Efficacy of adaptation measures to future water scarcity on a global scale

Sayaka YOSHIKAWA
Tokyo Institute of Technology
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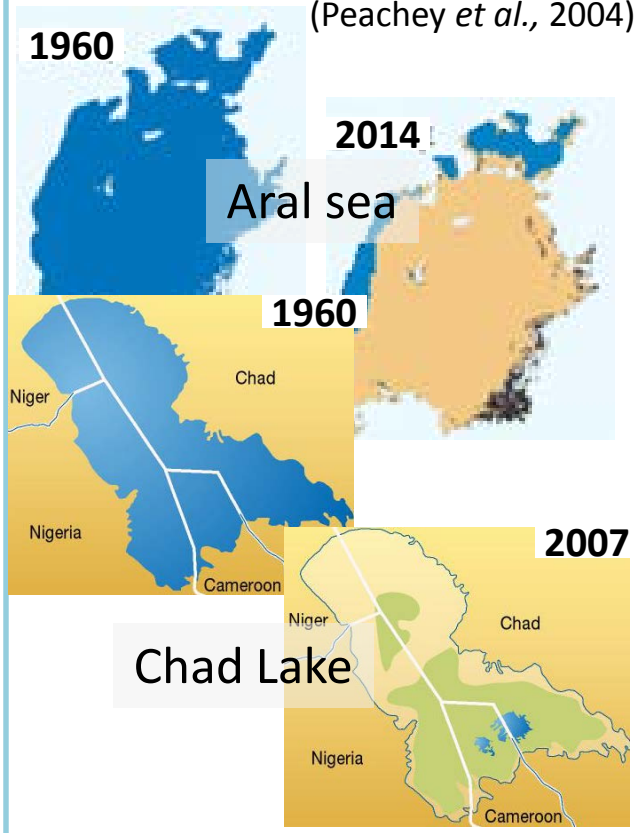
Depletion of water supply source

we have faced on depletion of water supply sources due to human activity and climate change.

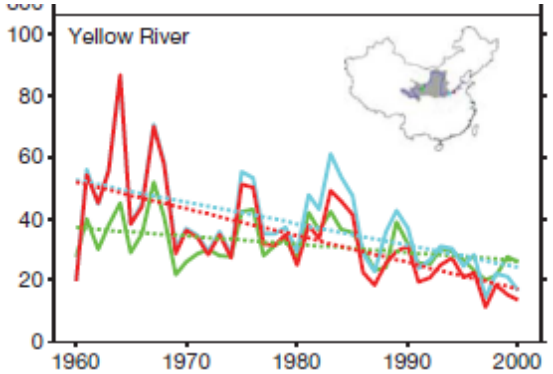
The shrinking Lake

(Peachey *et al.*, 2004)



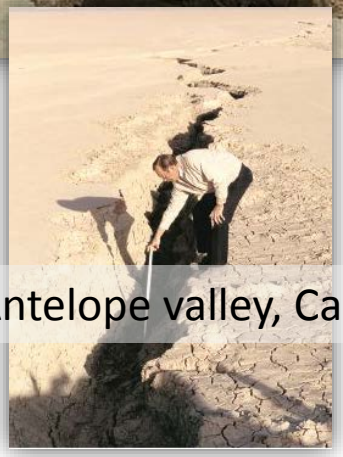
Running dry of discharge

(Piao *et al.*, 2010)



Observed annual discharge from 1960 to 2000

Groundwater depletion



Aral sea and Lake Chad have shrunk water regions. Yellow river was running dry, And North-western India and central United states have experienced groundwater depletion.

Questions

Is it sufficient to use existing water supply sources in the future?

Can we have efficacy of adaptation measures to future water scarcity?

