

What would Thomas Malthus tell us in the 21st Century? Challenges and Opportunities for Integrated Assessment Modeling from an International Development Perspective

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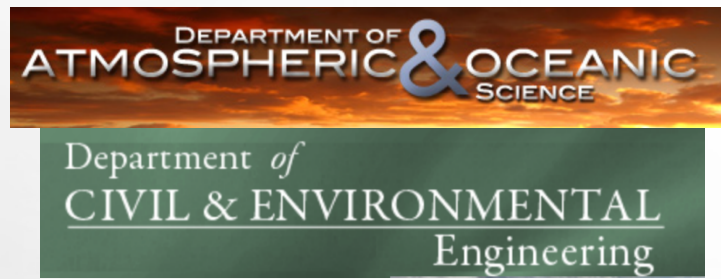
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Famous Quotes

“It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.”

Mark Twain



The water-energy-food challenge is already present and very real

Water shortages hit US power supply

Updated 10:54 20 August 2012 by [Sara Reardon](#)

OP-ED CONTRIBUTOR

Will Drought Cause the Next Blackout?

By [MICHAEL E. WEBBER](#)

Published: July 23, 2012 | 150 Comments

Austin, Tex.

China power crunch to worsen as drought slashes hydro

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Asia Risks Water Scarcity Amid Coal-Fired Power Embrace

(Reuters) - The worst drought to hit central China in half a century has brought water levels in some of the country's biggest hydropower producing regions

as bayou floods
Tue, May 17 2011

Japan keeps
Fukushima
shutdown target

Bloomberg News

China, India Lack Water for Coal Plant Plans, GE Director Says

Connecticut nuclear power plant shut down one unit due to hot water from Long Island Sound

Published: Monday, August 20, 2012

Maharashtra: Parli power plant shuts down after severe water crisis

By [Rashmi Rajput](#), Edited by [Amit Chaturvedi](#) | Updated: February 17, 2013 17:33 IST

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'Water becoming a serious constraint for power generation'

The power plant has an installed capacity of 1130 MW.


Pacific Northwest
NATIONAL LABORATORY

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“Environmental Security”: an ideal ground for research and application of IAM




Food Security

- Increase in food production required to feed a world of 8 billion by 2030, 9 billion by 2050
- Increased dependence on food trade exposes countries to water stress impacts abroad



Energy Security

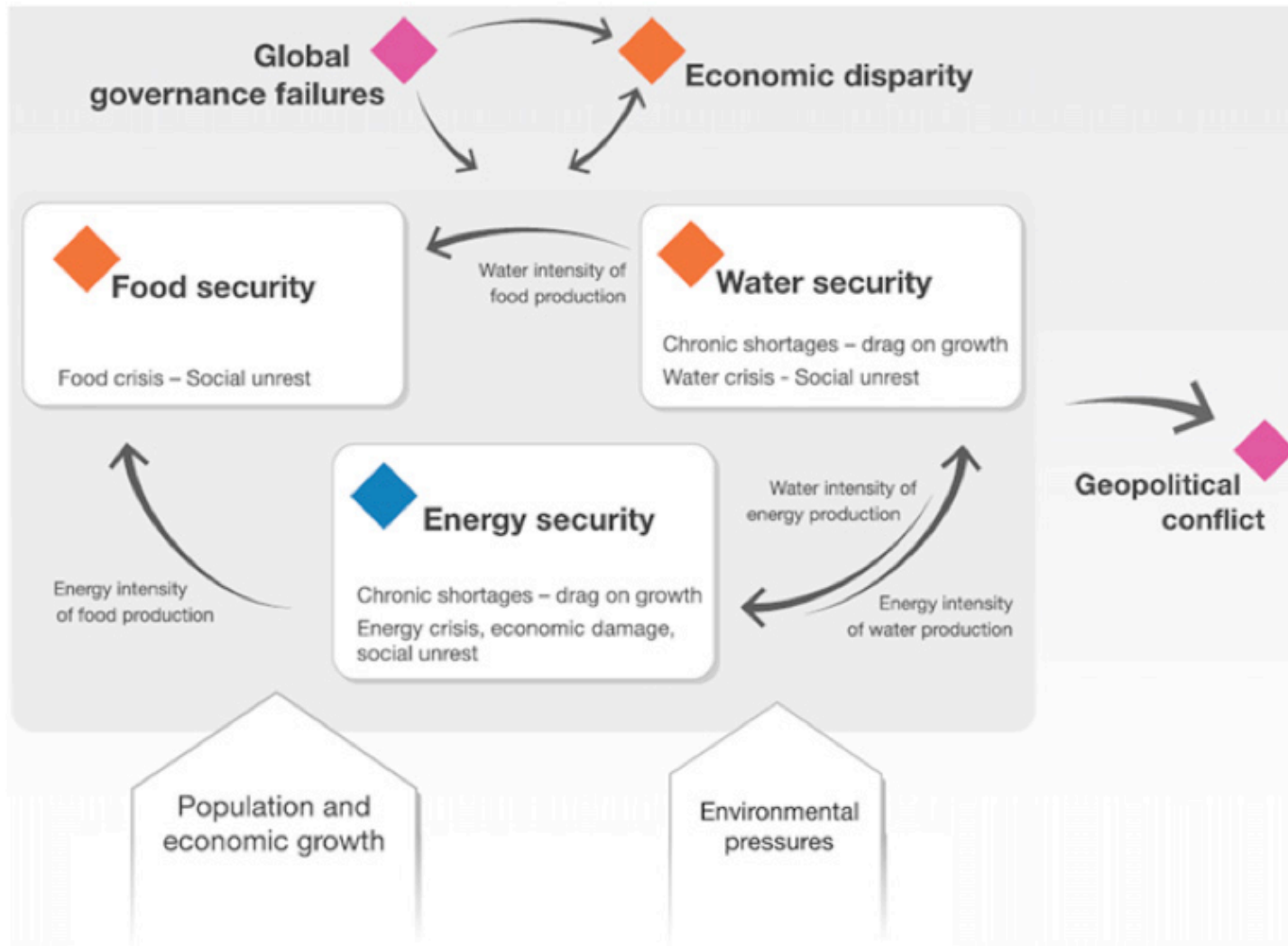
- Trade-offs between water and energy including integrated management of hydro and other energy sources
- Regional cooperation needed to optimize hydropower in conjunction with other water uses



Water Security

- Increased water demand from growing cities
- Growing numbers of people and value of assets at risk from flooding

Environmental Security and the Nexus



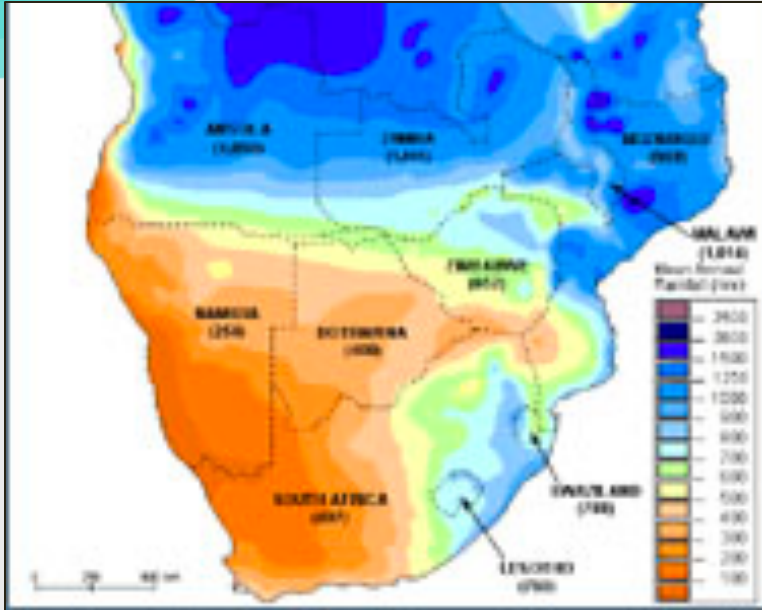
Nexus schematic with a WEF security focus (Bazilian et al. 2011).

