

Energy data for the economic modelling of water scarcity

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Integrated Water-Energy Modelling Workshop

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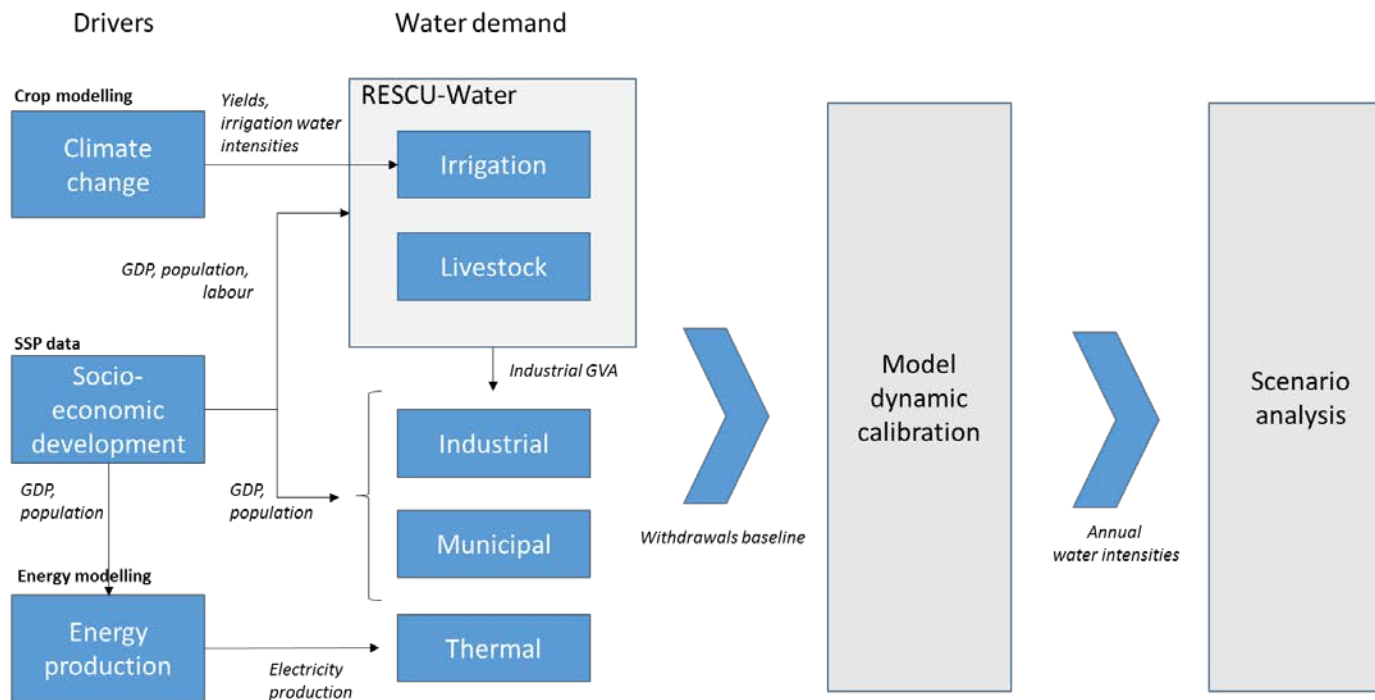
Research area

- **Water scarcity** one of the looming global threats to economic prosperity – WEF 2015
- Water resources unequally distributed across regions
- About 10% of renewable resources used in economic activities – irrigation 70% of abstractions, power cooling 15% (IEA WEO 2012)
- **Water demand:** How will pressure of the resource base evolve up to 2050? What will be the economy-wide impact of water scarcity?