Contents

1. An assessment global water requirements from various water supply sources (1960-2050)

2. Adaptation measure
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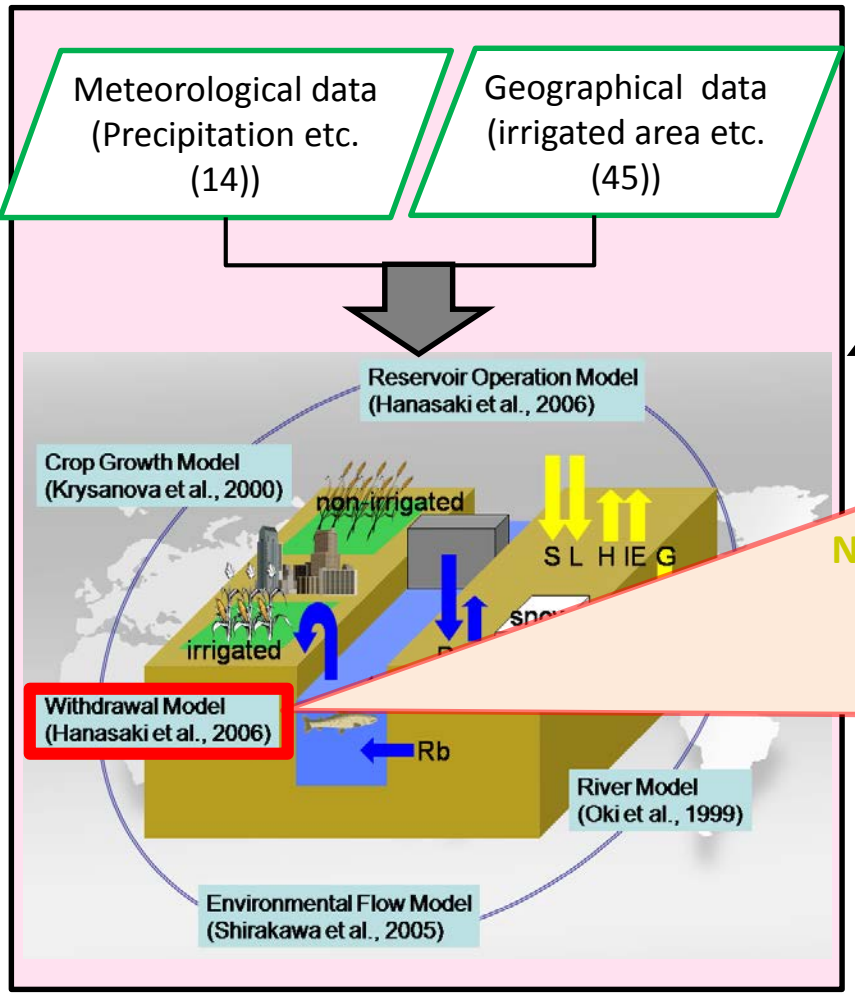
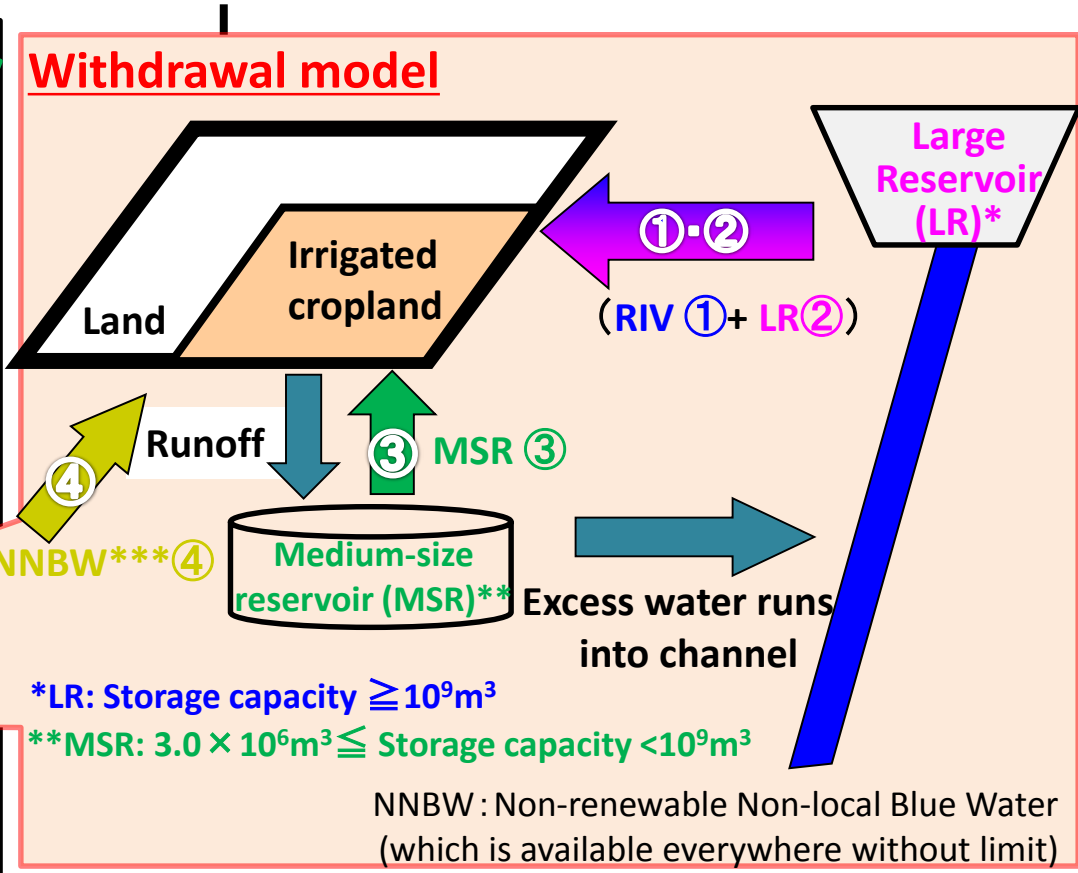
Integrated water resources model (H08)

- Simulate both natural water flow and anthropogenic water withdrawals
- On a daily time step at the resolution of 1.0° ×1.0° and 0.5° ×0.5°

(Hanasaki et al., 2008; 2010)



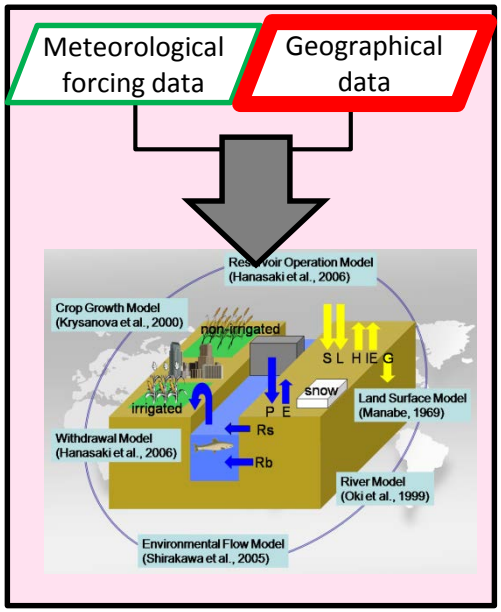


Total demand = Total requirement

= *RIV*①+*LR*②+*MSR*③+*NNBW*④

Data –Geographical data-

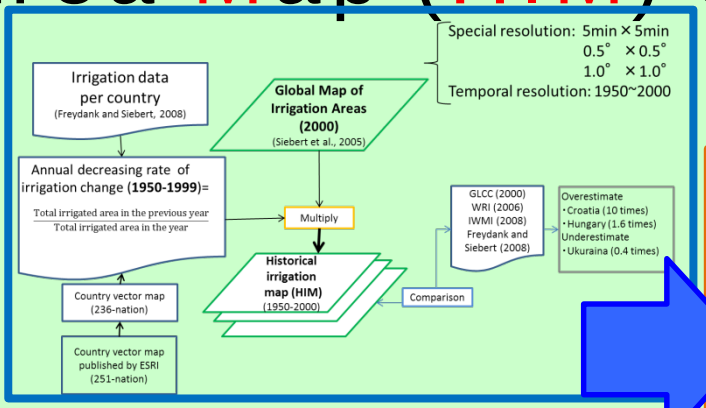
Historical Irrigation equipped area Map (HIM) data

