Balancing Adaptation and Mitigation Pathways for Pakistan

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COMMITTED

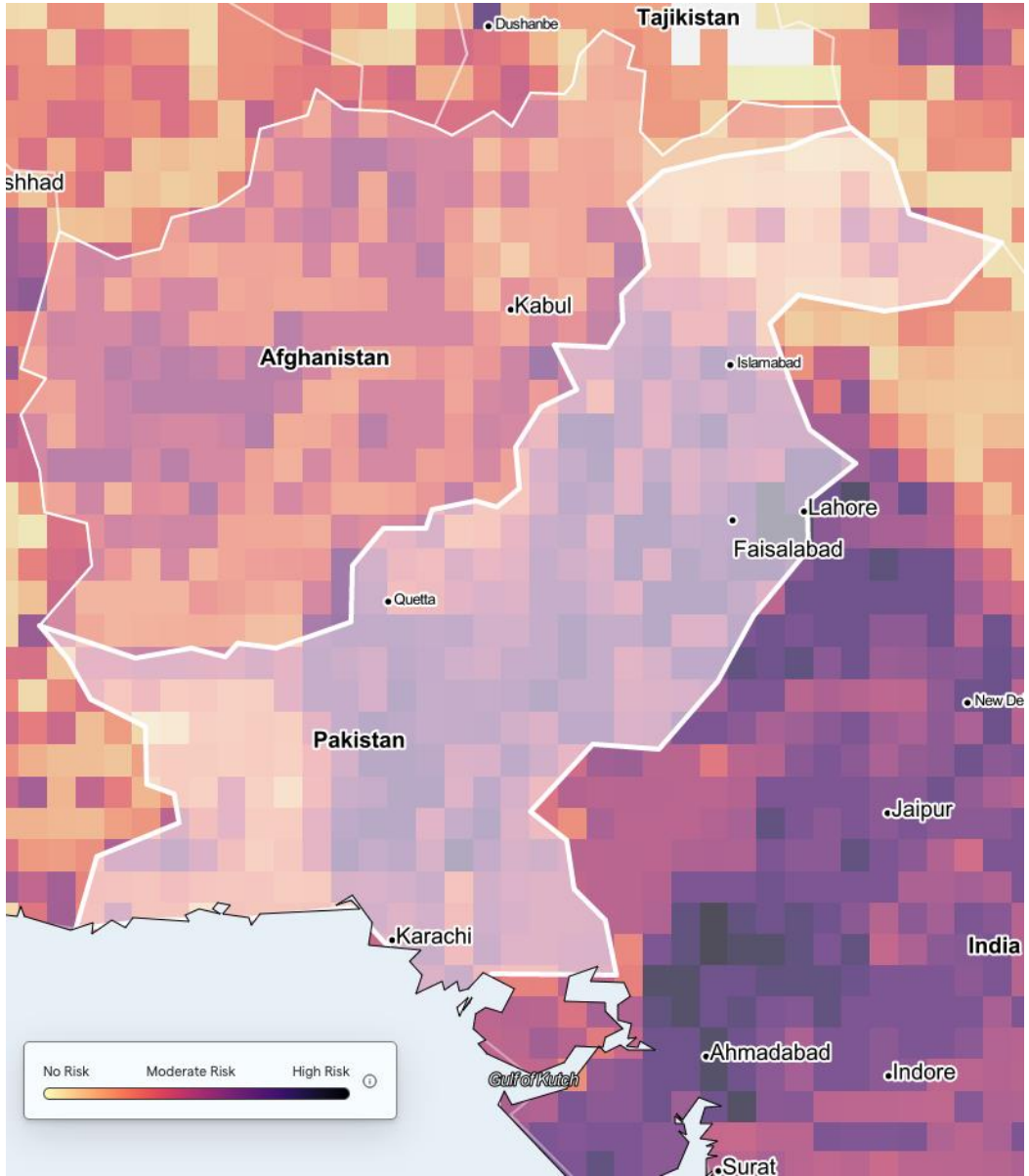
LUMS | Centre for Water Informatics and Technology