Working with International Development Banks

- ▶ World Bank, IDB, EBRD, ADB, AfDB, others.
- ▶ Development bank owners are its clients.
- ▶ These clients are countries (but really governments)...
- ▶ ...so, “country needs” are often mixed up with “political needs”.
- ▶ How can you effectively get science into the politically and demand-driven process?
- ▶ How do you do this in regions with varying political tendencies, agendas and levels of development?



South Africa: the case of a water scarce country

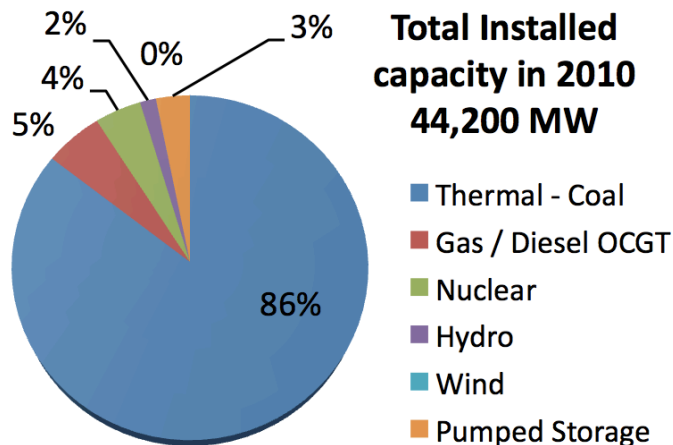


Water scarce country with very stressed basins in terms of water demands/allocation

Coal thermal power plants account for almost 90% of the power capacity installed

Competition for water across sectors will increase – power plants have priority, which could negatively affect other sectors such as agriculture

Fracking for shale gas is being explored, which will put additional pressure on water resources



Need for Water-Energy-Food integrated planning to achieve a sustainable future and avoid scarcity problems in the next years

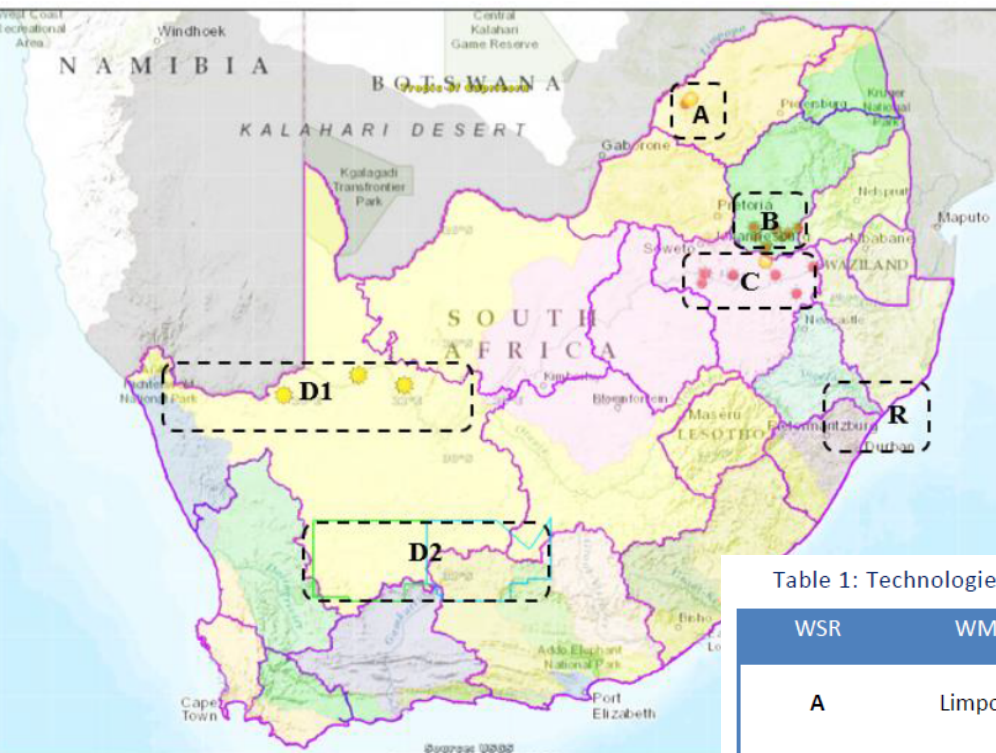


Table 1: Technologies represented in SATIM-W for Phase 1 implementation by water supply system.

WSR	WMA	Region	Activity
A	Limpopo	Lephalale	<ul style="list-style-type: none"> Open-cast coal mining Coal thermal power plants with FGD option Coal-to-Liquids refineries
B	Olifants	Mpumalanga, Witbank	<ul style="list-style-type: none"> Open-cast & underground coal mining Coal thermal power plants with FGD option. Coal-to-Liquids refineries
C	Upper Vaal	Mpumalanga, Secunda	<ul style="list-style-type: none"> Open-cast & underground coal mining Coal thermal power plants with FDG option Inland gas thermal power plants Inland Gas-to-Liquids refineries
D1	Lower Orange	Northern Cape, Upington	<ul style="list-style-type: none"> Concentrated Solar Thermal Power Plants (CSP)
D2	Lower/Upper Orange	Northern Cape, Karoo	<ul style="list-style-type: none"> Shale gas mining Gas thermal power plants Inland gas-to-liquids refineries
R	n/a	Richards Bay Coal Export Terminal	<ul style="list-style-type: none"> Coastal open-cycle coal power plants with seawater cooling and seawater FGD option

In SATIM-W the cooling systems for thermal power plants may be either closed-cycle wet-cooled or direct dry-cooled. The model is free to choose the cooling type, except for open-cycle wet-cooled plants which are restricted to the coastal region, as part of determining the least-cost energy-water integrated system.