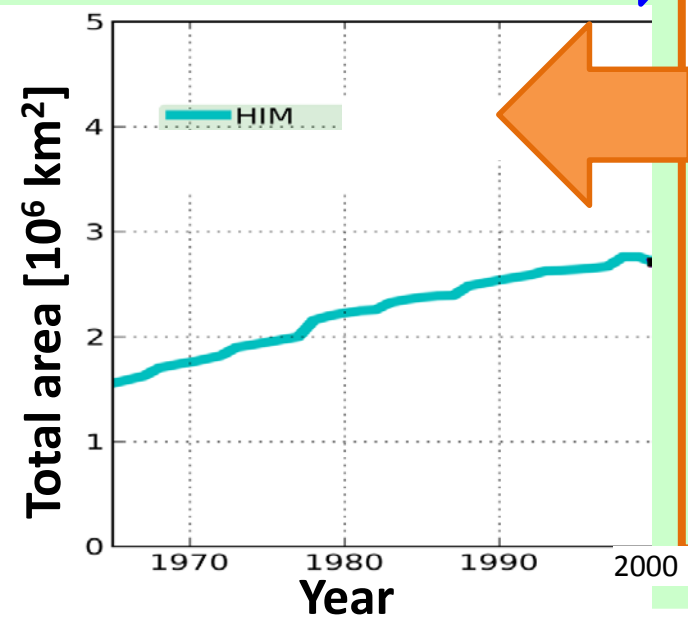


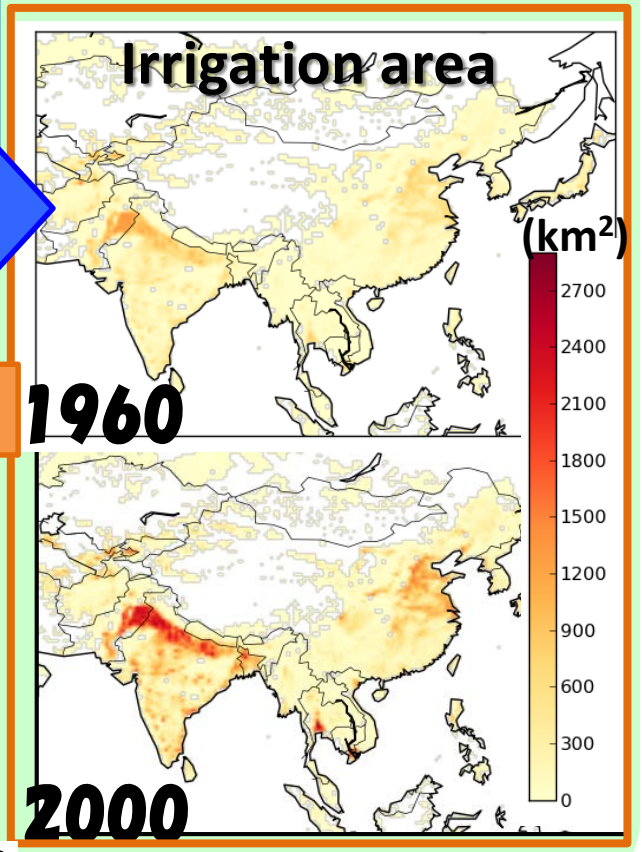
a global spatial and temporal database of irrigation area

→・ irrigation area map from Siebert et al. (2007)

・country based irrigation area change from Freydank and Siebert (2008).







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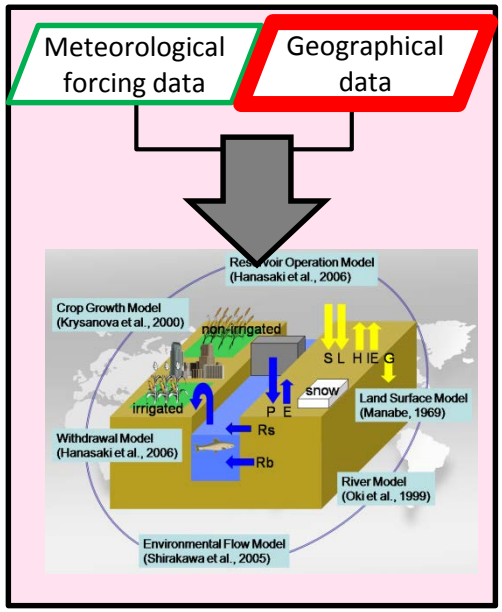
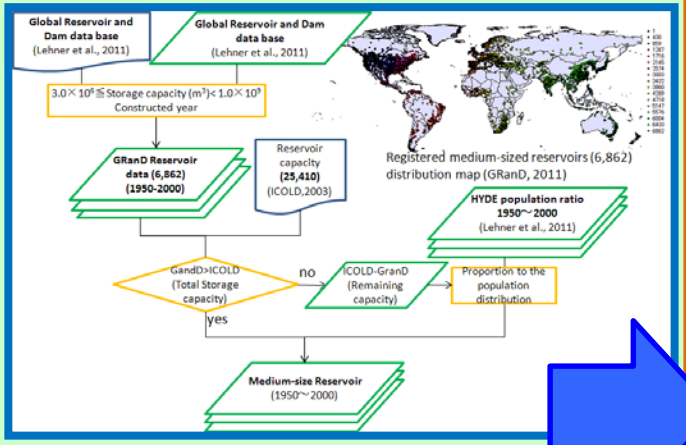
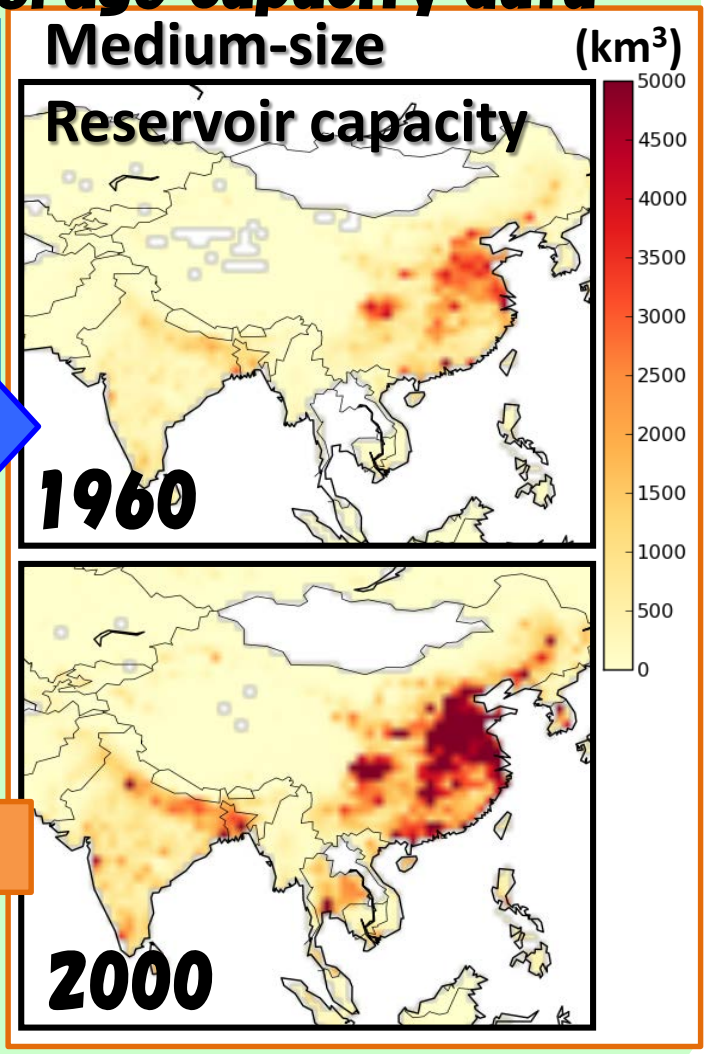
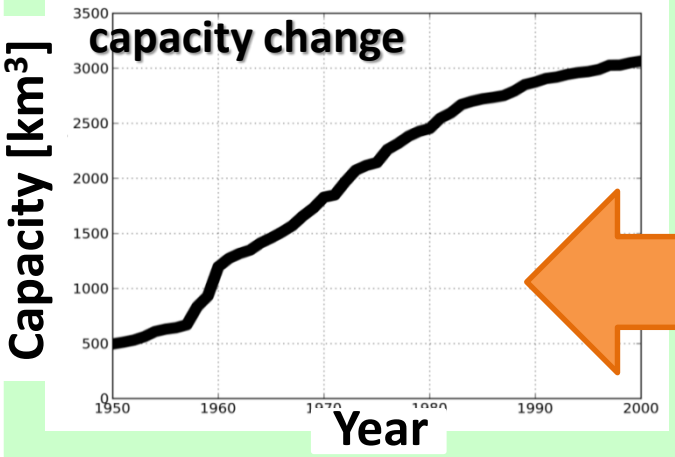