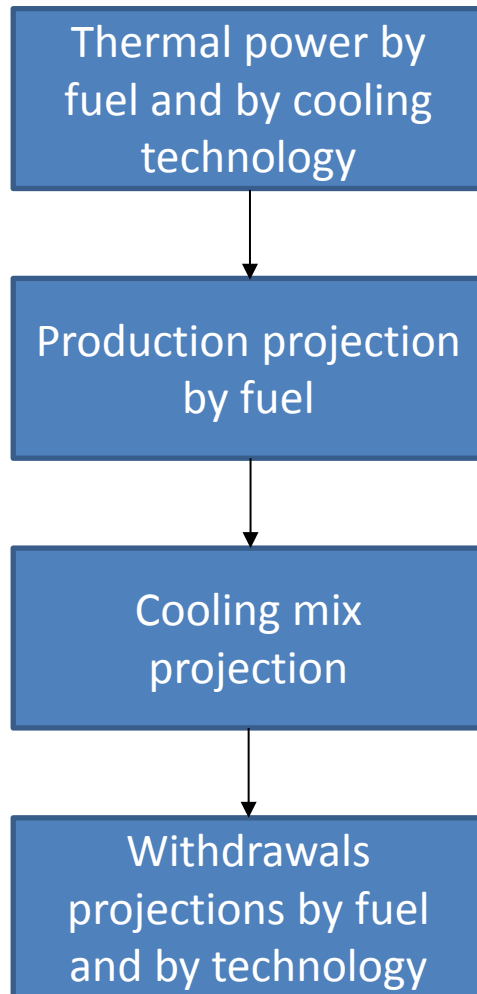


Analysis

- Withdrawals baseline construction for main user groups
- Modelling sectoral impacts of water scarcity – alternative water allocation methods



Thermal cooling - linking TIAM-UCL data



WaterGAP/EXIOBASE freshwater withdrawals by fuel and cooling technology

Water intensities (m^3/MWh) from Florke et al. (2013)

TIAM-UCL projections by fuel type for SSP2

WaterGAP power production by country – mapping to RESCU regions

Power plant depreciation rate

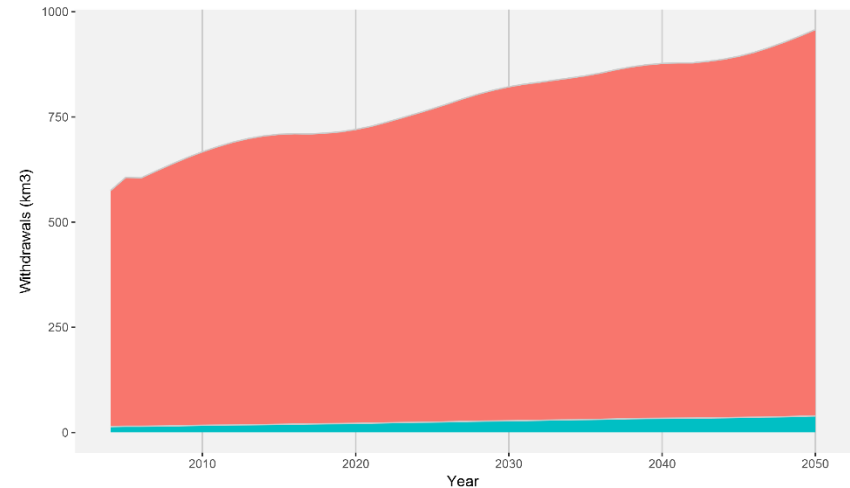
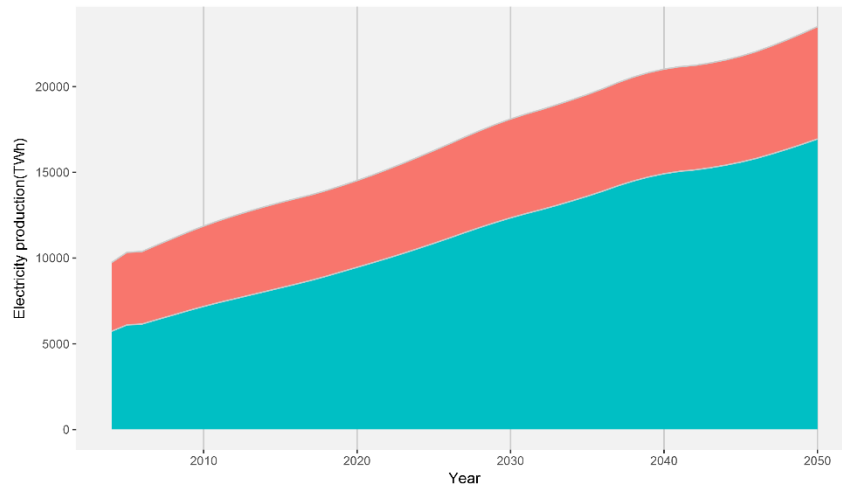
Tower cooling adoption rate – new capacity more efficient