Needed to “geo-reference” somehow the power plants and energy facilities in order to regionally constraint the amount of water available by assigning the different power plants and energy extraction locations to their basin

South Africa: Marginal Cost of Water Supply

Needed to add the cost of supplying water to the energy facilities by calculating the marginal cost of water supply for each basin

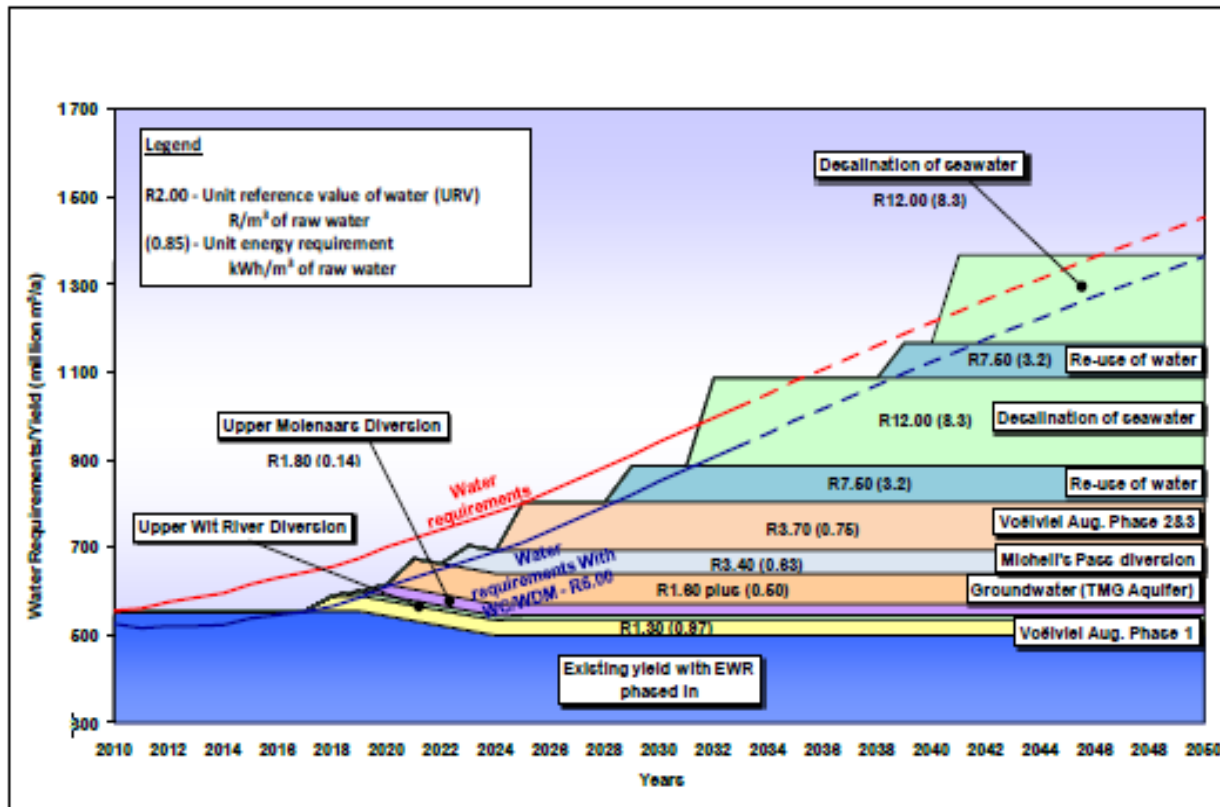
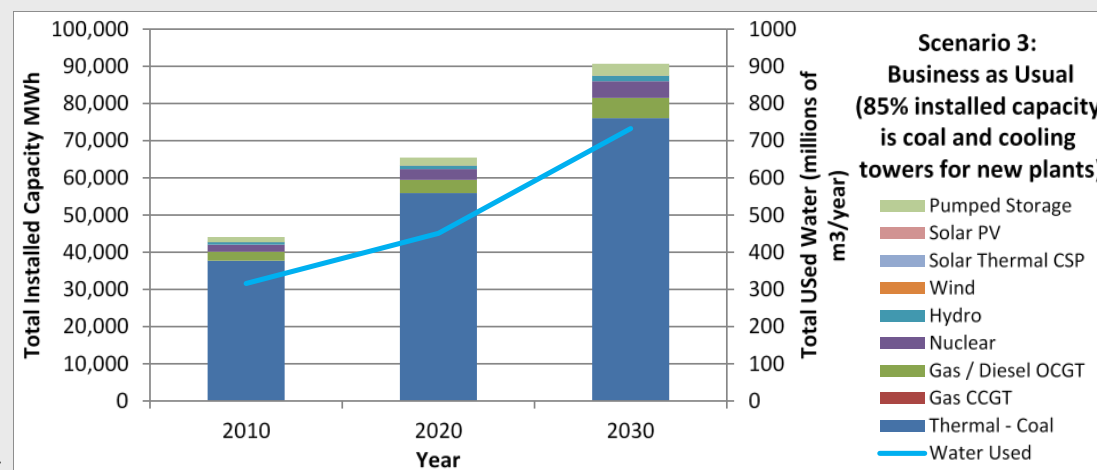
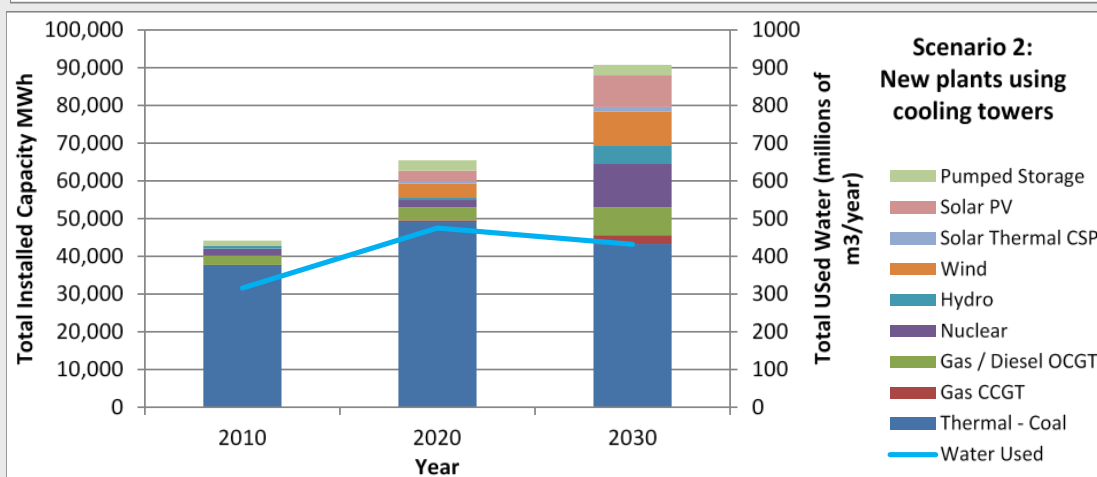
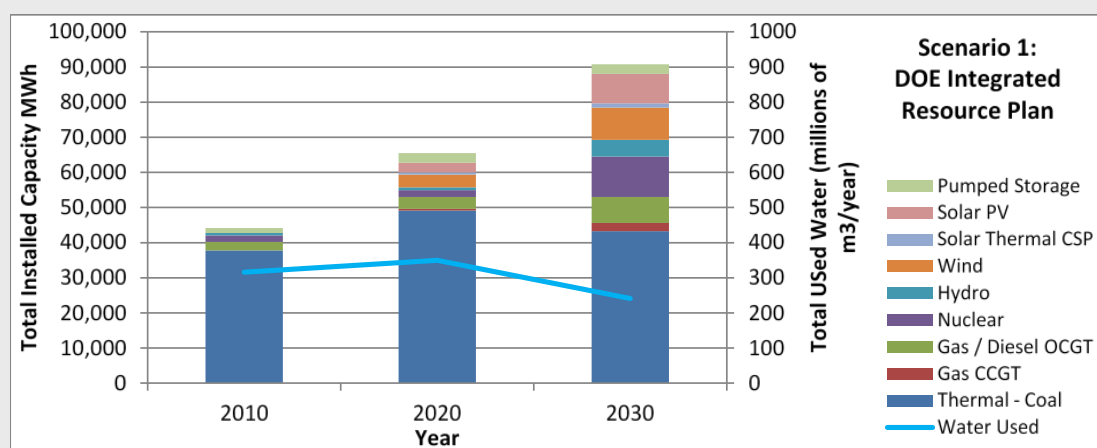


