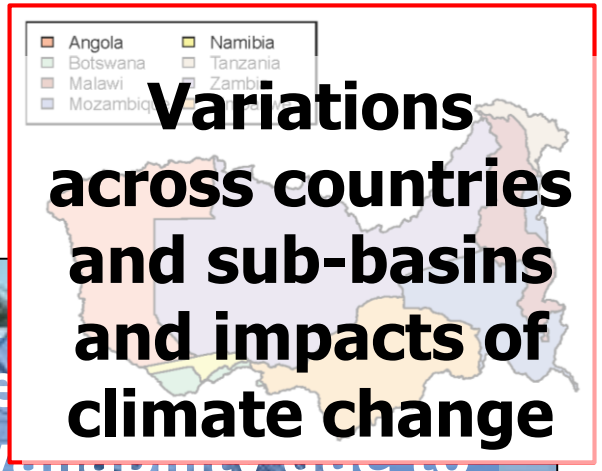
Identify opportunities for continuing the collaboration

Zambezi nexus: Literature review

Food/Land Use System

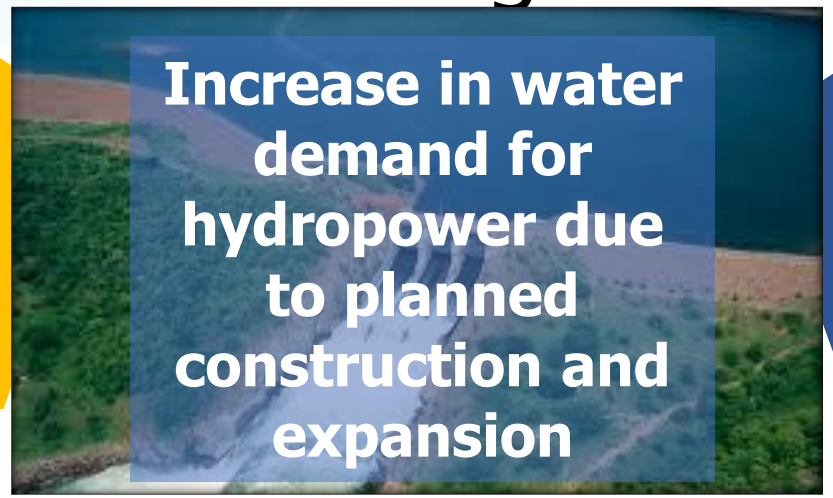






Climate change

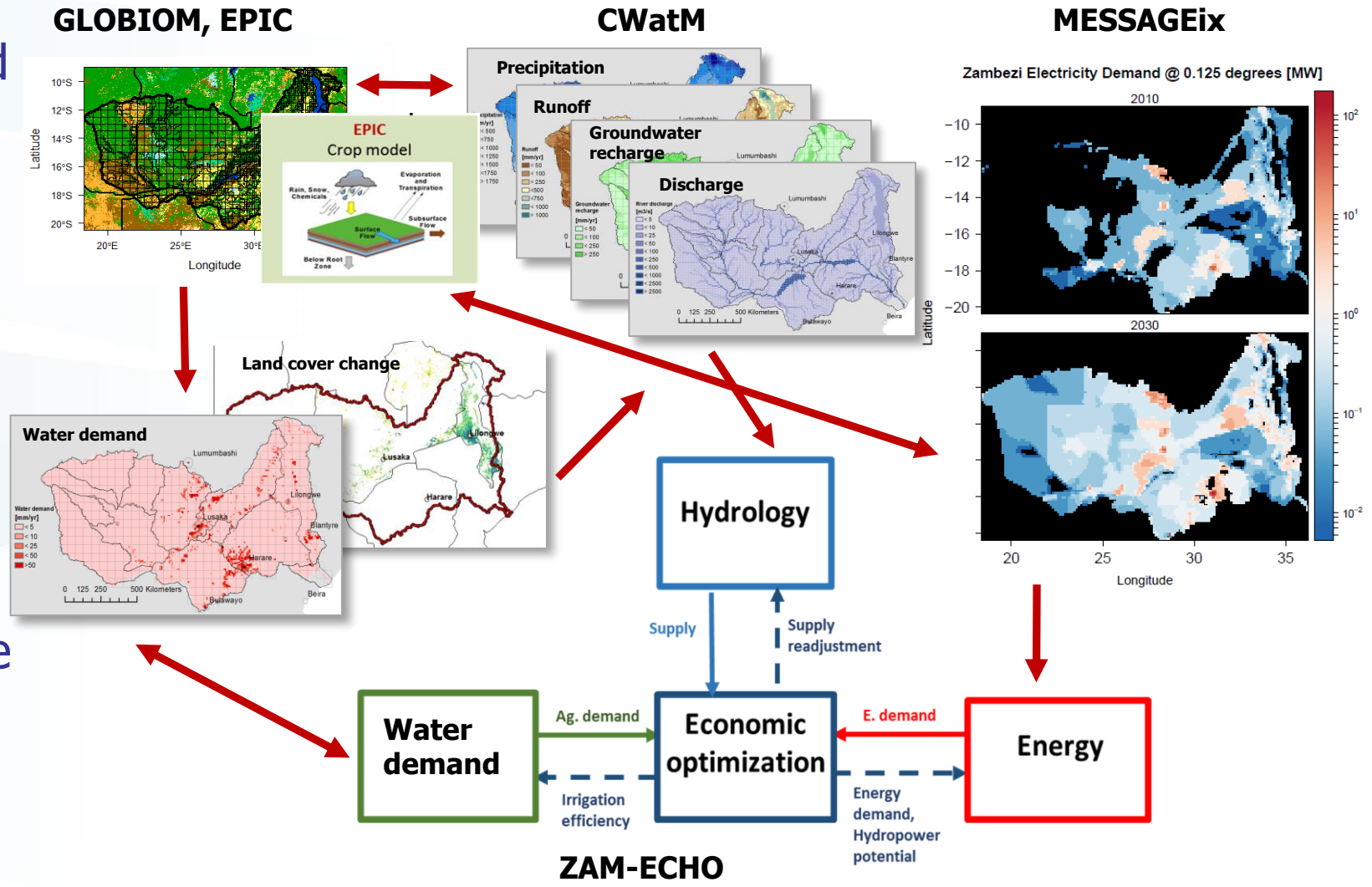
Energy System



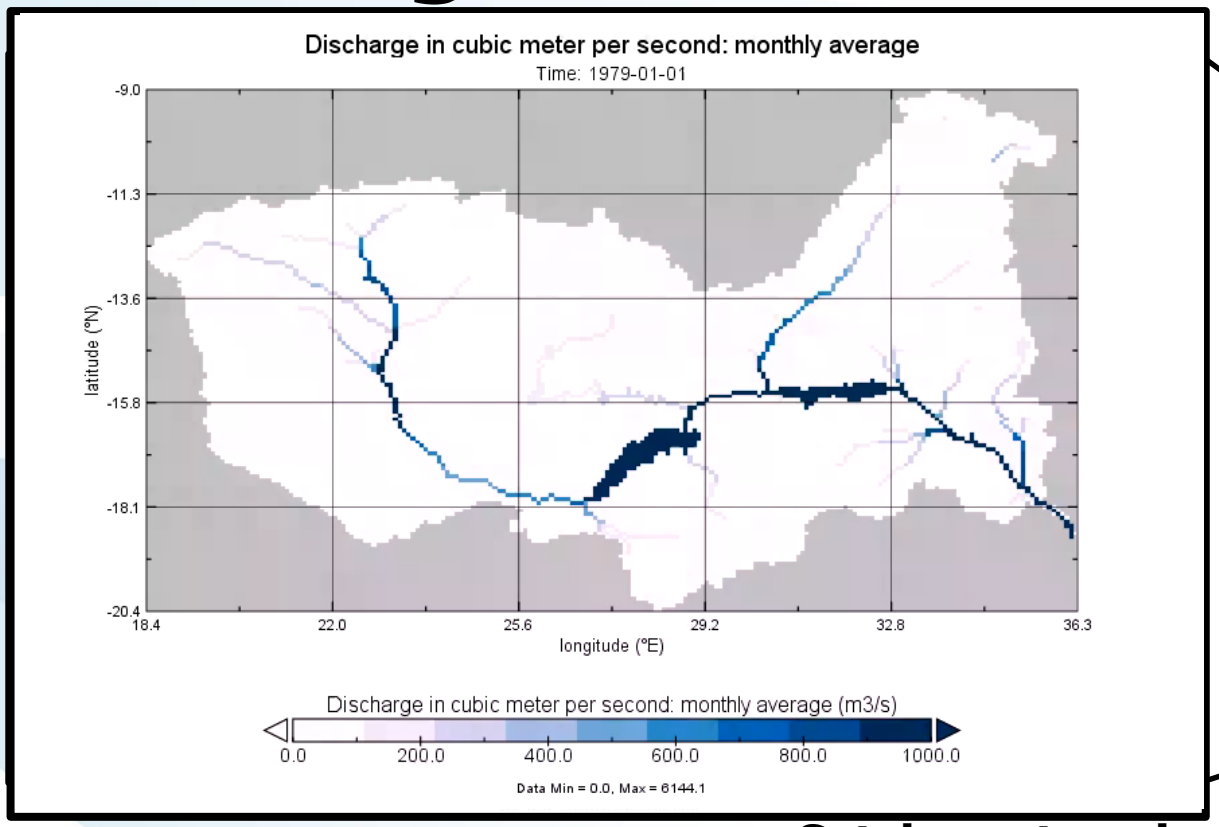