RESCU-Water regional aggregation

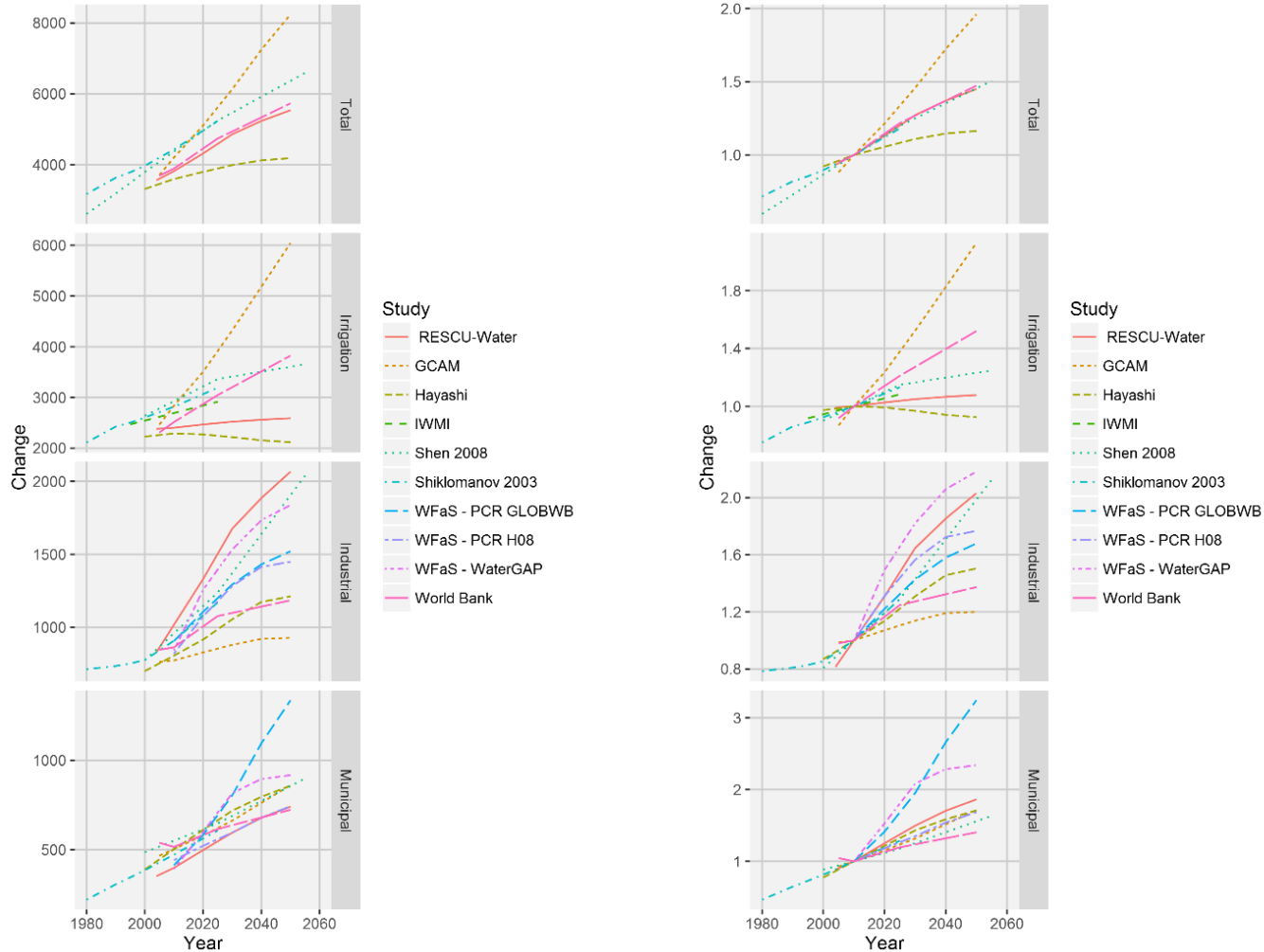


Global withdrawals for thermal power cooling – SSP2

- More electricity from tower cooling
- Low impact over withdrawals due to old power plants still operating