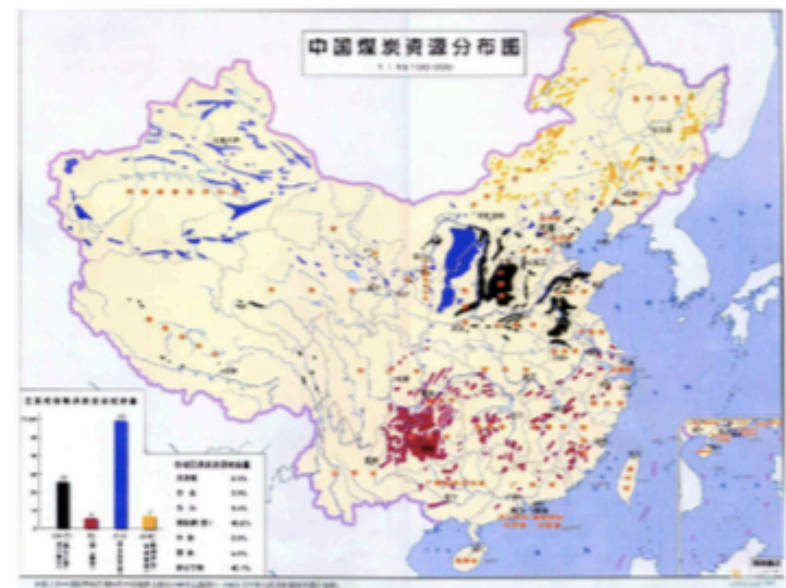
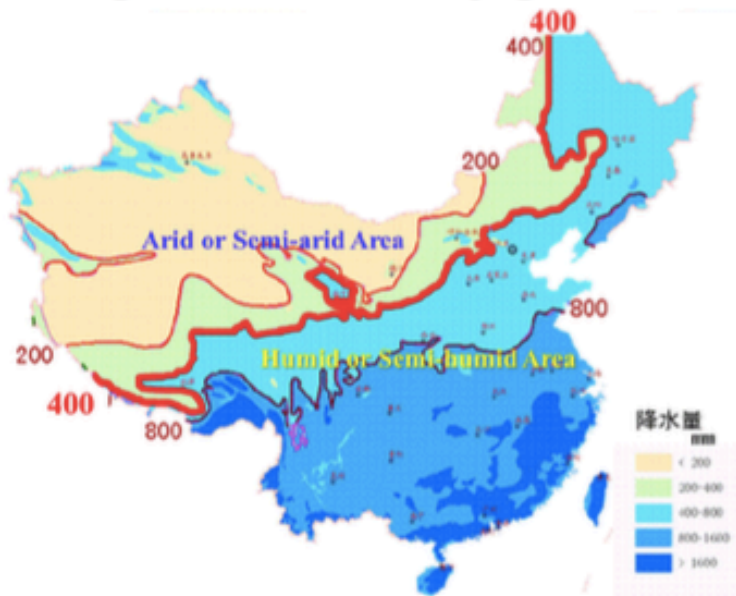
Figure 4.10 (a) Western Cape Augmentation Options (without climate change)



China: a case of mismatched water and energy resources

由于地理、气候等因素，中国水资源分布严重不均，化石能源和水资源呈逆向分布。水资源已成为是能源行业尤其是煤炭等化石能源的重要制约因素。

The spatial distribution of water resources and energy resources is seriously mismatched in China (Water is rich in South and Energy resources are rich in North). And, water is important factor in coal mining and electricity generation and other energy sector.

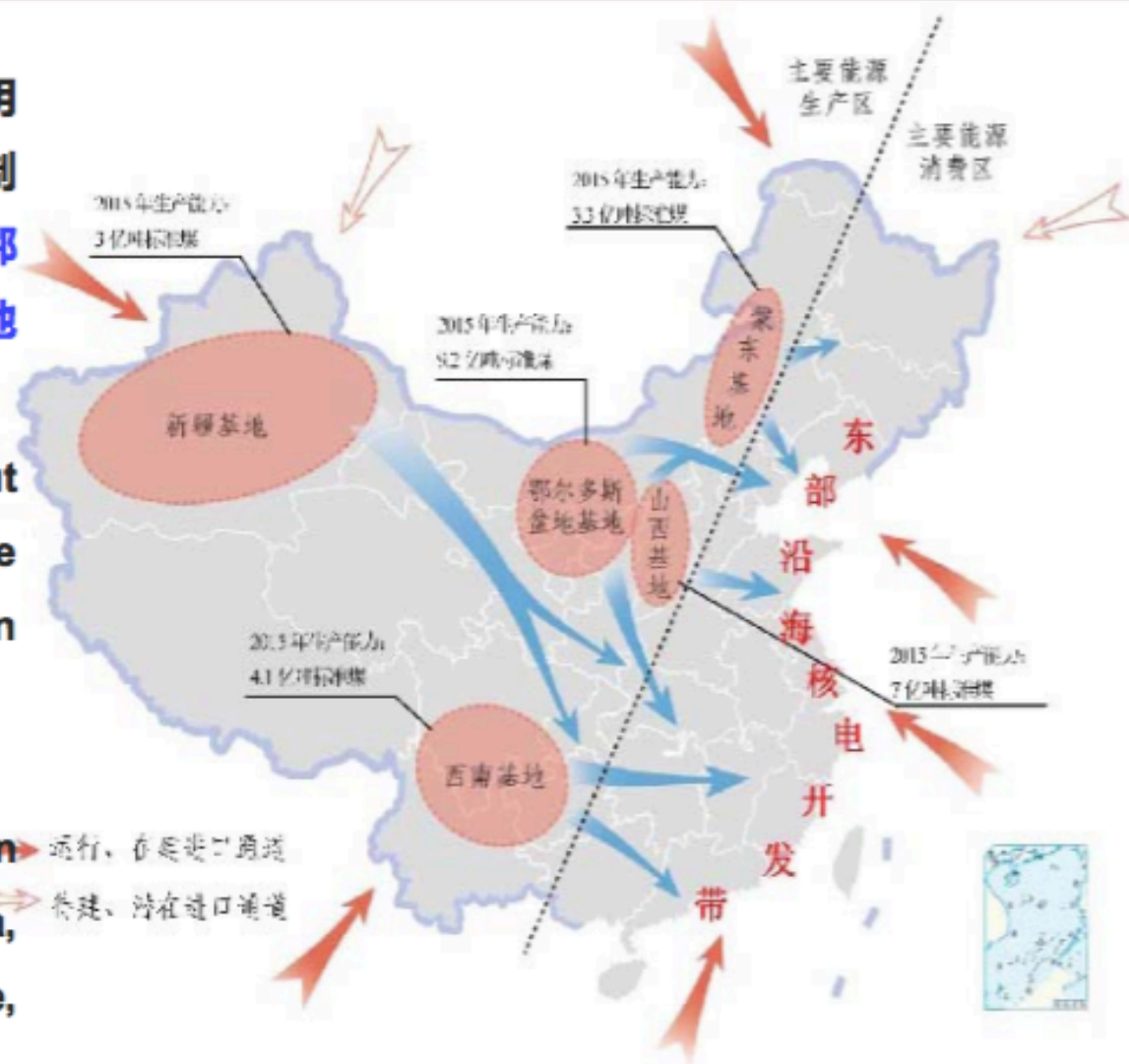




中国政府“十二五”规划纲要中明确提出，要“优化能源结构，合理控制能源消费总量”着重强调建设山西、鄂尔多斯盆地、内蒙古东部地区、西南地区和新疆五大国家综合能源基地。

The Chinese government put forward a plan to construct five comprehensive energy bases in China in 12th FYP.