Medium-size reservoirs storage capacity data





Global Medium-size reservoirs capacity change

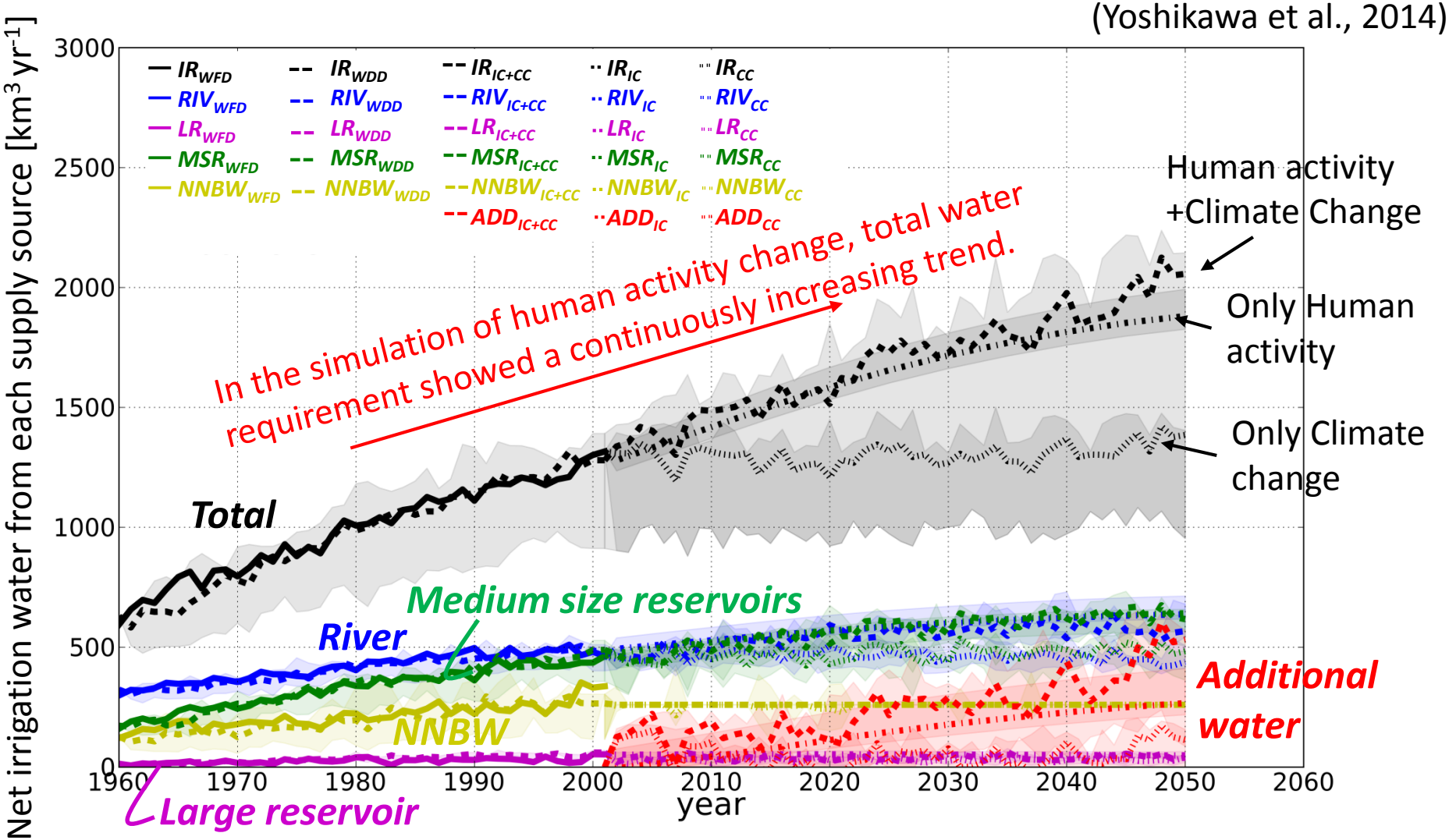


- GRanD (Lehner et al., 2011)
- ICOLD (2003)