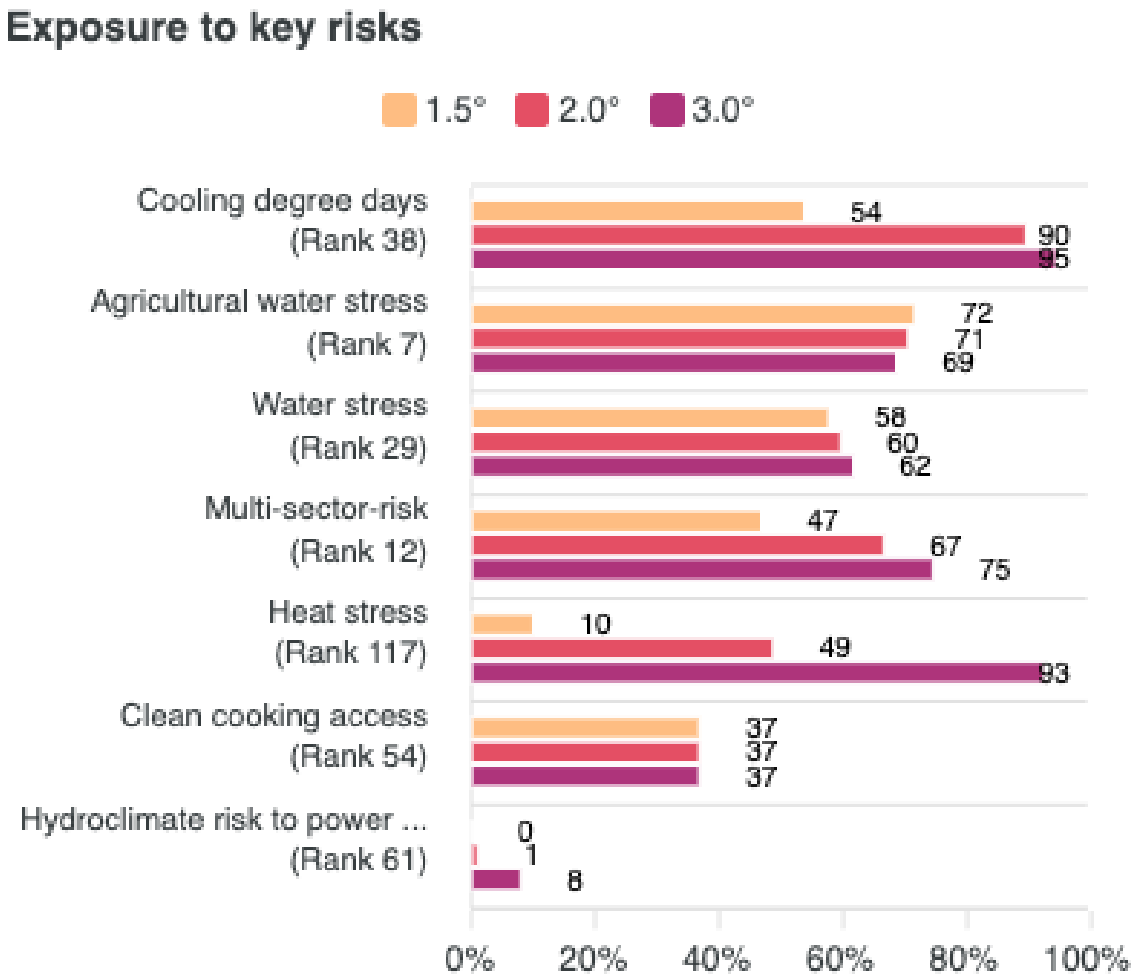
IIASA

Funded by DG CLIMA

Why does countries like Pakistan need to balance between mitigation and adaptation targets?

Despite 0.9% of global emissions, Pakistan is extremely vulnerable to multi-sector climate risks