In our research, we only focus on four energy bases in North China, excluding southwest energy base, which is quite not water stressed.



国家综合能源基地示意图

Economics: the water supply curve

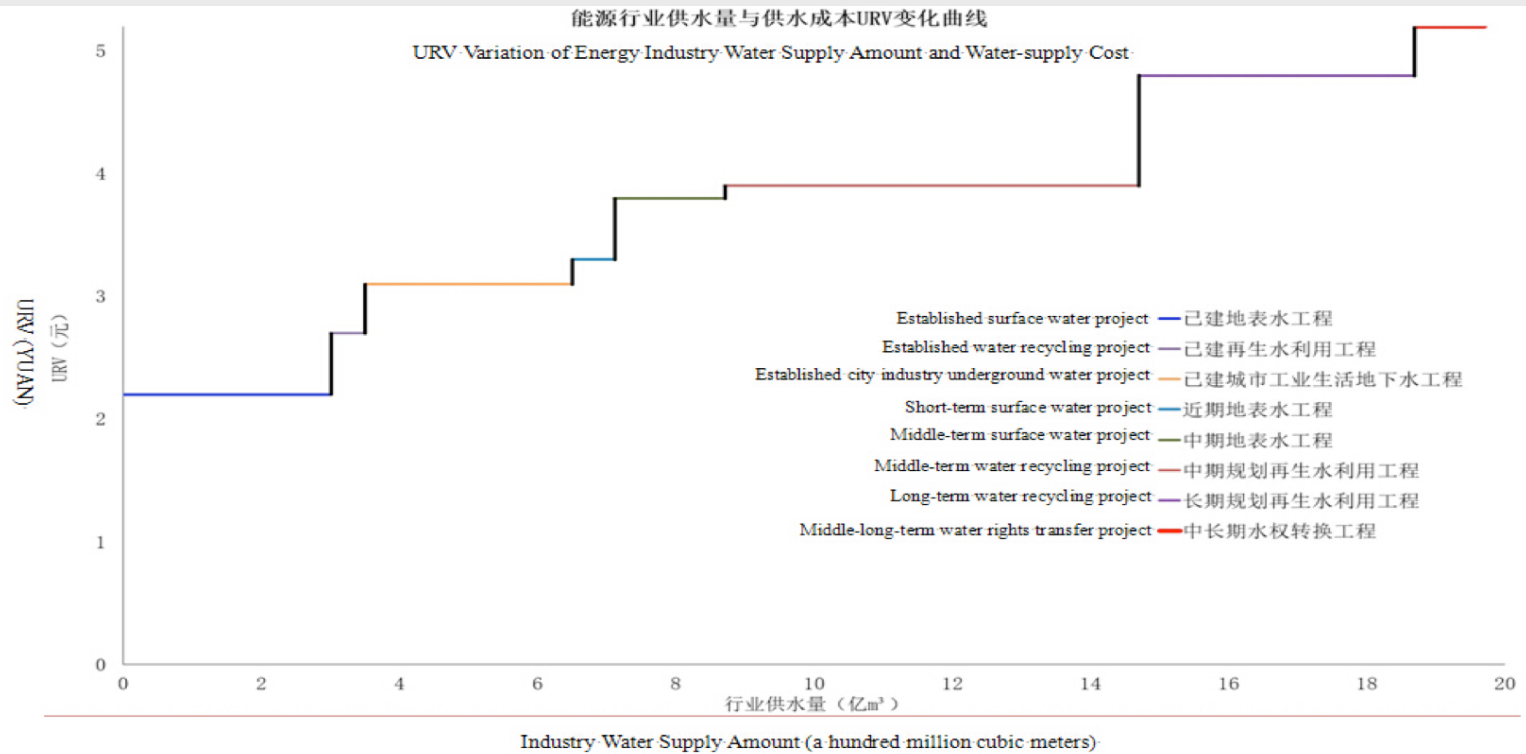


Figure 2: The Cost Curve of the Unit Water Supply for the Energy Sectors of the East Inner Mongolian Energy Base

LAC: Required Investment in Power Generation (2015-2025)

Required Investment in Electricity Generation for the Period 2015-2025

	Cumulative Capacity (MW)	Additional Capacity (MW)	Required Investment (2012 M US\$)	2014 GDP (2012 Bn US\$)	Investment as % of 2014 GDP
Brasil	219,003	46,047	\$135,730	1399	9.7%
Mexico	83,048	38,552	\$55,898	1266	4.4%
Colombia	21,175	5,295	\$18,868	261	7.2%
Chile	23,849	5,086	\$16,155	210	7.7%
Bolivia	2,810	1,441	\$2,666	15.6	5.8%
Peru	22,476	10,525	\$37,028	138	3.7%
Argentina	39,000	7,203	\$6605	402	1.6%
Venezuela	37,000	7,058	\$6472	228	2.8%
LAC	500,000	123,000	\$304,393	4564	6.7%