The remaining storage capacity was calculated from the difference between the comprehensive inventory in ICOLD (2003) and the aggregated storage capacity at the country scale. The geographical distribution of the remaining storage within each country was then weighted in proportion to population

Water requirements from several water supply sources (1960-2050)

(Yoshikawa et al., 2014)



River: irrigation pply from river, ***Large reservoir***: irrigation water supply from large reservoirs ***MSR***: irrigation water supply from medium size reservoirs, ***NNBW***: irrigation water supply from non-renewable non-local blue water

Additional water: Difference in NNBW between future and past periods

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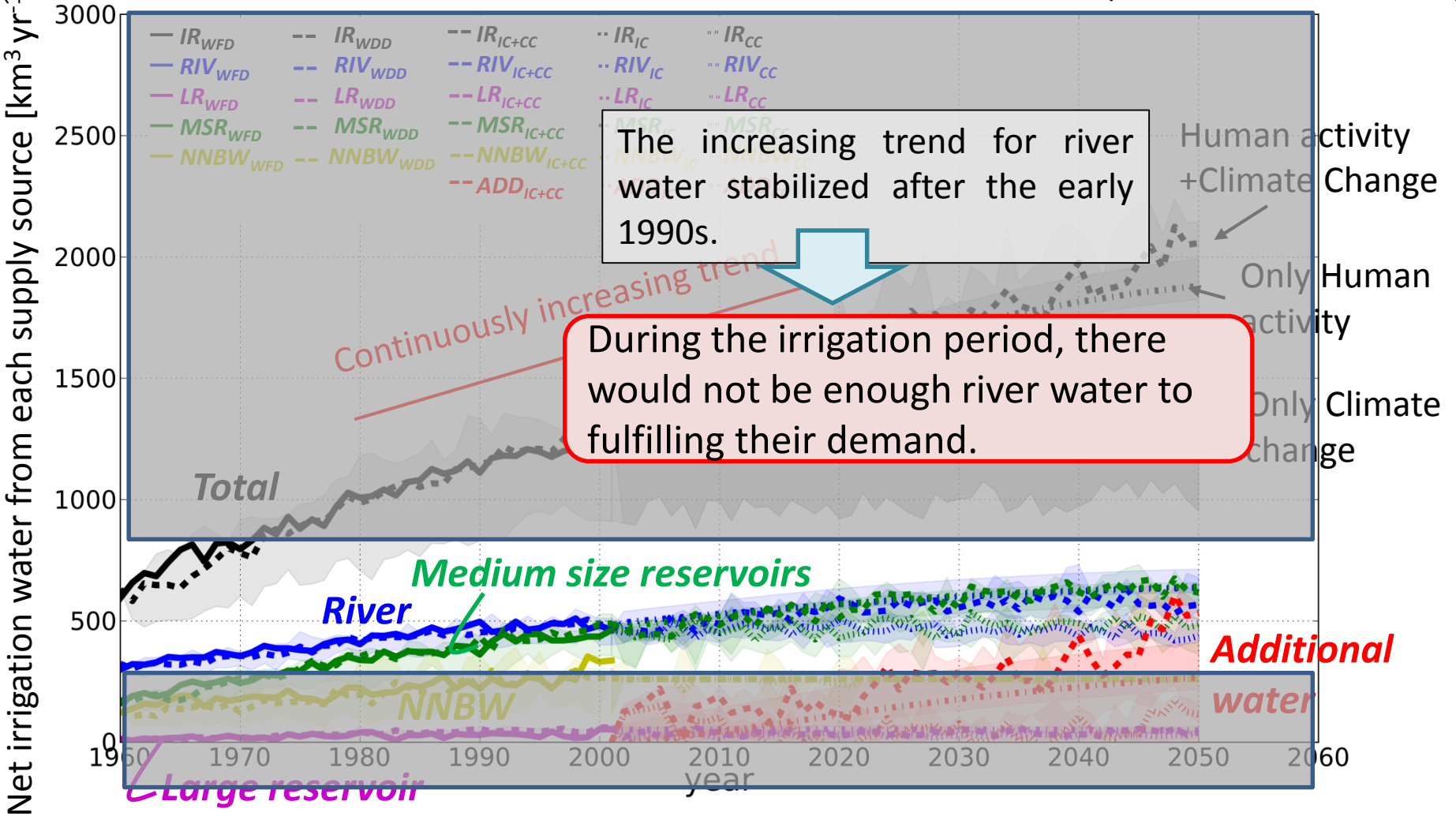