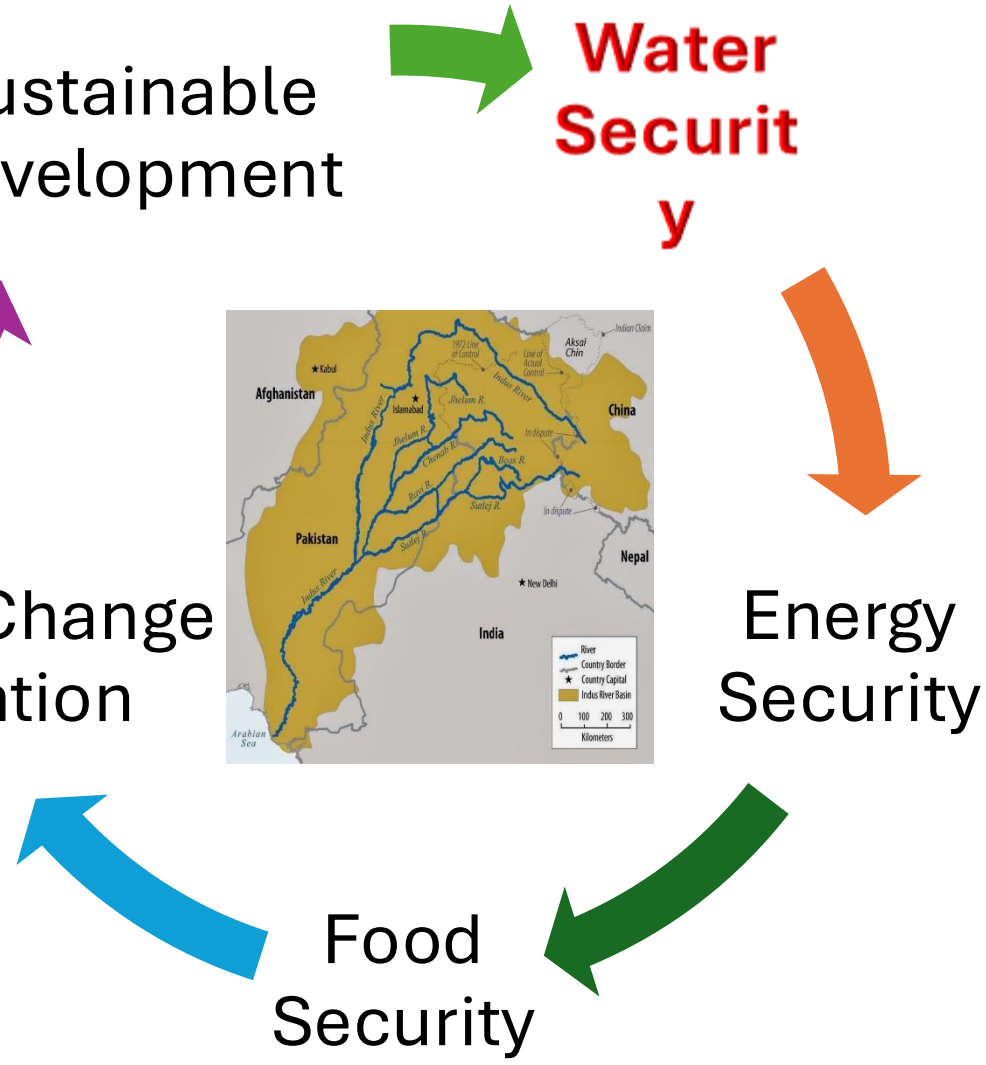




Byers et al. 2018
More details at hotspot-explorer.org

A strong case of Climate Adaptation

- Recent floods in 2022 unprecedented floods ravaged more than 35% of Pakistan
- killing more than 1,700 people
- 35 million displaced or affected
- > 10 billion dollars of damages and economic losses.



Addressing the gap

Defining Research Perspective

- Convincing narrative on co-benefits of low emissions for Pakistan
- Sustainability – Mitigation nexus
- Emissions burden sharing with regional partners e.g India, China

Sectoral Enhancement

- Using previous work expanding further sectors e.g. agriculture sector transition
- Improving spatial & temporal resolution

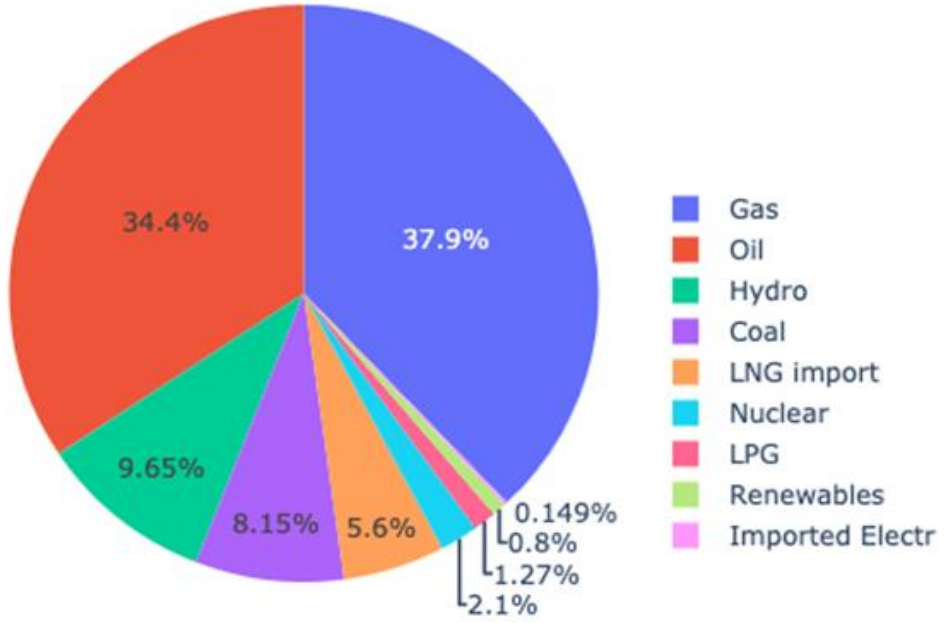
Capacity Building

- Capacity building of modelling team at LUMS by IIASA
- Stakeholder training workshops on modelling & policy dialogues
- Contributions to cross-country model-policy activities

Using MESSAGEix framework for pathways analysis

Pakistan's energy system faces multifaceted challenges

- Reliance on oil and gas in the energy mix
- Underutilization of renewable resources
- Circular debt hampers smooth functioning of the system
- Weak governance of distribution companies
- Inefficiencies such as electricity theft and lack of access
- Energy conservation and efficiency requires special emphasis



Primary Energy Supply by Source (2020/2021)
Source: National Electric Power Regulatory Authority (NEPRA) Report

Using MESSAGEix IAM to address the gap

- Open-source modeling tool for long-term energy planning and GHG scenario analysis
- A linear optimization model for planning over several decades (mid-term or long-term)
- A system of interlinked resources, technologies, commodities, levels, etc. to deliver certain services
- Technology rich, bottom-up representation of technologies
- Optimal configuration of energy system : meet specified energy demands at the lowest costs