Water System

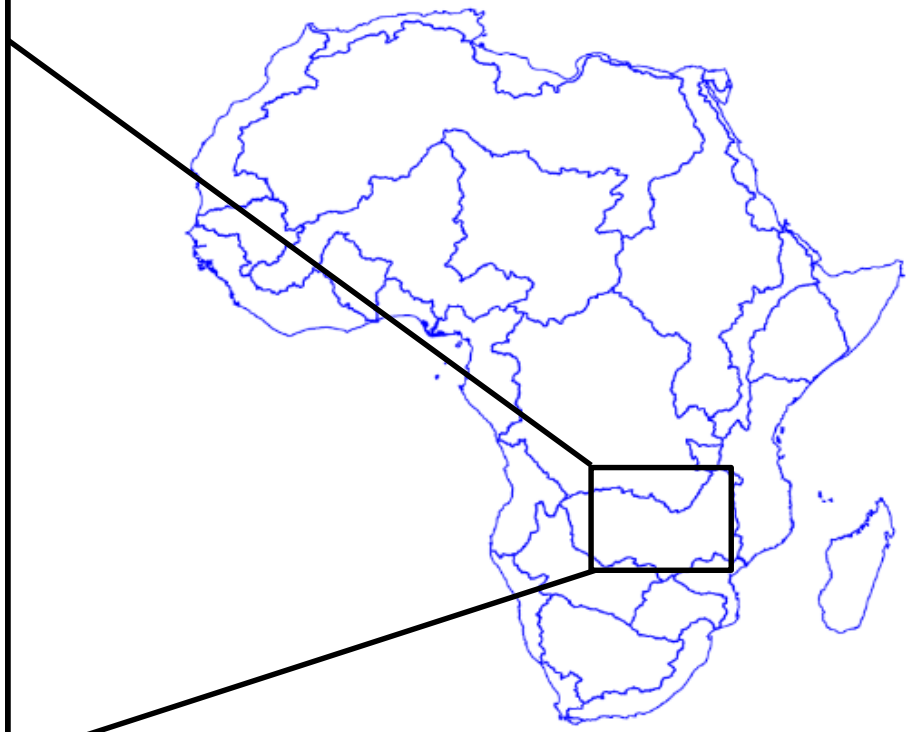
Nexus modelling tools: sectoral tools linked through model inputs and outputs

- Biophysical conditions and suitability
  - Updated with local datasets from stakeholders
- Economic feedbacks from changes in prices of crop/land/water/energy