Projections in other studies



Water scarcity analysis - RESCU-Water

- Global economic model (CGE) – 20 world regions, 31 productive sectors
- Dynamic-recursive – 2004-2050 simulations based on SSP storylines
- GTAP9-Power database with 11 technologies aggregated into thermal and non-thermal
- Adaptation to water scarcity possible through a switch to non-thermal power production
- Bottom-up representation of crop production – irrigated and rainfed technologies



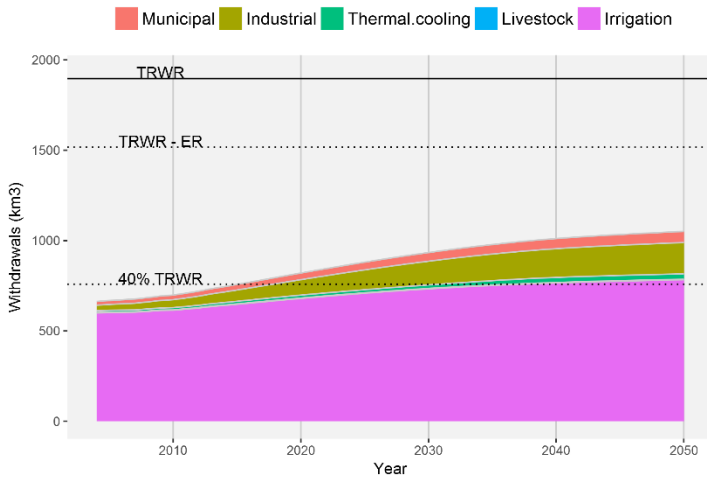
Water scarcity scenarios

- Regional water use constraints based on sustainability thresholds – India, South Asia, Middle East, Northern Africa
- Four water management options
 - Full allocation (FA) – perfect mobility across the economy
 - Limited mobility (LM) – 5% of resources re-allocable
 - Market fragmentation (MF) – separation between agri and non-agri users
 - Agriculture last (AL) – non-agri users unconstrained