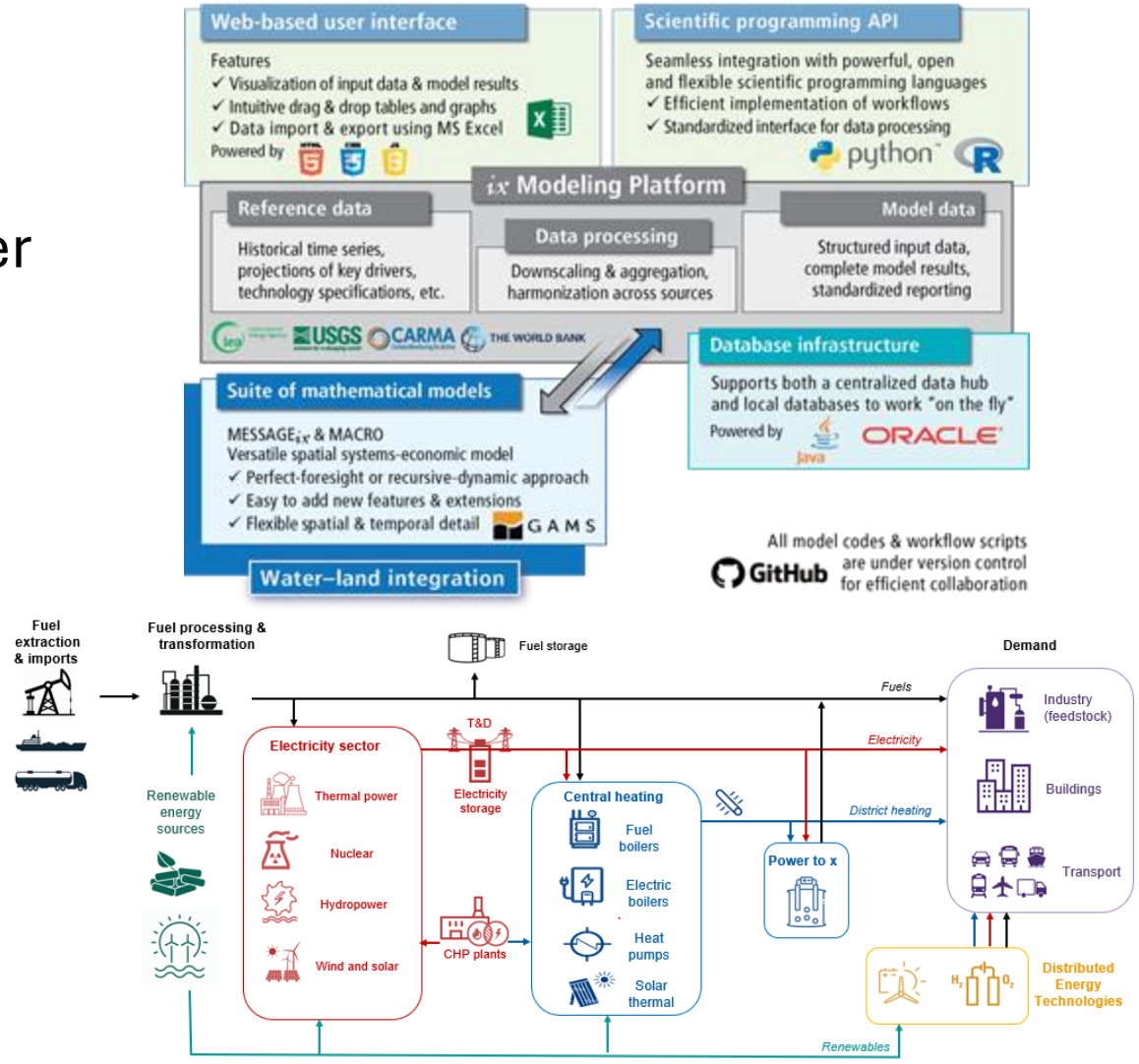


Figure: Behnam Zakeri (IIASA)

https://docs.messageix.org

Huppmann et al. 2019

Pakistan doesn’t have a defined Net Zero target year

Current Policy (CurPol)

- Planned projects (Hydropower mostly)
- Increased import of coal, crude oil
- High reliance on natural gas

Proposed NDCs (NDC)

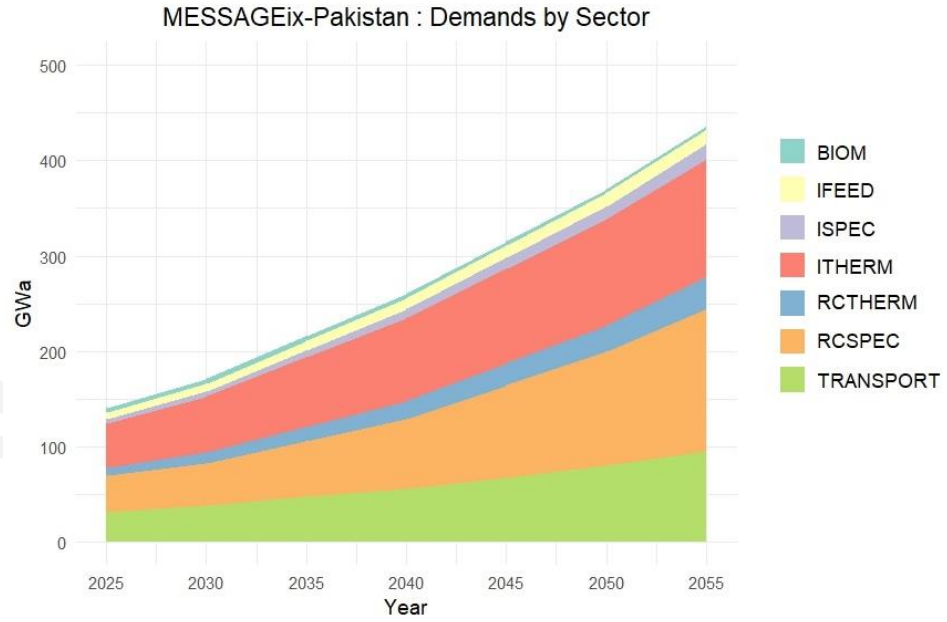
- 20% renewable energy by 2025 & 30% by 2030
- Sectoral actions account for 6.4 Mt CO_2eq emissions reduction by 2030
- Lower Vehicle emissions using improved fuel