- Regional and global trade of crops/energy
- Development under future global change
- Optimization methods to find solutions



Preliminary results of nexus tools: modeling of water discharge



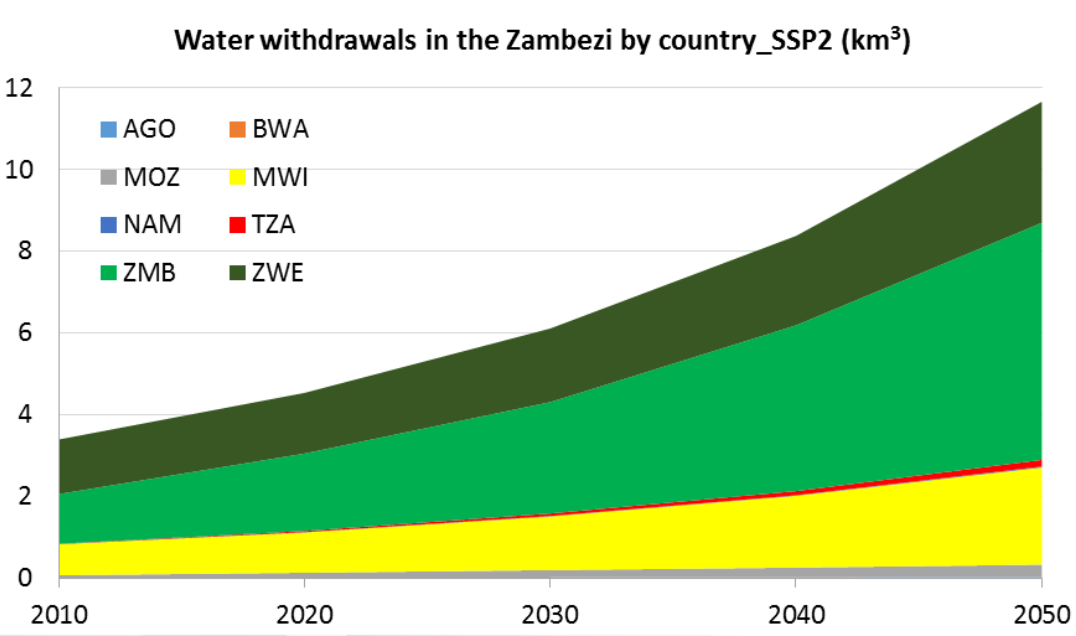


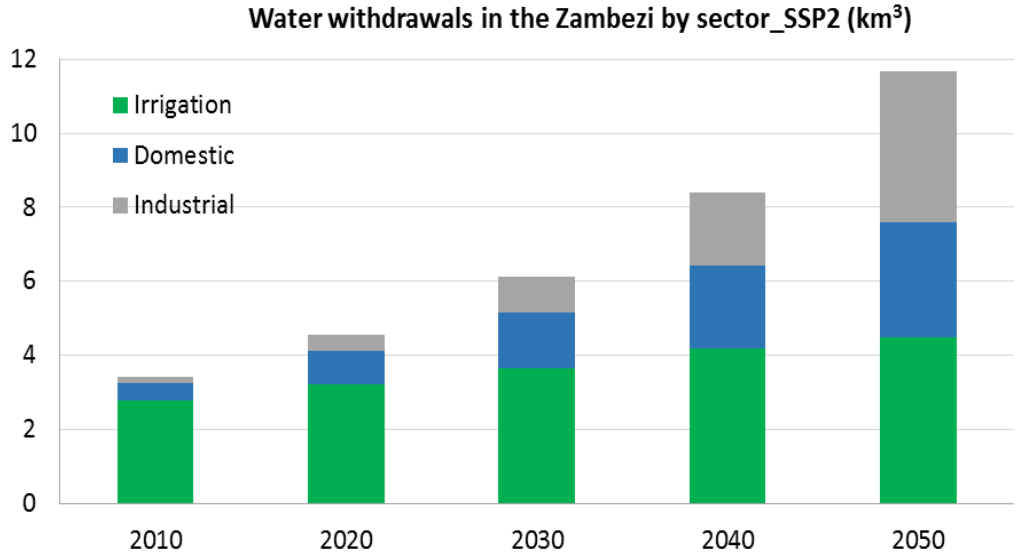
Catchment-scale with reduced form network