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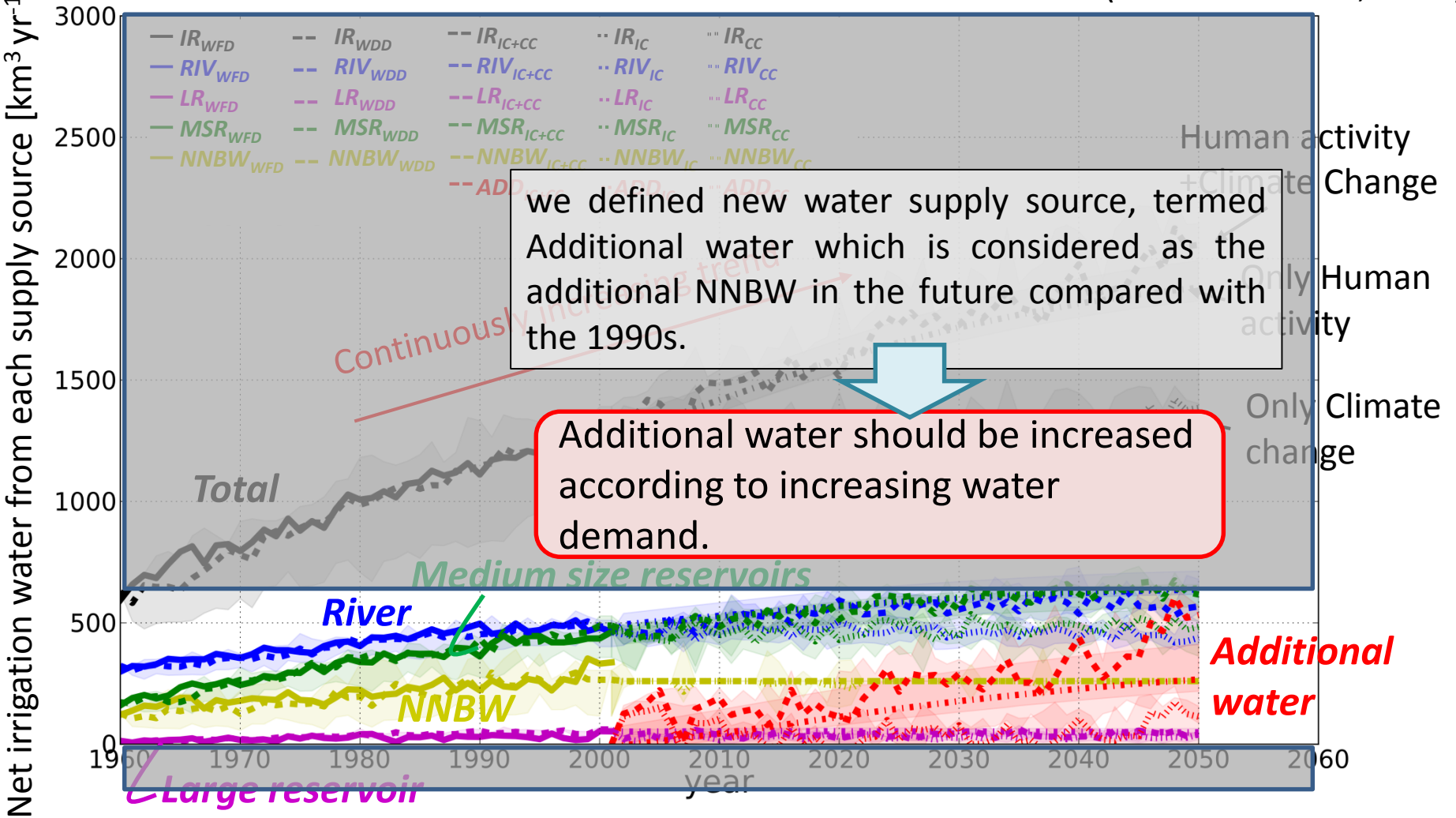

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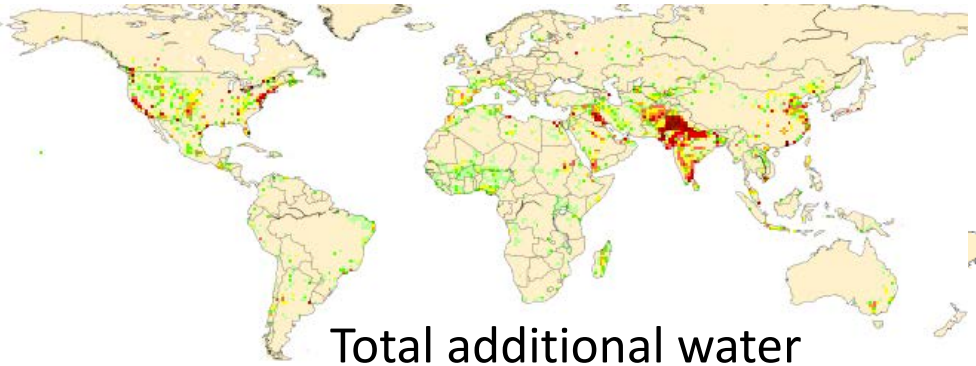
Additional water: Difference in NNBW between future and past periods

Additional water requirement

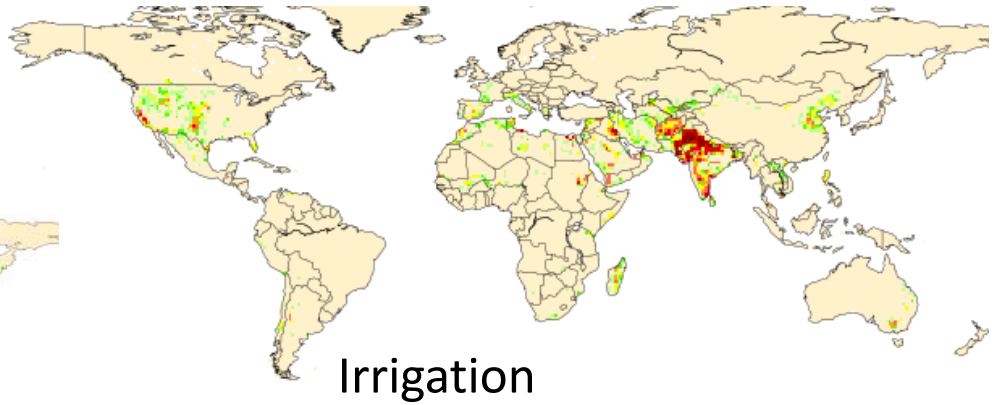
2040s
(Human activity + Climate Change)

(Yoshikawa et al., 2014)