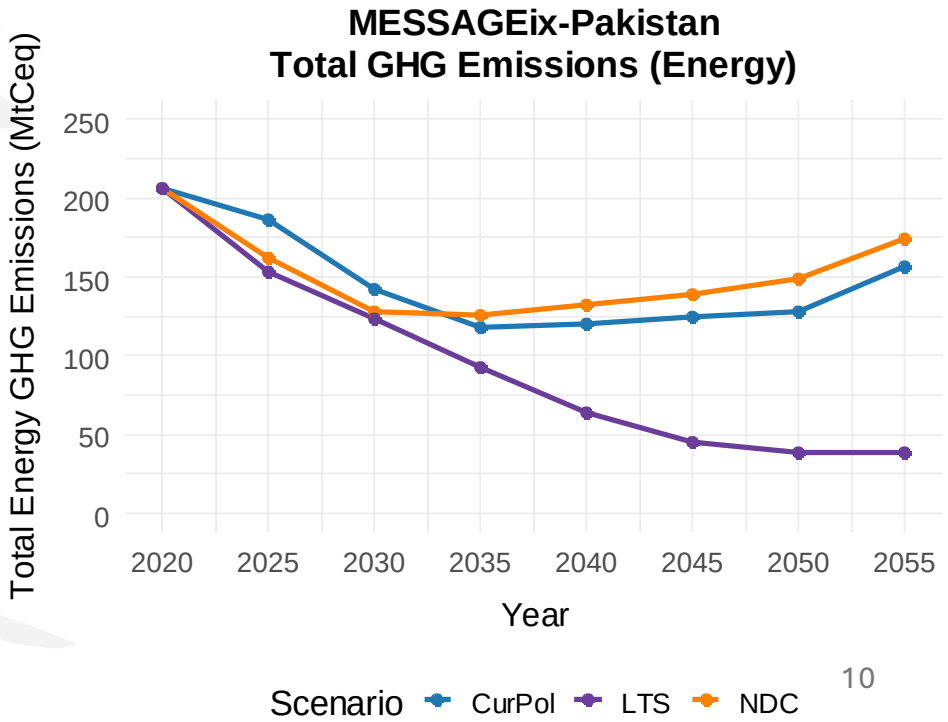
Long Term Strategies (LTS)

- Define emission goals consistent with Paris
- Consistent with regional emissions targets
- Burden Sharing tests

Rising energy demand makes emission reductions challenging at a fixed carbon price

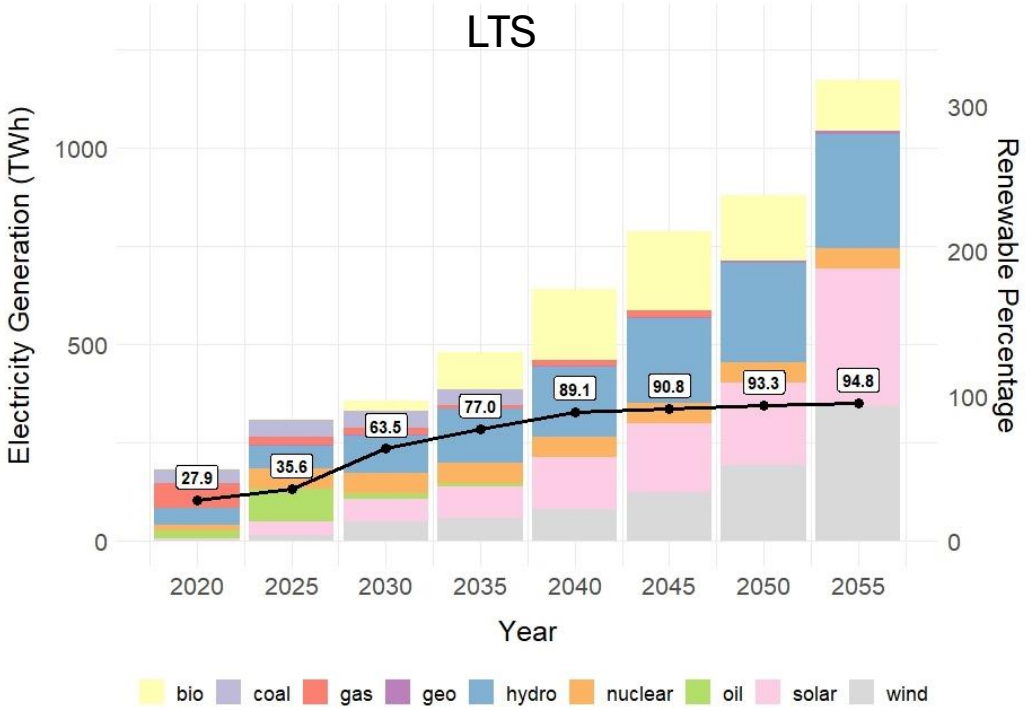
- Lower CurPol emission levels due to reliance on imported coal instead of extraction, reduction in coal power plants, and phase-out of oil-based power generation.
- NDC emissions projected to increase after 2035 due to a constant carbon tax and rising energy demands.
- Post-2045, LTS emissions will mainly come from the cement industry and the transmission and distribution of gas and ethanol.
- Projected population growth necessitates exploring more stringent policies to address rising emissions.