Linkage of grid based high resolution hydrological modeling to sub-basin/region based hydro-economic modeling and water quality modeling

Preliminary results for BAU:

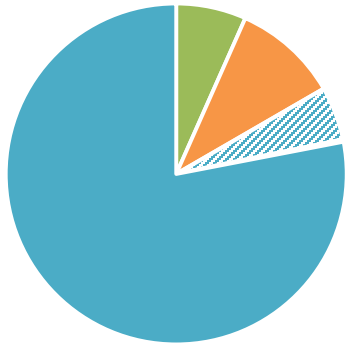
Water demand by sector, source and country



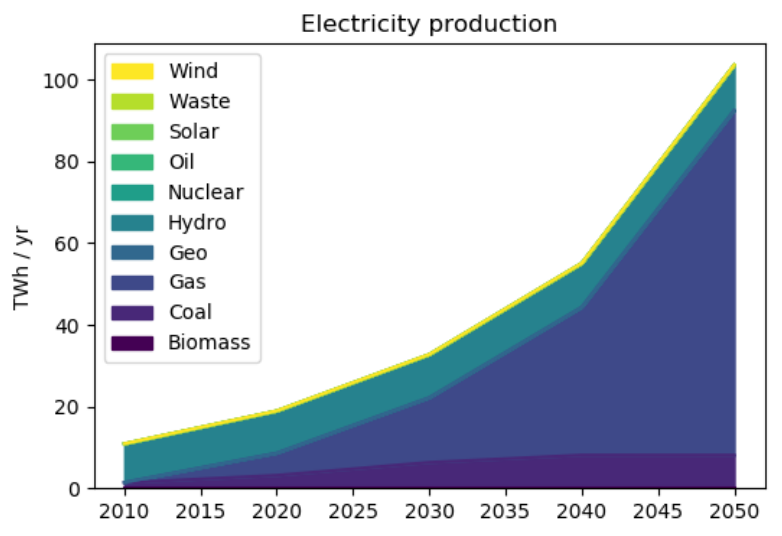


Water demand for irrigation increases by 50%, but other sectors grow by 400%

In 2050, irrigation water will use > 80% of surface water withdrawals

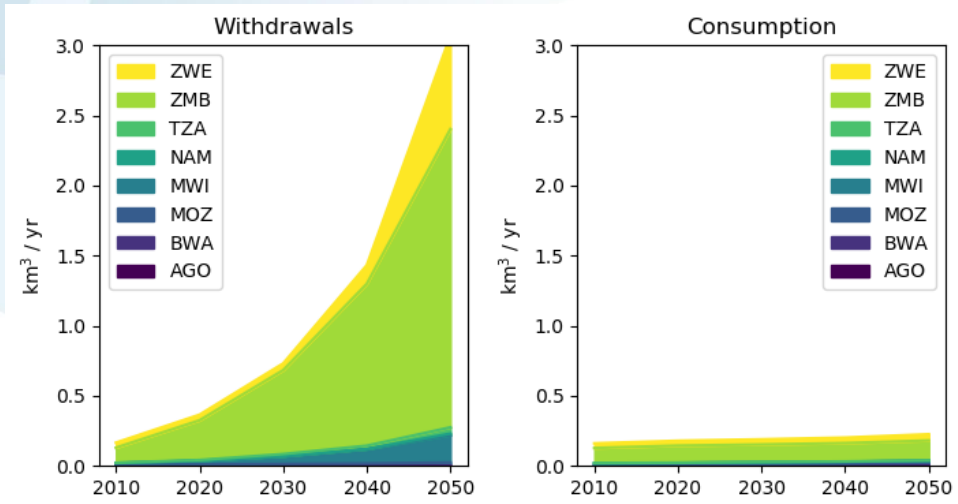


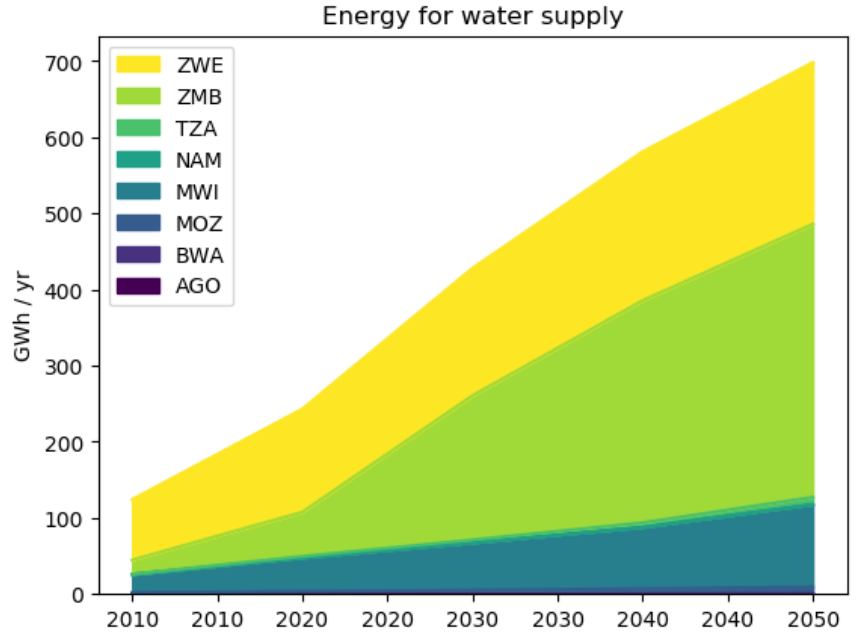
Preliminary results for BAU:
Energy and water in the Zambezi



Generation remains water-dependent

Energy for water also grows – but is **only 1%** of total electricity supply

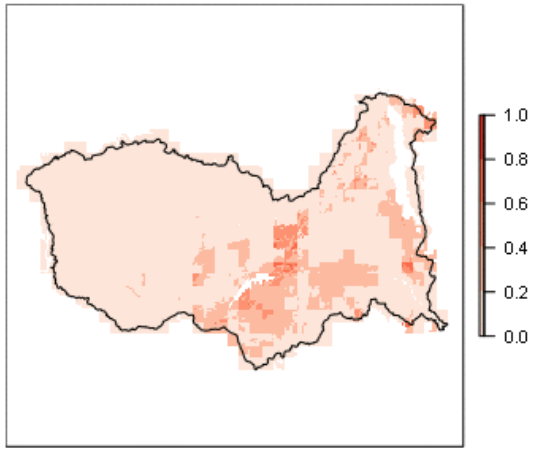




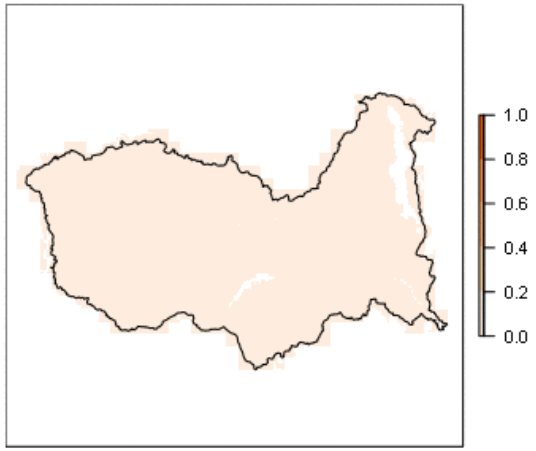
Preliminary results: Land use change in the Zambezi

Land use, 2010 (in pct. of pixel)