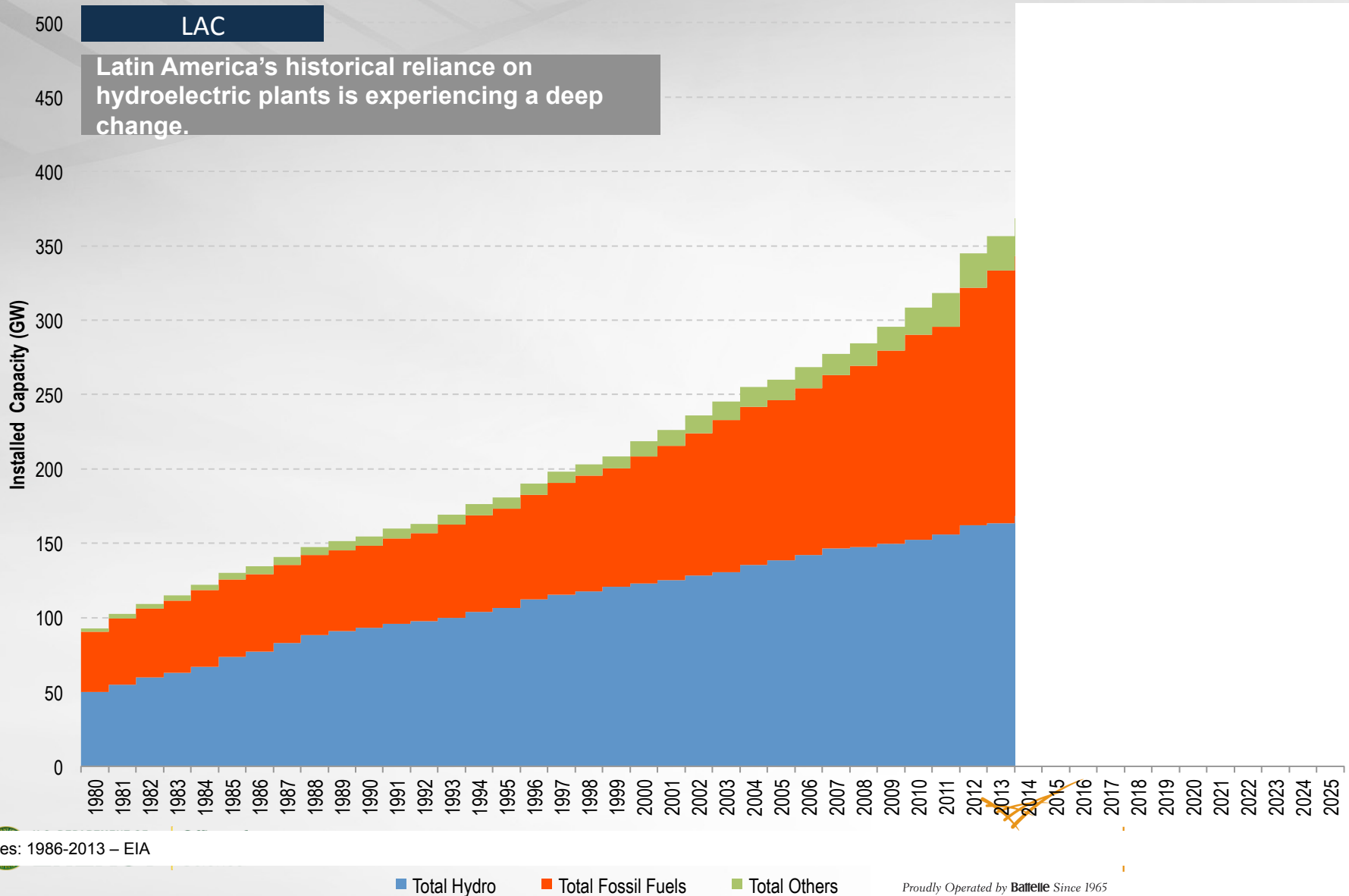


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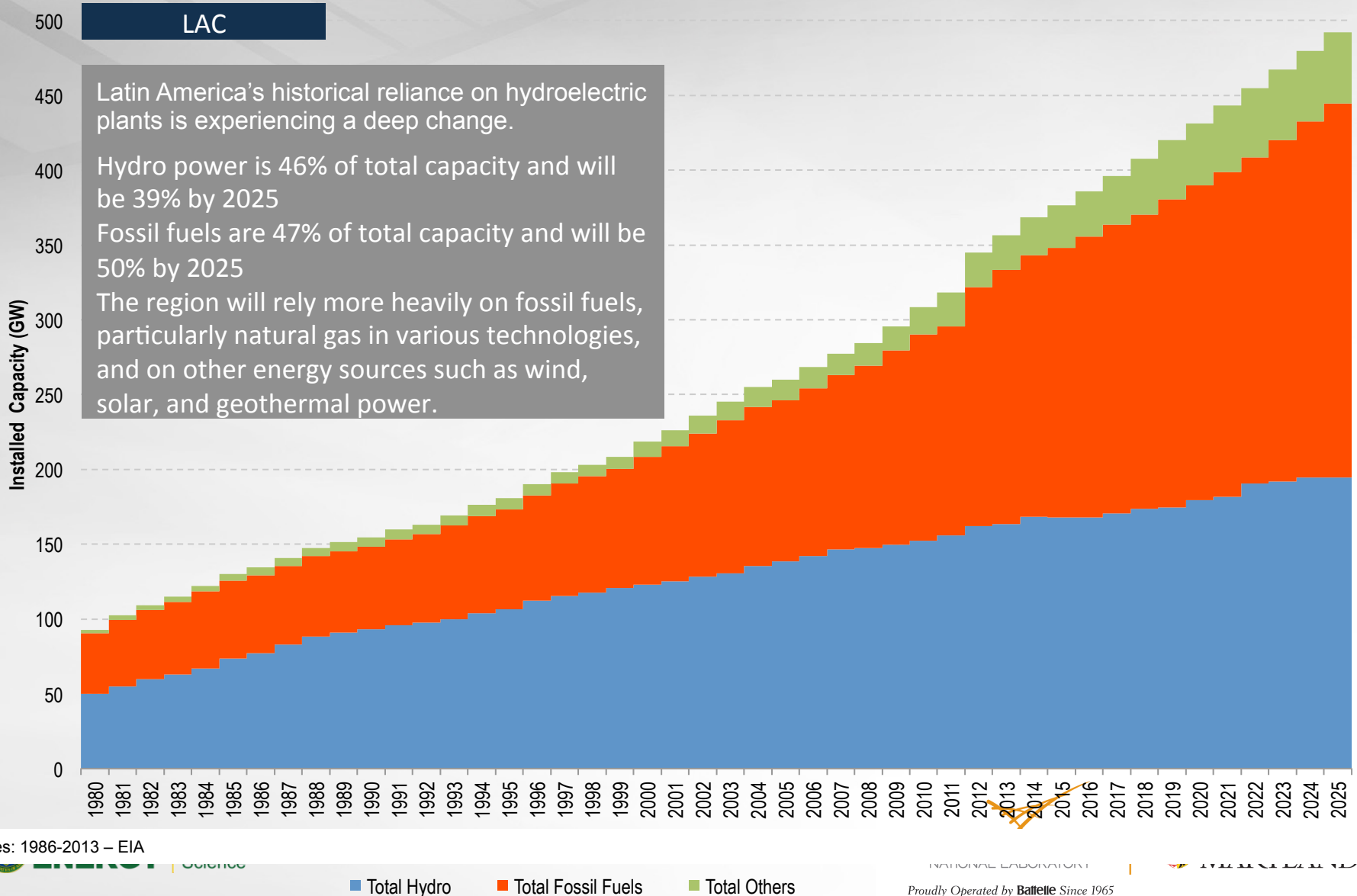
Electricity