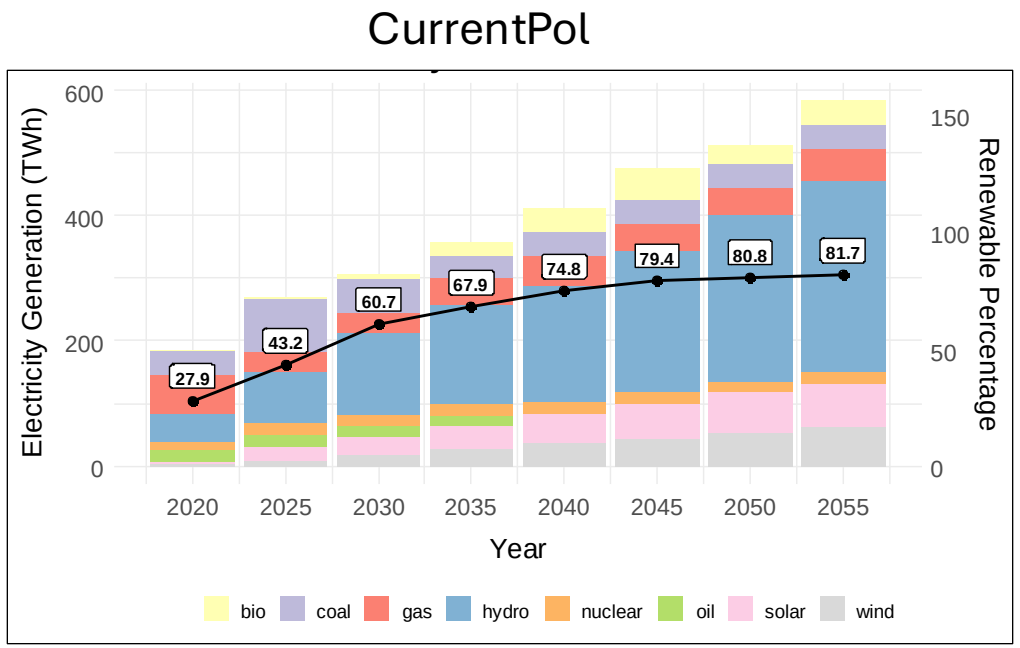


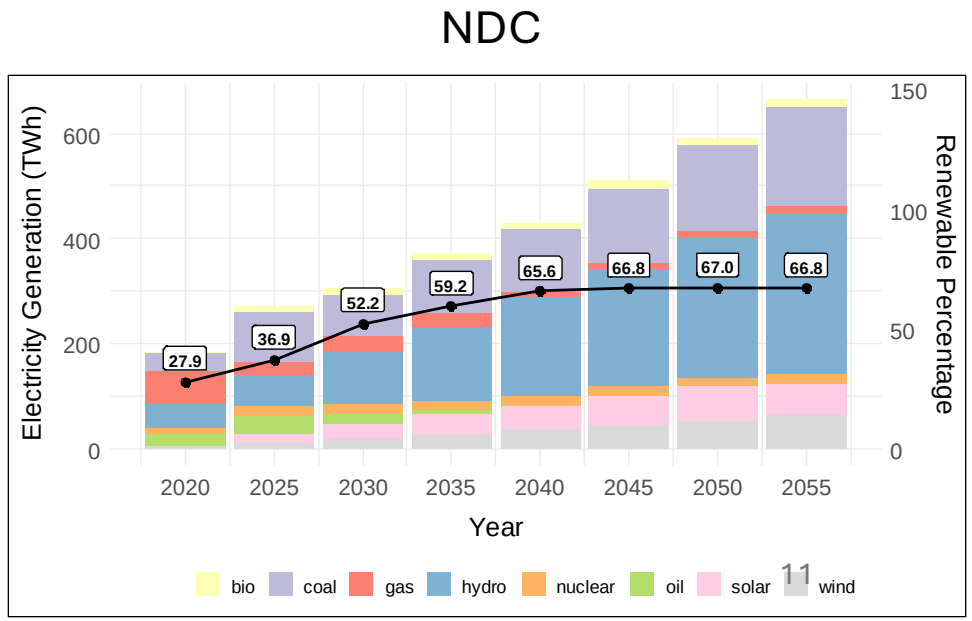


Electrification of sectors

- Coal phase out is essential for a smoother energy transition
- Solar and biomass offer dependable renewable options to replace the current fossil fuel-based energy mix.
- The feasibility of electrification may face constraints due to socio-political factors.