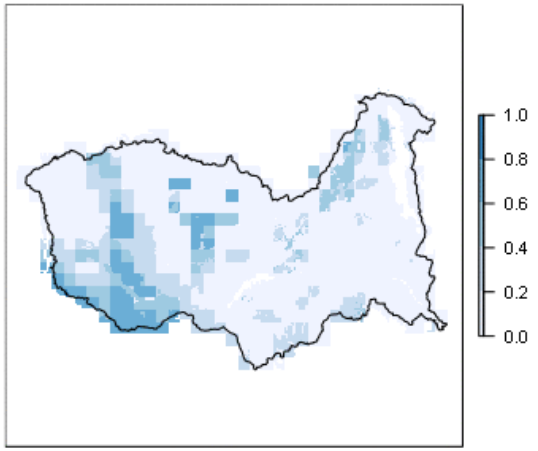
Cropland



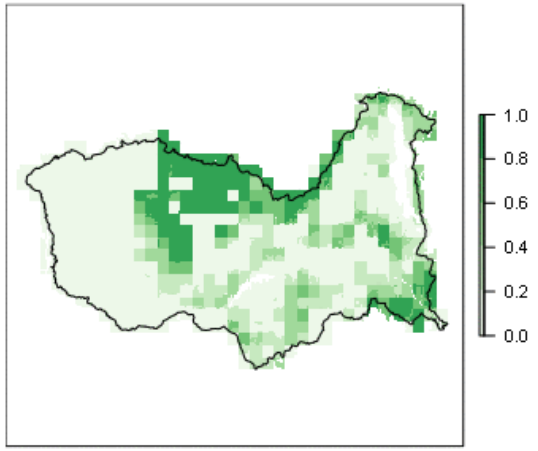
Short rotation Plantations



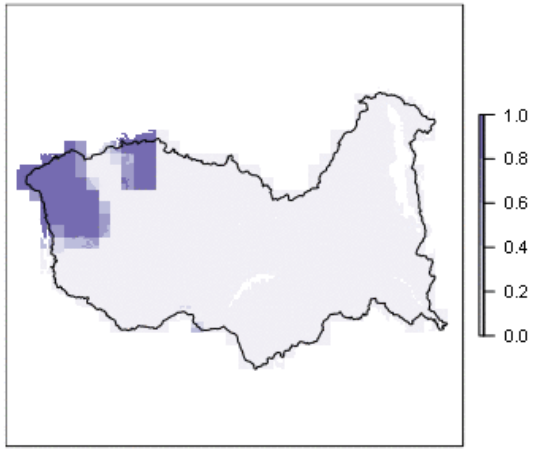
Grassland



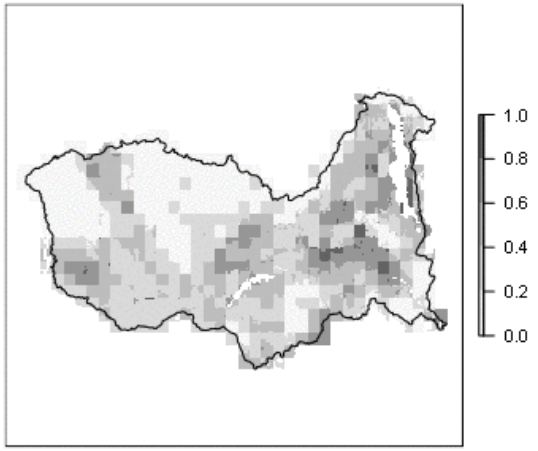
Primary Forest