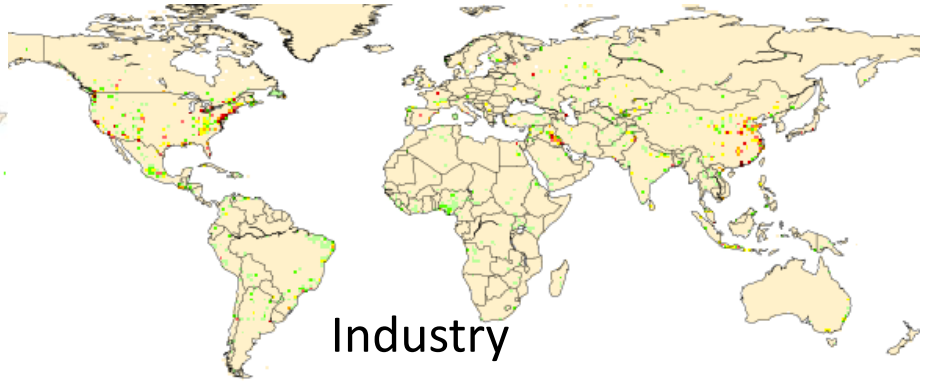


Total additional water

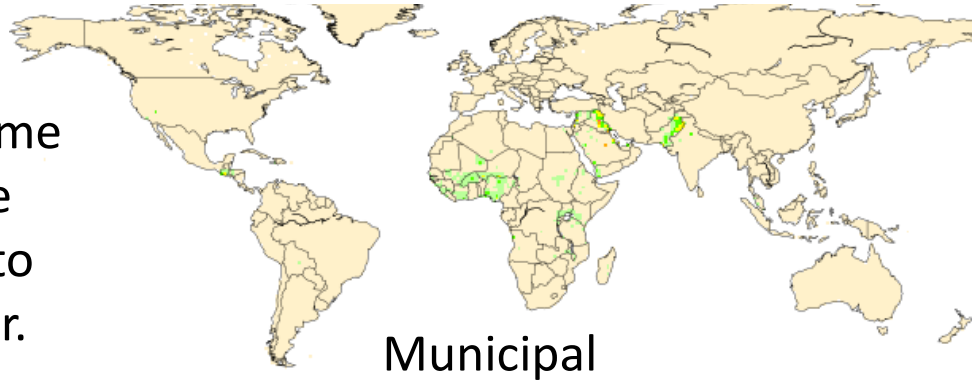
(× 10^6 m^3/y)



Irrigation



Industry



Municipal

This indicates that the red area may become more high water shortage in 2040s. At the same time, it means that the areas need to takes every measure to obtain more water.

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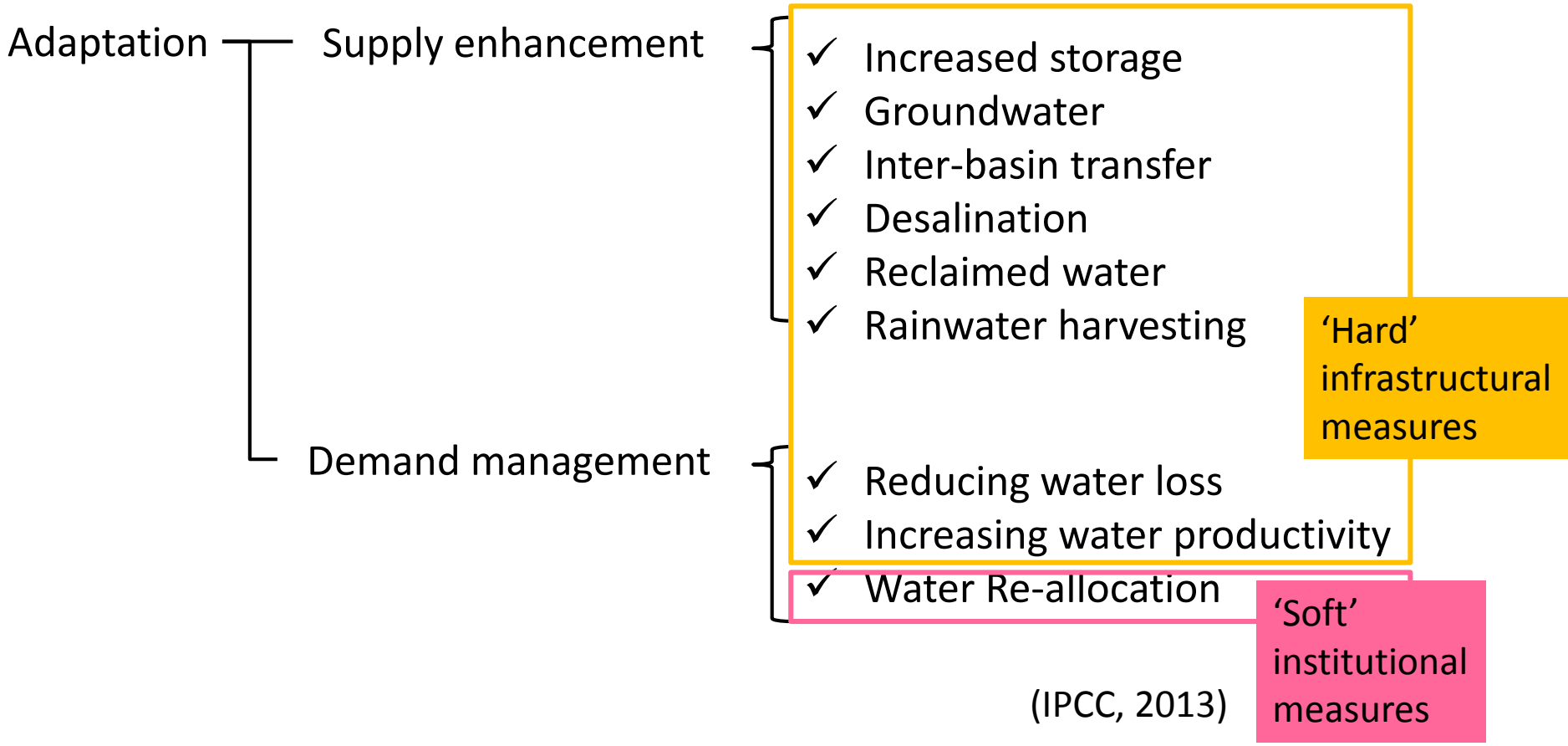
Options to coping with water scarcity