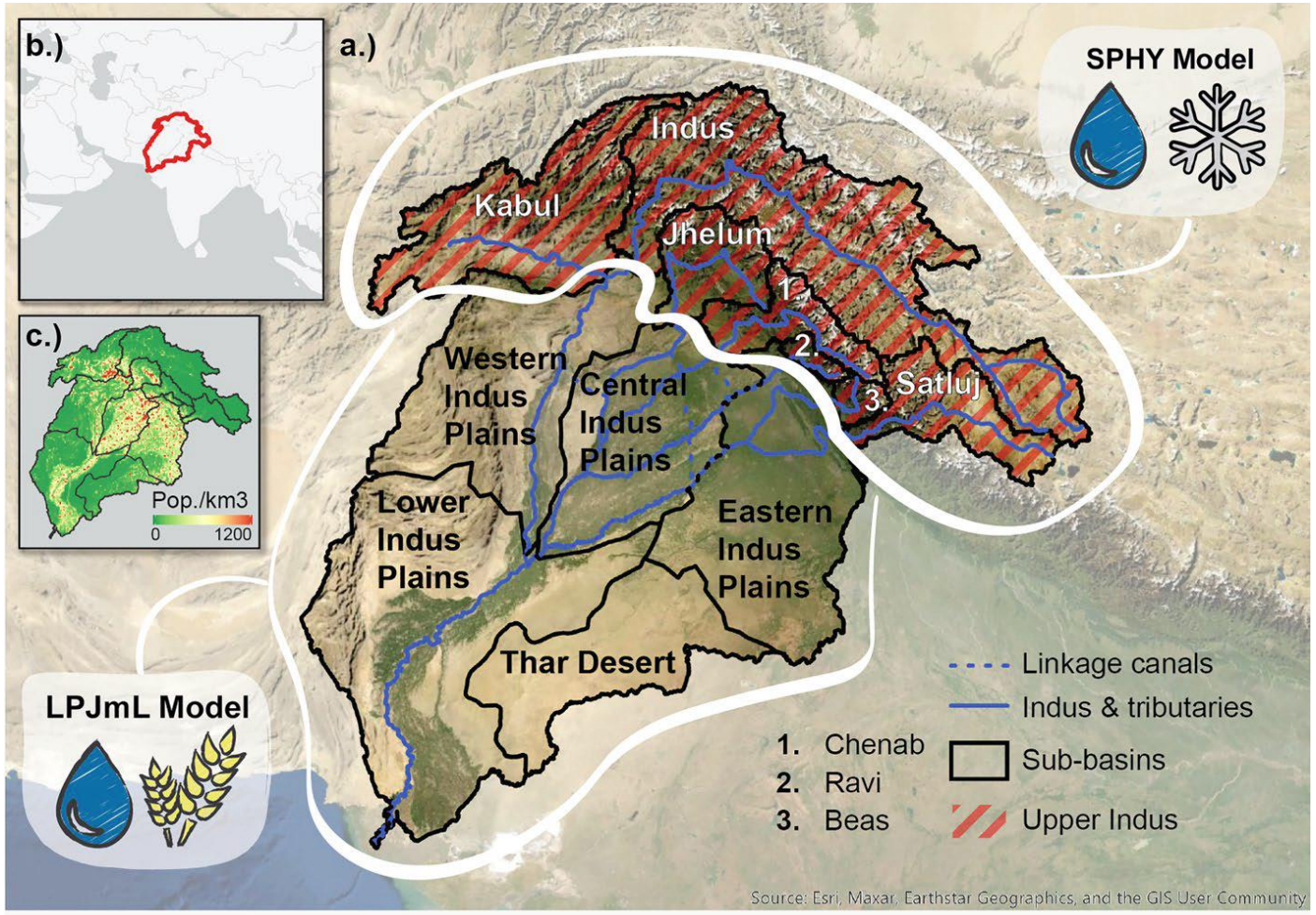




Addressing the challenges require multi-sectoral understanding beyond the energy sector

Balancing water security and food security is challenging

- Ensuring per capita food production would aggravate water stress.
- Conversely, a shift to sustainable water management leads to infeasible food self-sufficiency.
- Biophysical limits do not allow simultaneous food production and improved water security.



Julius, et al. *Environment, Development and Sustainability* (2023): 1-36.