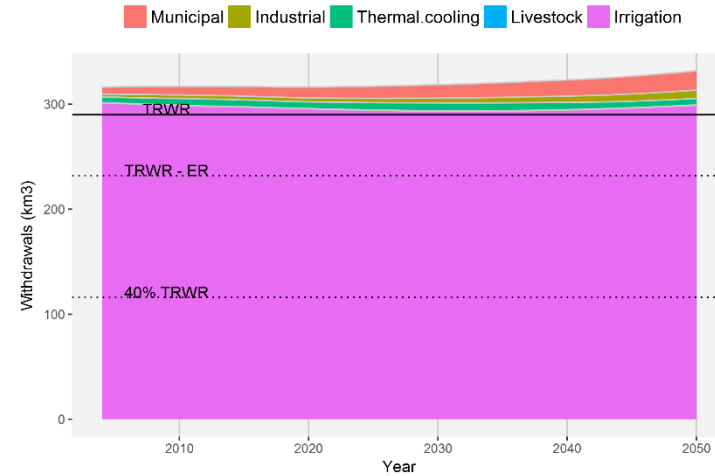


Withdrawals baseline in water scarce regions

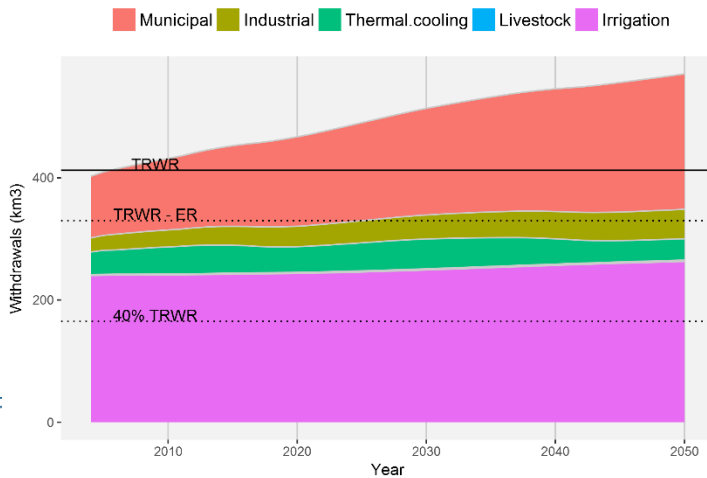
India