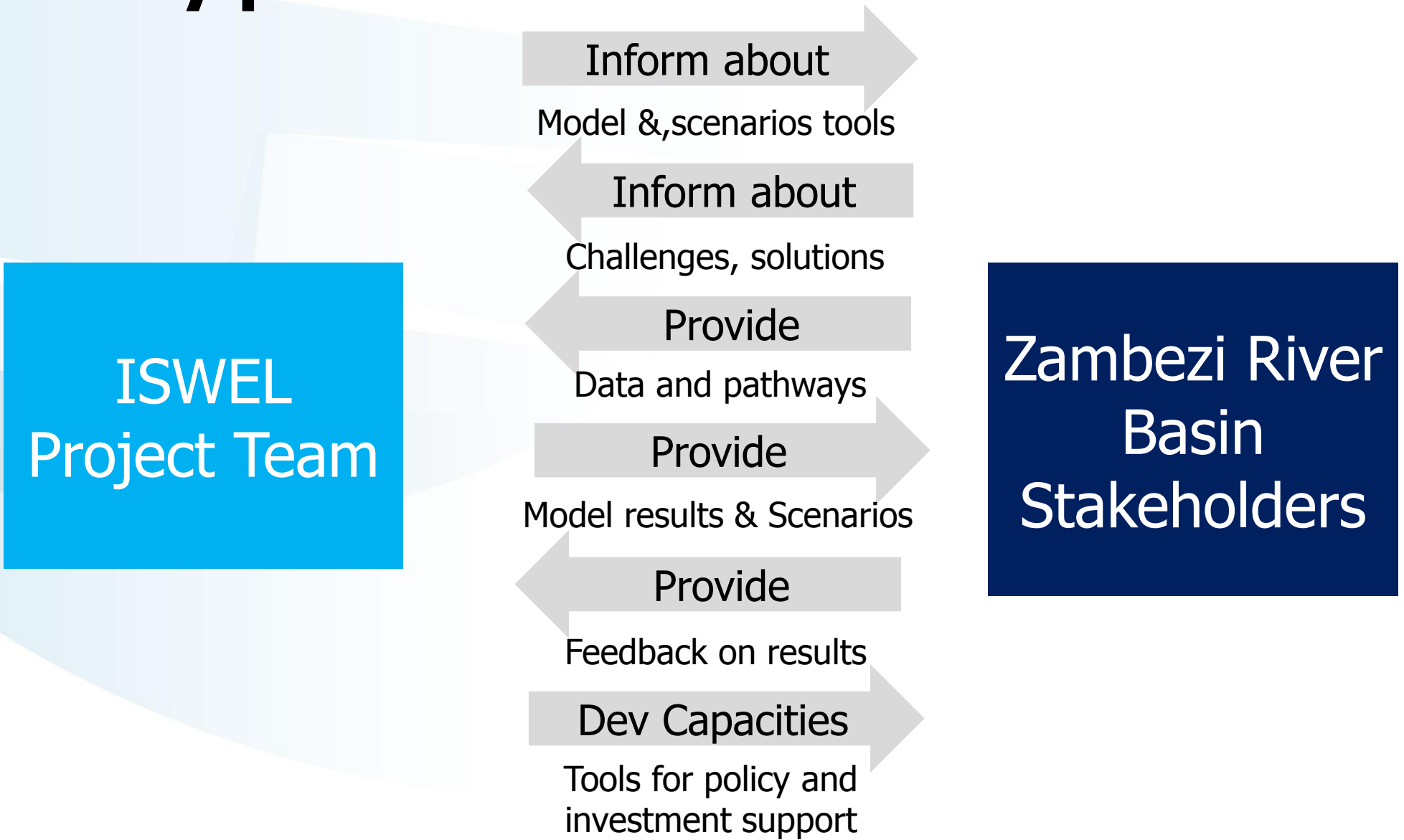
Managed Forest



Other natural land



Tool development and stakeholder engagement: Two-way process



Workshop to understand and co-develop basin nexus pathways (July 2018, Harare)