*Ongoing work

State of the Art in Modeling Ag System Change in the Indus

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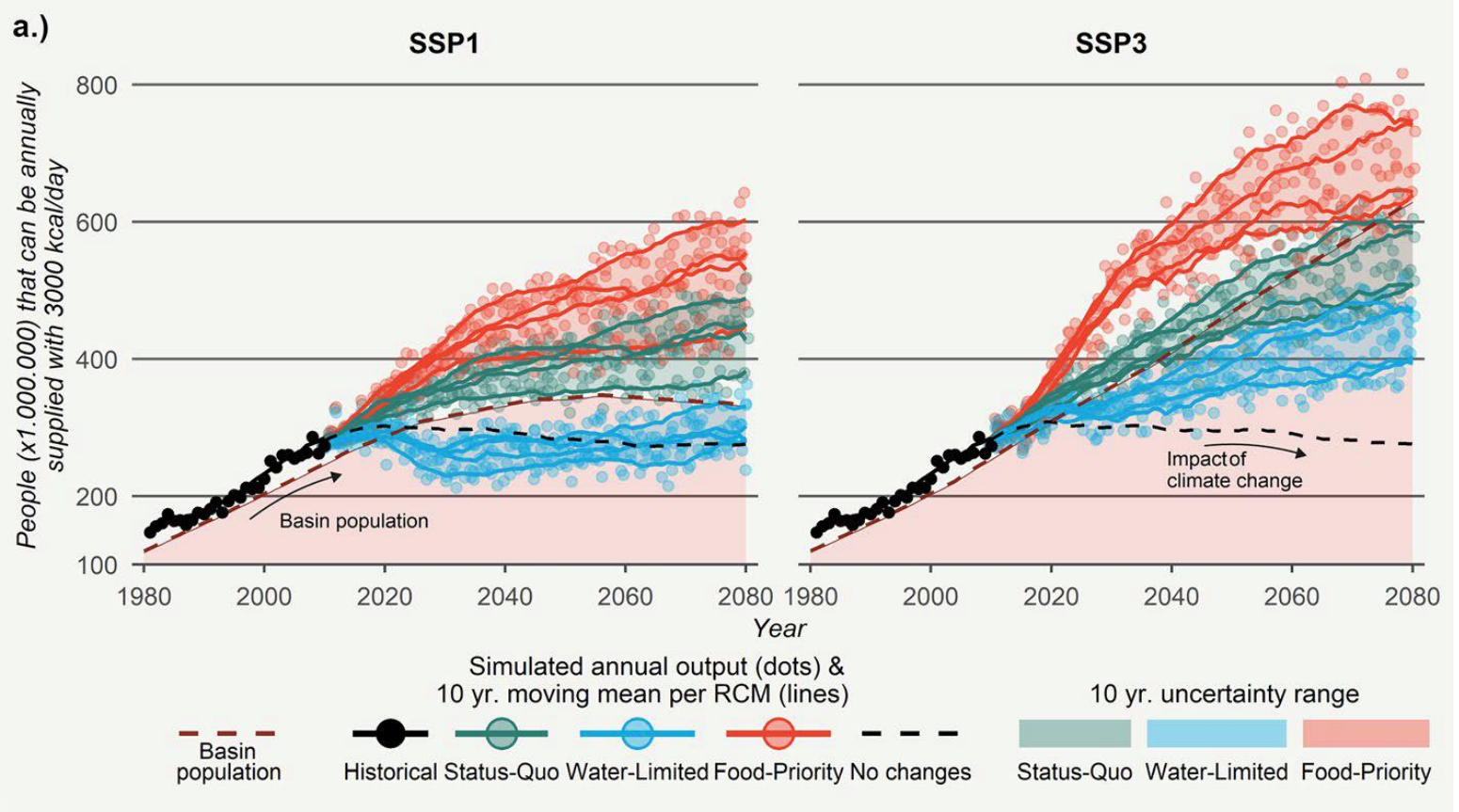

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Scenario Co-creation with Stakeholders

You can create your own scenarios

- SSP1
- SSP2
- SSP3
- SSP4
- SSP5

Shared Socioeconomic Scenarios (SSPs)

- RCP2.6
- RCP4.5
- RCP6.0
- RCP8.5

Representative Concentration Pathways (2.6, 4.5, 6.0, 8.0 Wm^{-2}).

- GFDL
- HadGEM
- IPSL
- MIROC
- NorESM

CMIP5-era GCMs (GFDL, HadGEM, IPSL, MIROC, NorESM)

- 5%
- 25%
- 40%

Groundwater availability scenarios of the physical water availability are allowed

- Restricted
- Expanded

Surface water storage scenarios (NoExp: No additional reservoir storage; MaxExp: full expansion of surface reservoirs

- WaterGapHM
- PCR-GLOBWB

Observational groundwater depletion datasets that we calibrate against

Understanding multi-sector policy challenges

	Policy	Question	Description/	Stakeholder pathway
ENERGY	Environmental flow	What level of environmental flow is a good compromise between costs, benefits and water demand?	Per capita electricity demands remain at historical levels	Economy: per capita electricity demands increase
ENERGY	Electricity demand reduction	SGD 7.3 + 20% end-use efficiency improvement relative to 2015	Per capita electricity demands remain at historical levels	Environment: improve demand side efficiency
ENERGY	Clean energy access	SDG 7.2 By 2030, 50% substantially the share of renewable energy in the global energy mix	No policies beyond current planned infrastructure	Environment Society: set targets of renewable penetration
ENERGY	Power plant cooling	SDG 7.b By 2030, expand infrastructure and upgrade technology	No policy	Environment: Increase the available storage level from 2030 onwards
CLIMATE	Climate change impacts	SDG 13.a Implement the commitment undertaken at the UN Framework Convention on Climate Change	No constraints on emissions	Environment: targets on GHG emission reduction

Scenarios Co-creation – Targets

Sectors	Indicators	Low Emissions	Climate Resilience	Economic Development
Water	1(a) Sustainability/ Environmental Flows			
	1(b) Irrigation technologies			
	1(c) Extreme Events			
Energy	2(a) Access/ Loadshedding			
	2(b) Demand side measures			
	2(c) Supply side measures			
Land	3(a) Land cover/ land use			
	3(b) Yields/ technologies			
	3(c) Unintended consequences			

Scenarios Co-creation – Feedbacks

	Scenarios →	Low Emission		Climate Resilience		Economic Development	
Sectors	**Indicators**	**Tradeoffs**	**Synergies**	**Tradeoffs**	**Synergies**	**Tradeoffs**	**Synergies**
Water	1(a) Sustainability/ Environmental Flows						
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Key Messages

The local policy and NDC commitments need more evidence-based solutions.

Agriculture and Energy systems transitions are key for reducing emissions however, the water stress poses risks to

Irrigation (water) and climate have complex synergies and trade-offs in the Indus Basin

Regional effort sharing targets need to be developed to align with global climate targets.

Thank You!

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