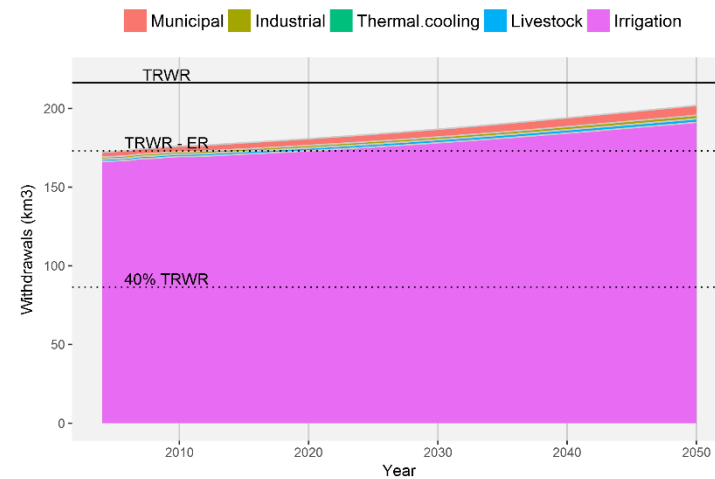
South Asia



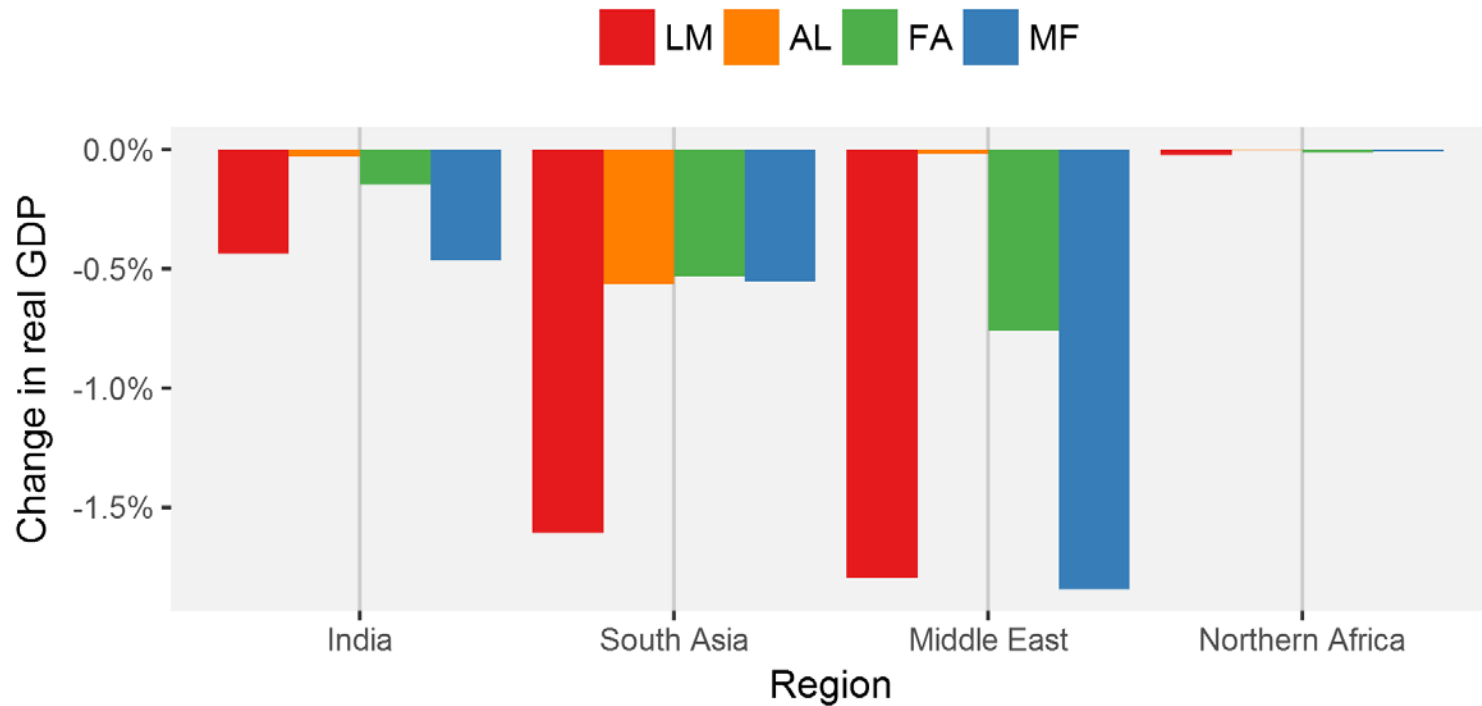
Middle East



Northern Africa