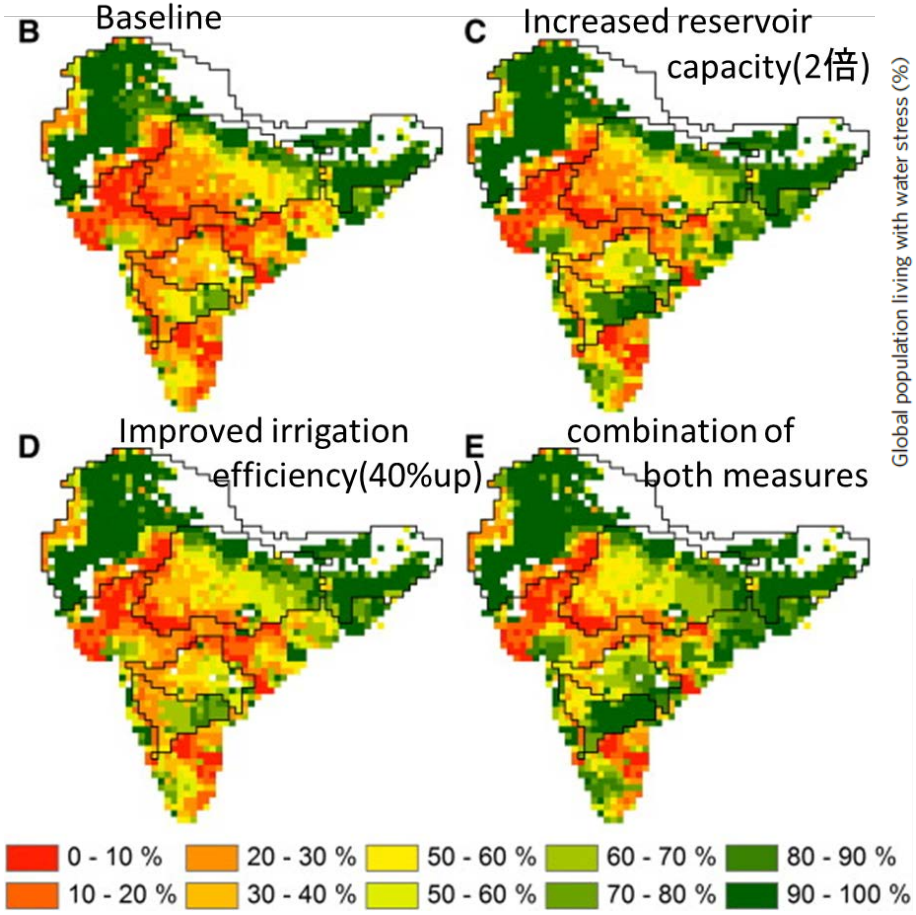
For reducing these future high water stress, adaptation measures would be vital. (FAO, 2012)



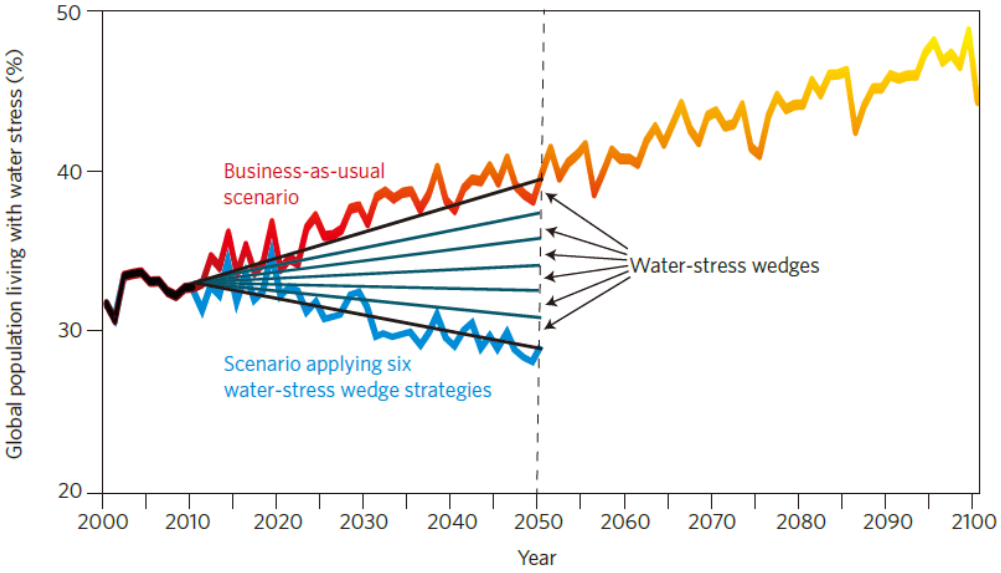
(IPCC, 2013)

Previous studies

(Biemans et al., 2013)



(Wada et al., 2014)



Extending water scarcity assessments, a few attempts are being made to determine how a combination of reservoirs, desalination plants, and drip irrigation could reduce water scarcity on a global scale.

Now our team also are doing effort

Adaptation options		References
Supply enhancement	Increased storage	Hanasaki et al (in prep)
	Groundwater	
	Inter-basin transfer	
	Desalination	Hanasaki et al (2016) Gao et al (under review)
	Reclaimed water	Yoshikawa et al (in prep)
Demand management	Reducing water loss Increasing water productivity	Nagano et al (in prep)
	Water Re-allocation	

However, little attention has been paid to water re-allocation in the context of adaptation to water scarcity on a global-scale.

Questions

Is it sufficient to use existing water supply sources in the future?

→ **No**, if irrigation areas and climate change have impacts on future water requirements.
(more water will be required from additional water supply sources.)

Can we have efficacy of adaptation measures to future water scarcity?

→ may **Yes**, but now we didn't estimate how much water can be taken from water markets. Estimations of other adaptation measure are also under process. We need to know social background of each place for doing simulation of reducing future high water stress.

Challenge towards global water assessment

Necessity of elucidation of Anthroposphere mechanism（social and historical background involved in water resource management on global scale）

↓

What? How? Who? in each scale

- Legal condition
- Public acceptance
- Economic condition
- Ecosystem and environmental consideration

⇒ Difficulty of policy implementation

Transdisciplinary work would be essential to this challenge.

Thank you for your kind attention

Sayaka Yoshikawa
(sayajo@chikyu.mei.titech.ac.jp)
http://kanaelab.jimdo.com/