Installed Capacity



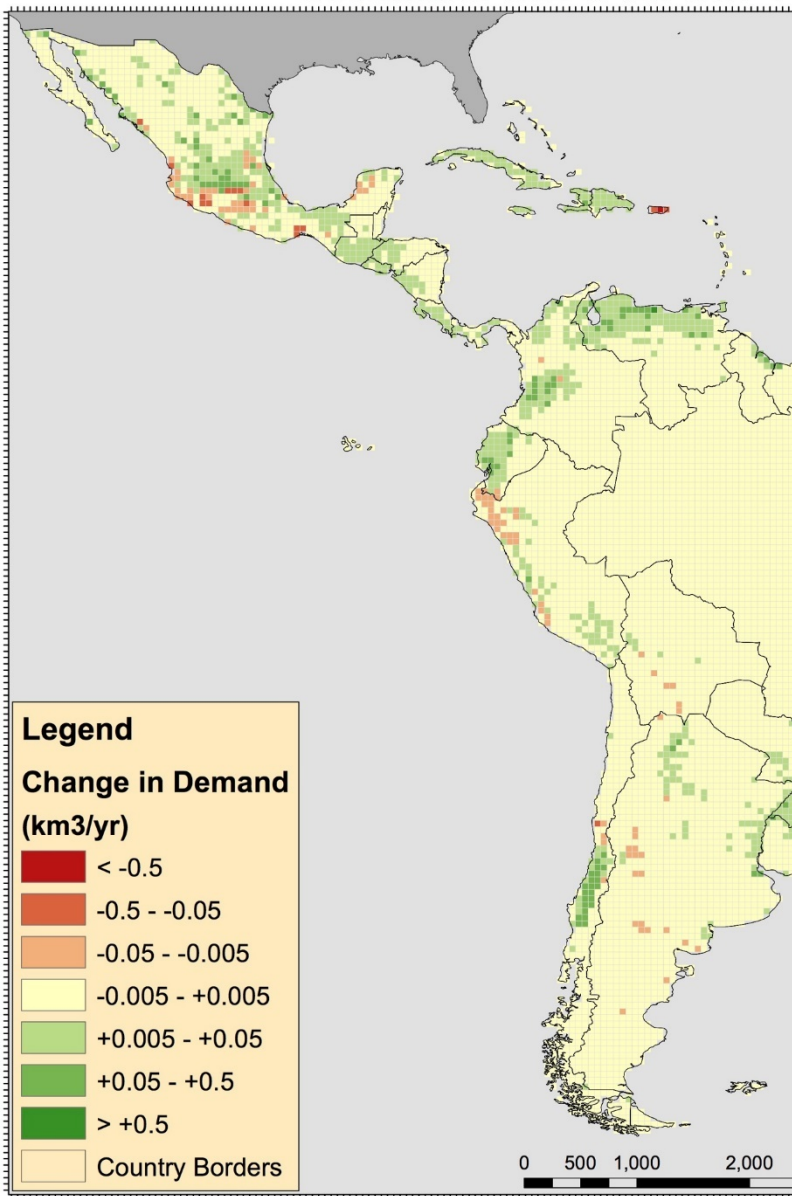
Electricity

Installed Capacity



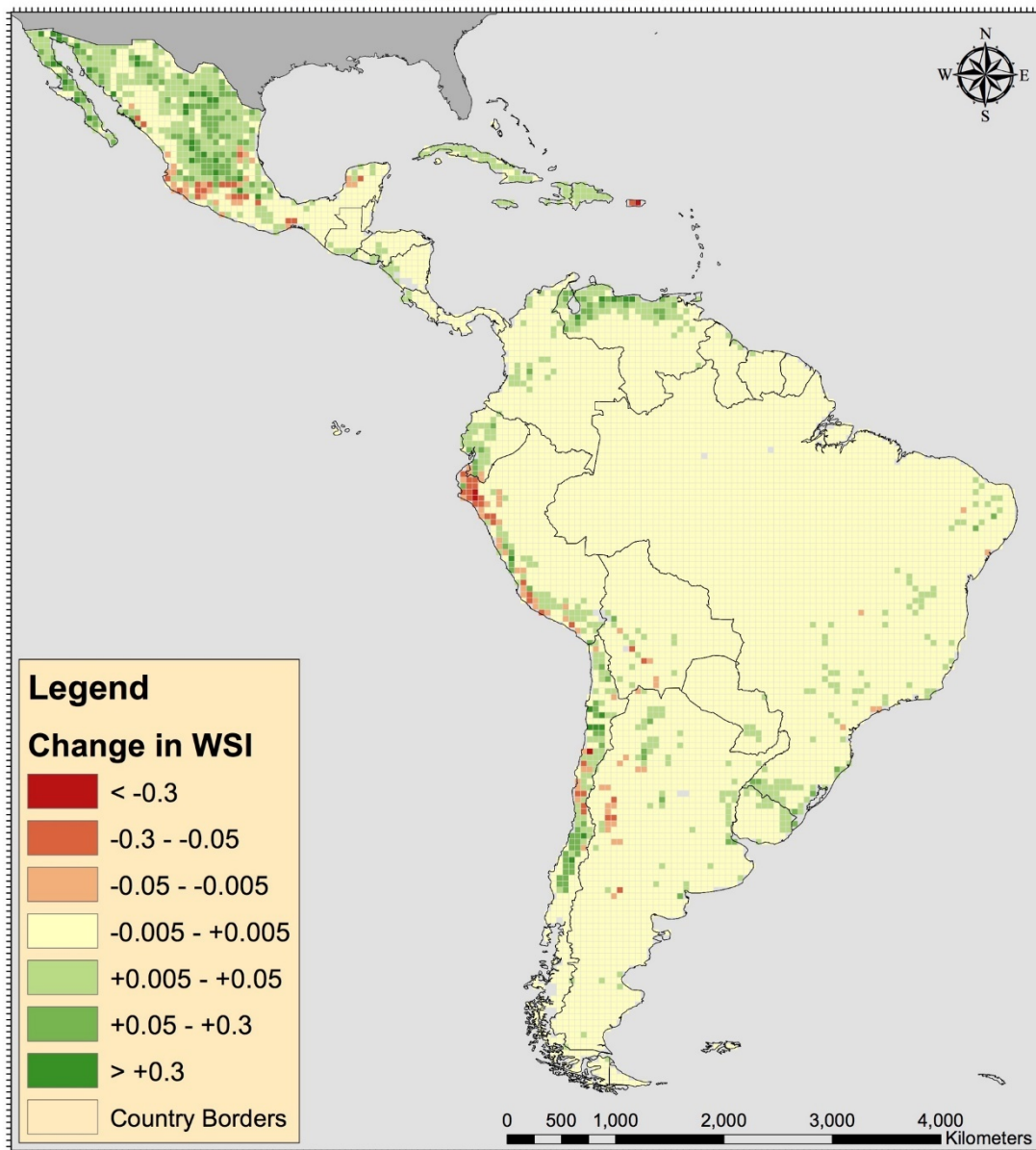
Change in Water Demand (km³/yr) for the Latin America and Caribbean (LA)