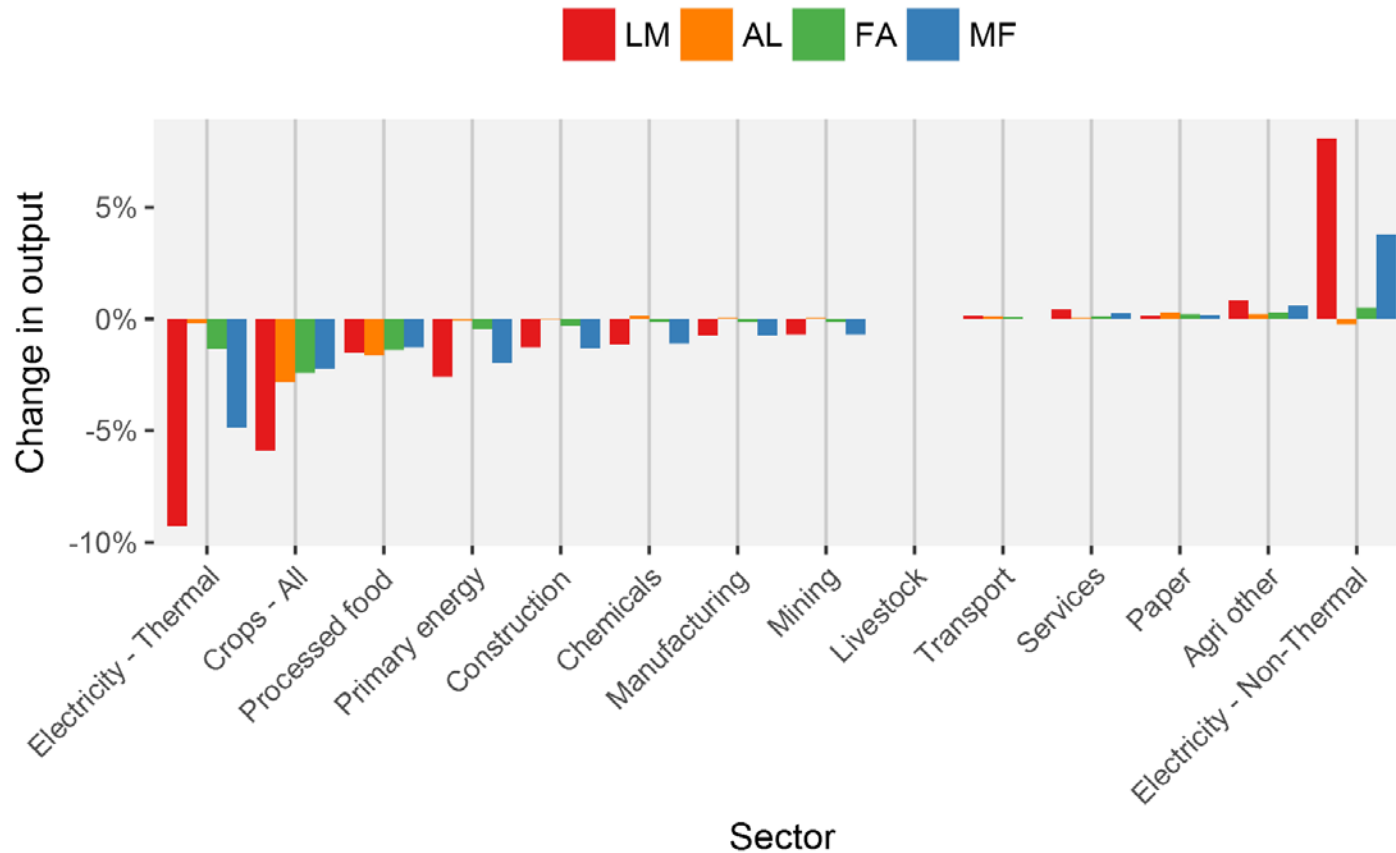


Macroeconomic impacts

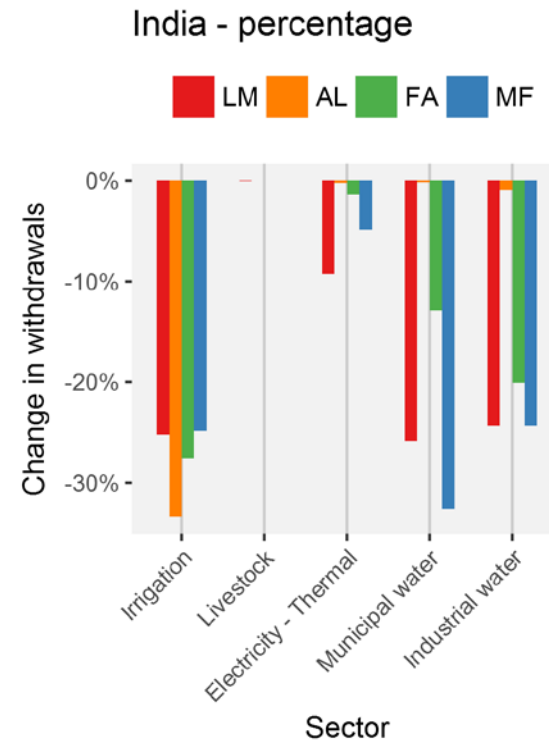
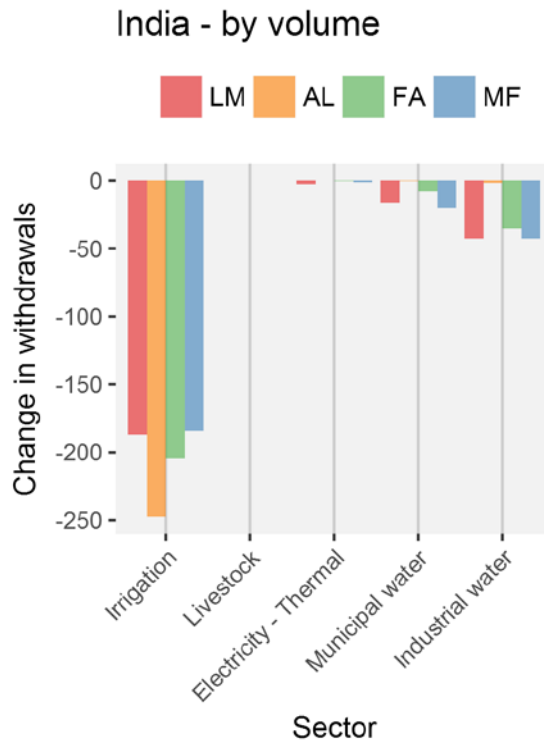