STEP 1 Current Situation

STEP 2 Business as Usual Pathway

STEP 3 Desired Future Pathways

STEP 4 Robustness of Pathways

INTERNAL
(PATHWAYS)

Solutions =
Policies, Technologies,
Infrastructures

Trade-offs

Synergies

Current Situation

Challenges

Resilient Future 1

Resilient Future 2

Resilient Future 3

Resilient Futures

differentiated by value differences between stakeholders

provide reference for

Business as usual

Past & present

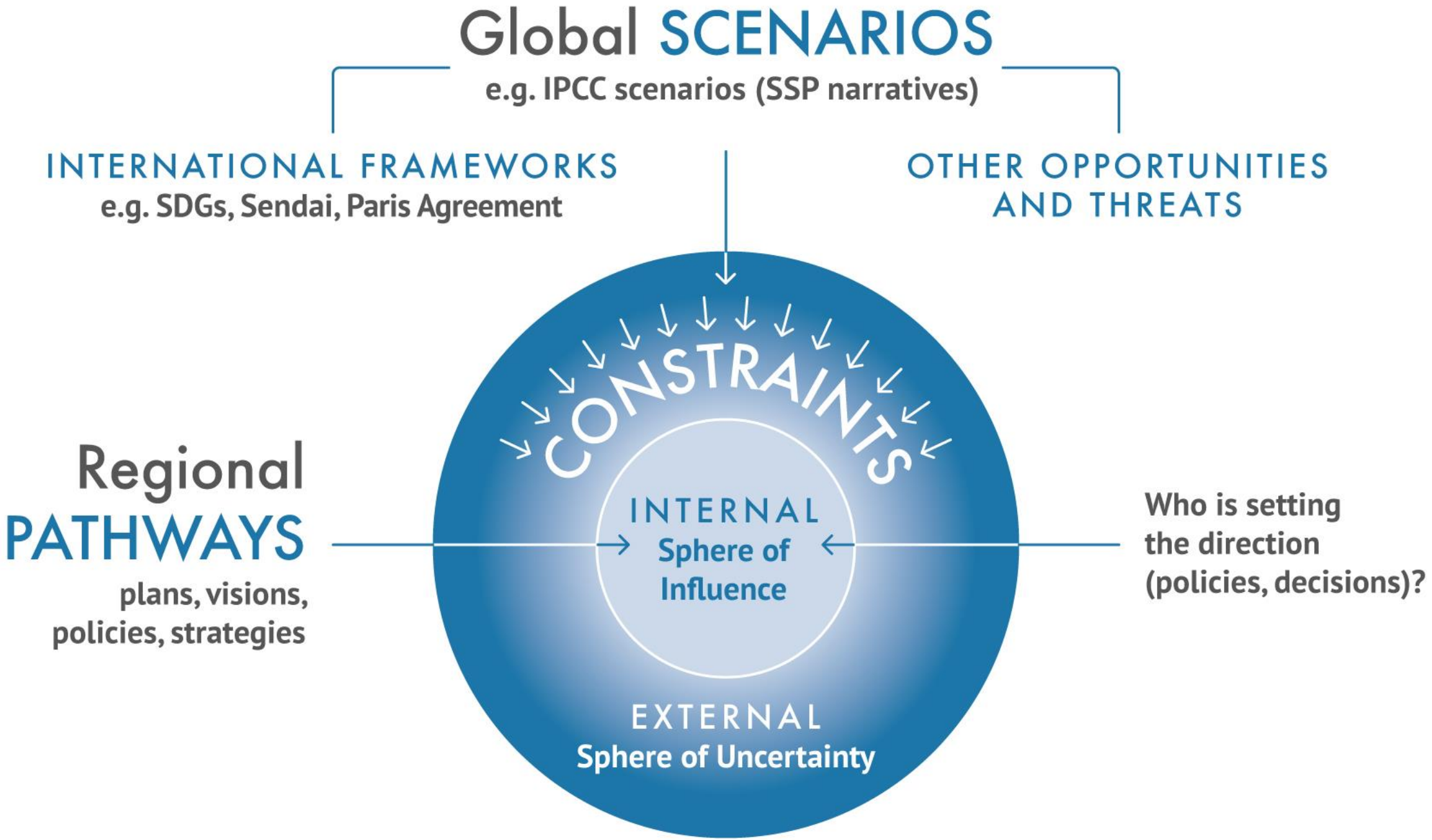
Possible future

Constraints

Input based on SSPs

EXTERNAL
(SCENARIOS)

Risks


Global SCENARIOS
e.g. IPCC scenarios (SSP narratives)
INTERNATIONAL FRAMEWORKS
e.g. SDGs, Sendai, Paris Agreement
OTHER OPPORTUNITIES AND THREATS
CONSTRAINTS
Regional PATHWAYS
plans, visions, policies, strategies
INTERNAL
Sphere of Influence
EXTERNAL
Sphere of Uncertainty
Who is setting the direction (policies, decisions)?