Year: 2050
Scenarios: SSP3 vs. SSP1



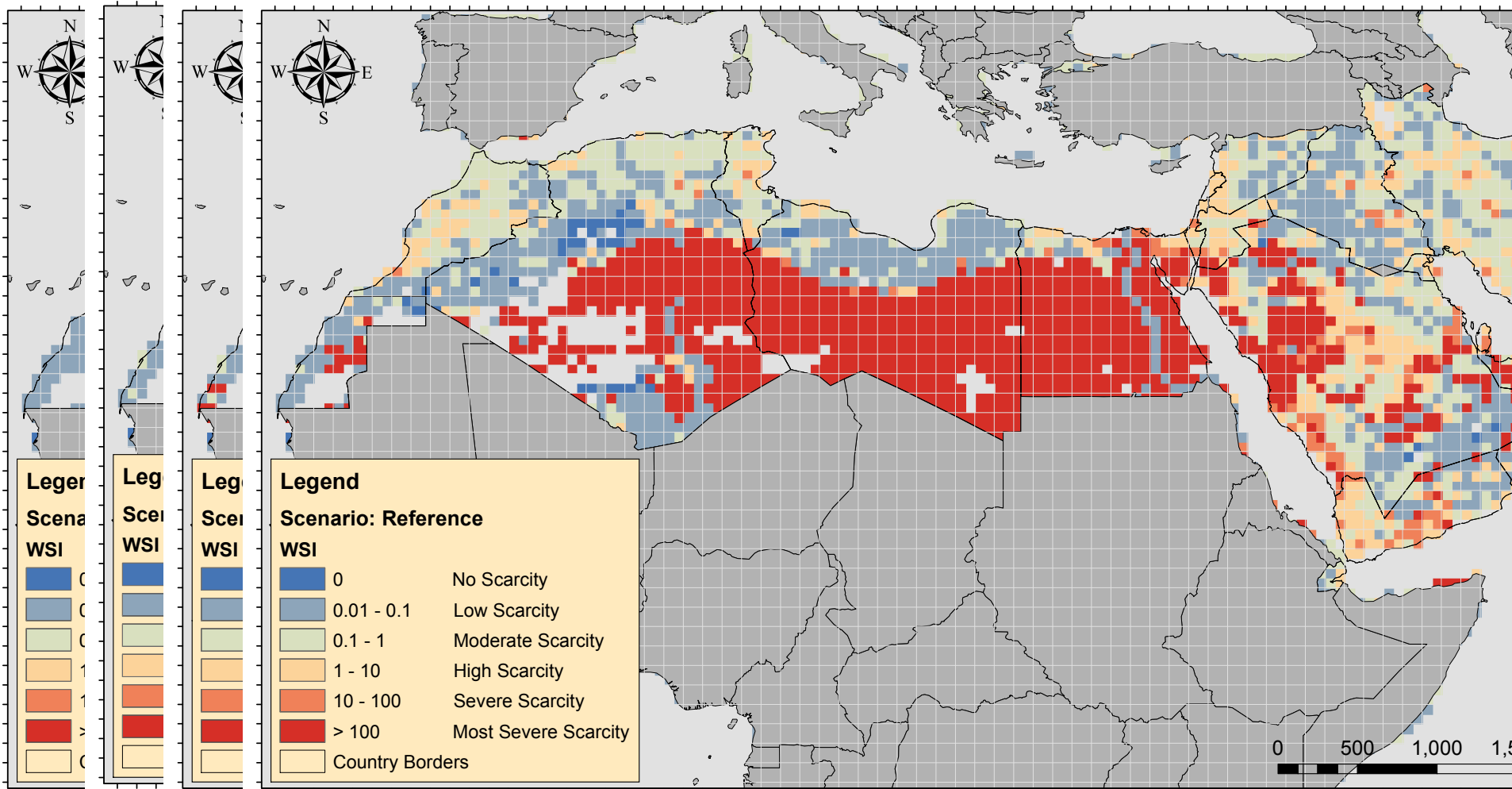
Change in Water Scarcity Index (WSI) for the Latin America and Caribbean (LAC) Region

Year: 2050
Scenarios: SSP3 vs. SSP1



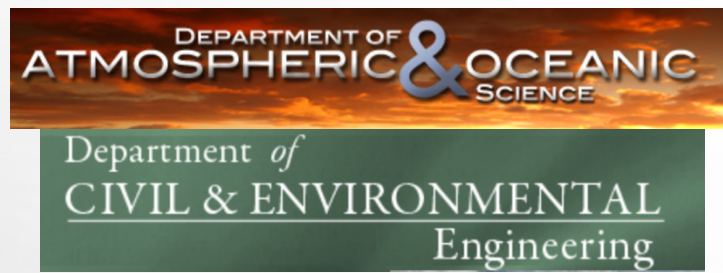
Water Scarcity Index (WSI) for the Middle East and North Africa (MENA) Region

2100



Some takeaways (this is what Malthus would tell us) 😊

- "Nexus Thinking" -> focus on **upstream integrated planning** toward investments (avoid "stranded assets"). This is where larger gains can be achieved. It is a tougher sell though, and the **economics/financial case** must be made.
- Environmental security worldwide is highly influenced by **human signal** (demand for water, energy, food). Climate change adds stress to that signal (policies matter!).
- Strong need to **build capacity** (regional, in-country) toward integrated planning, and identification of tradeoffs and synergies in water-energy-food systems.



“Water and Climate Systems”

- Offered 2015-pres
- Taught using social media (Facebook) and Dropbox for file sharing
- All lectures (presentations, videos, readings) are openly distributed and available
- Trying to bridge science-policy interface using IAM
- Attracts students in natural and social sciences



The screenshot shows the Facebook interface for the 'Water-Climate Systems' group. At the top, there is a world map with color-coded regions. Below the map, the group name 'Water-Climate Systems' is displayed, along with a 'Closed Group' status and buttons for 'Joined', 'Share', and 'Notifications'. The navigation bar includes 'Discussion', 'Members', 'Photos', and 'Files'. A search bar is present on the right. The main content area features a 'Write Post' section with options to 'Add Photo / Video', 'Create Poll', or 'More'. Below this is a 'RECENT ACTIVITY' section showing a post by Fernando Miralles-Wilhelm from 20 hours ago. The post text reads: 'Hi folks: here is the assignment for the assignment on water: Compute Water withdrawal under the Reference scenario for two countries of choice where water scarcity already exists or will exist in the future. Please choose countries that make the assignment interesting 😊 Also, please note that because of the focus on 2 countries, no spatial mapping is needed.... See More'. Below the post is a banner for the 'Food and Agriculture Organization of the United Nations' (FAO) with its logo and the text 'AQUASTAT database' and 'FAO.ORG'. On the right side, there are sections for 'ADD MEMBERS', 'MEMBERS' (listing 13 members), 'DESCRIPTION' (with a link to 'Add a Description'), 'TAGS' (with a link to 'Add Tags'), 'GROUP CHATS' (with a link to 'Start New Chat'), 'BRING PEOPLE TOGETHER' (with a link to 'Create a Group'), and 'RECENT GROUP PHOTOS' (with a link to 'See All').

Water-Climate Systems
Closed Group

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Search this group

Write Post Add Photo / Video Create Poll More

Write something...

Water-Climate Systems Post

RECENT ACTIVITY

Fernando Miralles-Wilhelm
20 hrs

Hi folks: here is the assignment for the assignment on water:
Compute Water withdrawal under the Reference scenario for two countries of choice where water scarcity already exists or will exist in the future. Please choose countries that make the assignment interesting 😊
Also, please note that because of the focus on 2 countries, no spatial mapping is needed.... See More

Food and Agriculture Organization of the United Nations
AQUASTAT database
FAO.ORG

ADD MEMBERS
+ Enter name or email address...

MEMBERS
13 Members

DESCRIPTION
Tell people what this group is about. Add a Description

TAGS
Add a few descriptive keywords. Add Tags

GROUP CHATS
No group chats, start one now.
+ Start New Chat

BRING PEOPLE TOGETHER
Groups are separate spaces where you can share photos and make plans with just the people you want.
Create a Group

RECENT GROUP PHOTOS
See All

Another thing Malthus may tell us today...

“(IAM in international development) is like teenage sex:
everyone talks about it...
nobody really knows how to do it...
everyone thinks everyone else is doing it...
so everyone claims they are doing it...”