India – change in output 2050

India



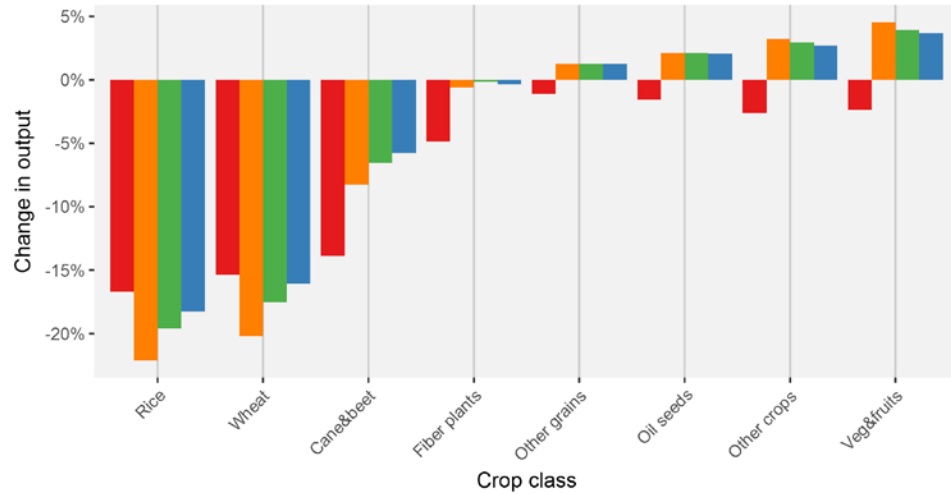
India - withdrawal changes 2050



India – crop production changes 2050

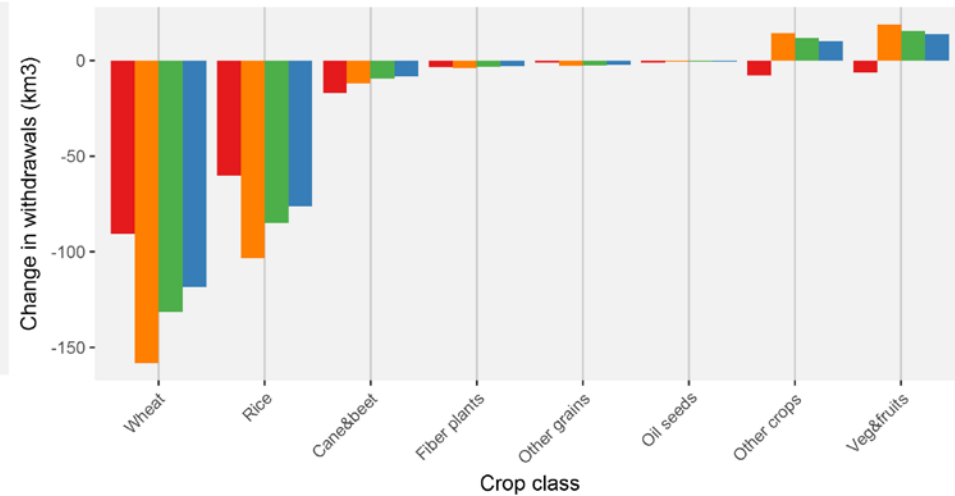
India - output change

LM AL FA MF



India - withdrawal changes

LM AL FA MF



Conclusions and next steps

- Baseline subject to many uncertainties e.g. spatial expansion of energy systems
- Significant trade-offs between crop production (food security) and other sectors
- Thermal power production – minor role in withdrawals reduction but highly exposed to water scarcity
- Next steps – co-benefits of low-carbon transitions, potential for retrofitting power plants



Thank you.

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RESCU-Water

- Global dynamic-recursive – 2004-2050 with SSP storylines
- GTAP9-Power database – 20 world regions, 31 productive sectors
- Economy-wide representation of water uses
 - As natural resource for self-abstractors (irrigation, livestock, thermal power cooling, water distribution networks)
 - As commodity for supplied users (industrial and municipal)
- Advanced mechanisms of adaptation to water impairments
 - Crops: irrigated → rainfed growing methods
 - Power production: thermal → non-thermal technologies
 - Input substitution of supplied water
- Alternative water management options
 - Full allocation (FA) – full water mobility
 - Agriculture last (AL) – no-agri users unconstrained
 - Market fragmentation (MF) – separation of agri- and non-agri water users
 - Limited mobility (LM) – only 5% re-allocable / institutional and infrastructure constraints