Integrated Solutions for Water, Energy, and Land (ISWEL) project

WORKSHOP
Developing Integrated Water, Energy, and Land Scenarios for the Zambzi Basin

Harare 10-11 July 2018

ZAMCOM

https://vimeo.com/292929336

IIASA gef UNIDO


Zambezi Basin Visions
3 Desired Futures with 3 Priorities:
Society
Environment
Economy
WWW.AIRPANO.COM

VISION: ECONOMY

Development through cooperation and economic integration

Zambezi has made the leap to become a competitive economy thanks to large scale investments programs that contributed to secure access to key natural resources and foster the physical and economic integration of the riparian countries.

Key areas for development:

- **ENERGY:** Hydropower as the main source of electricity for urban and industrial activities. Solar and wind power replace charcoal in the rural areas
- **FOOD/LAND:** Intensification of agriculture mostly through the development of new irrigated areas and expansion of drip irrigation
- **WATER:** Water monitoring systems in place to control water availability/quality as well as floods/droughts. Inter-basin water transfers agreements (e.g. Congo)
- Expanded communication infrastructures (road, railway, air)
- Trade and Transboundary Cooperation Agreement

VISION: SOCIETY

Inclusive development and cooperation

This leap has been made possible thanks to implementation of an ambitious transboundary cooperation plan, that includes joint investments to improve supply as well as communication infrastructures, and trade agreements. This mechanism of sharing costs and benefits allows countries to meet jointly their development targets for both urban and rural population.

Key areas for development:

- **ENERGY:** Hydropower as the main source of electricity for urban/rural and industrial activities. Solar grids in the more remote areas.
- **FOOD/LAND:** Large scale program to develop technical capacities and provide access to credit of small farmers.
- **WATER:** Investments are oriented towards securing WASH and improved (surface) water use efficiency
- Trade and Transboundary Cooperation Agreement

VISION: ENVIRONMENT

Healthy environment as a basis for prosperous economy and society

Zambezi Basin has made the leap to become a competitive, equitable and green–based economy: thanks to the deployment of a large-scale program that prioritize the rehabilitation of degraded lands and the effective management and conservation of most unique ecosystems. This investment to maintain green infrastructures constitutes the pillar over which eco-tourism economy flourishes, whose revenues are shared equitably among state countries and rural communities.

Key areas for development:

- **ENERGY:** Increasing demands met through expansion of solar grids. Existing hydropower projects adapt their operations to secure environmental flows downstream.
- **FOOD/LAND:** Investments into Climate SMART agriculture. Developing technical capacities and access to credit contributes to boost farms' economy in the rural areas.
- **WATER:** Groundwater potential is tapped to meet new growing demands. Efforts are also allocated to secure WASH and implement flood/drought management tools.
- Environmental legislation enforced to reduce pollution and prevent deforestation upstream

Next Steps

Until end of 2018

1. Complete the nexus modeling tools and validate current tools using stakeholder feedback
2. Quantify preliminary scenarios based on the outcomes of stakeholder workshops

2019

1. Validation of scenarios and model results with stakeholders (first quarter)
2. Second capacity building workshop on nexus tools (first quarter)
3. Project final results (third quarter)
4. Next steps for implementation in the Indus and other basins

Synergies and collaborations

- **ZAMCOM:** Support the development of the Zambezi Strategic Plan (ZSP) through scenario and modeling process
- **World Bank CSIP Zambia:** Assessment of agricultural pathways and strategies for Zambia to inform the national Climate Smart Investment Plan (CSIP)
- **Zambia Irrigation for Climate Resilience and Food Security Project (ZICRFS):** Proposal submitted to CultiAf-2, to assess irrigation potential in Zambia, led by the Indaba Agricultural Policy Research Institute (IAPRI) in Zambia
- **Young Scientists Summer Program (YSSP):** flagship program of IIASA, invite PhD students from the Zambezi region


Young Summer Student Program (YSSP):
Funded summer research fellowship for
PhD students
Applications for Summer 2019 open now!
www.iiasa.ac.at/yssp

Presentations and scientific publications

Conference presentations

- Palazzo, A. et al., *Hotspots in land and water resource uses on the way toward achieving the Sustainable Development Goals,* Impacts World 2017 Conference | 11-13th October 2017
- Palazzo, A. et al., *Future energy, food, and water trade-offs in the Zambezi river basin: A model analysis of Zambia*, Global Food Security Conference | 3-6 December 2017
- Van Dijk, M et al, Generating high-resolution national crop distribution, maps: Combining statistics, gridded data and surveys using an optimization approach, accepted for the ICAE 2018, Vancouver
- Parkinson et al., Hydro-economic modeling of integrated solutions for the water-energy-land nexus in Africa, AGU Fall meeting, 11-15 December 2017, New Orleans
- Burek et al., Improving Water Resources Management on Global and Region Scales – Evaluating Strategies for Water Futures with the IIASA's Community Water Model, AGU Fall meeting, 11-15 December 2017, New Orleans

Scientific publications

- Greve, P. et al. (2018). *Regional scaling of annual mean precipitation and water availability with global temperature change. Earth System Dynamics* 9 (1): 227-240.
- Magnuszewski, P. et al. (2018). *Exploring the Role of Relational Practices in Water Governance Using a Game-Based Approach. Water* 10 (3): p. 346.
- Kahil, T. et al. (2018) A continental-scale hydro-economic model for integrating water-energy-land nexus solutions. Water Resources Research. Under review

Thank you!

For further questions, please contact:

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