Climate Change Impact on Water and Food: The Role of the Water Energy Food Nexus

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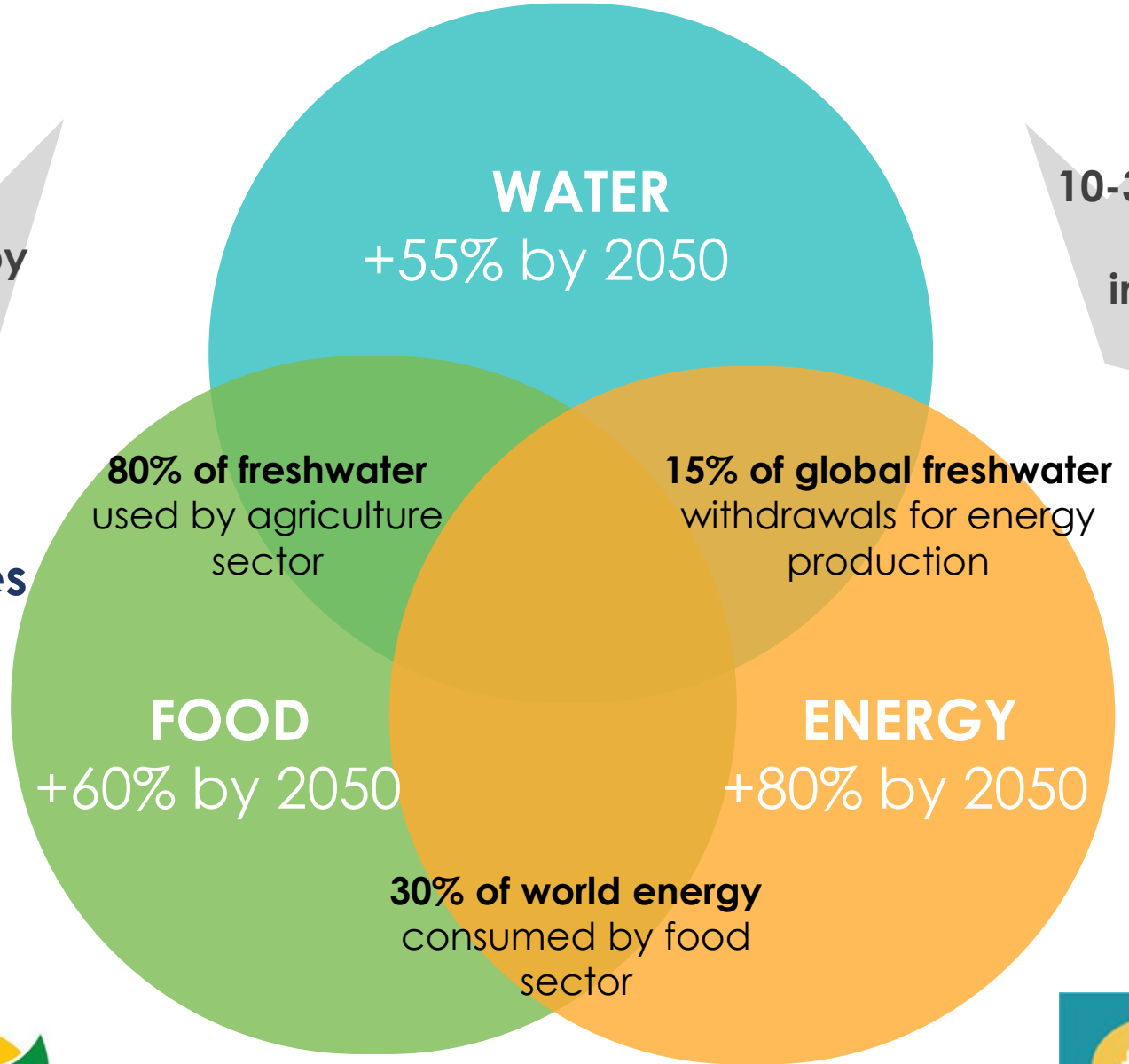
Outline

1. Situational Analysis and projections for water, energy, food and impact of human migration in Lebanon
2. Climate Change Regional Overview and impact on water, energy, food and infrastructure
3. Framework for climagte adaptation and resilience
4. Role of WEF Nexus in addressing the primary resources security under Climate Change
5. Lessons learned from other similar regions
6. WEFRAH initiative
7. Closing comments

Challenge of Today's Water Allocation Model & Interconnected Primary Resources

9 billion population by 2050

10-30% less precipitation than in 1980-1999 in most sub-tropical regions (IPCC)



Challenges

1. Inter-dependencies
2. Inequity
3. Distribution
4. Allocative model

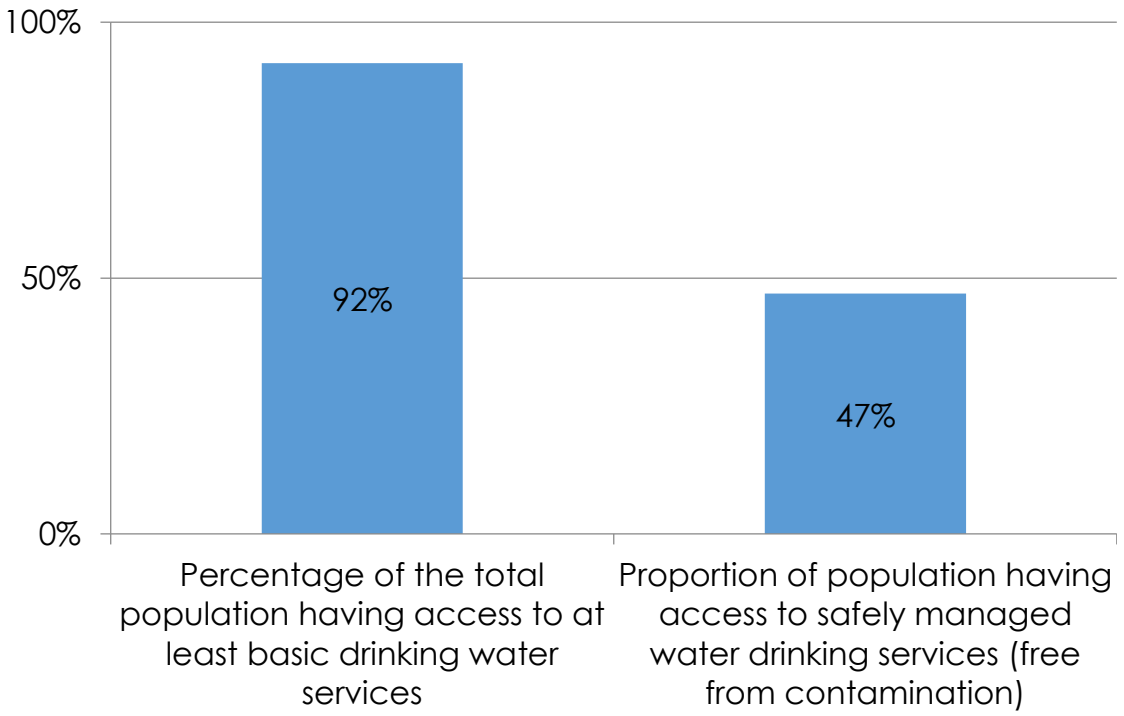
New Business Model is Needed

BASED ON VALUES

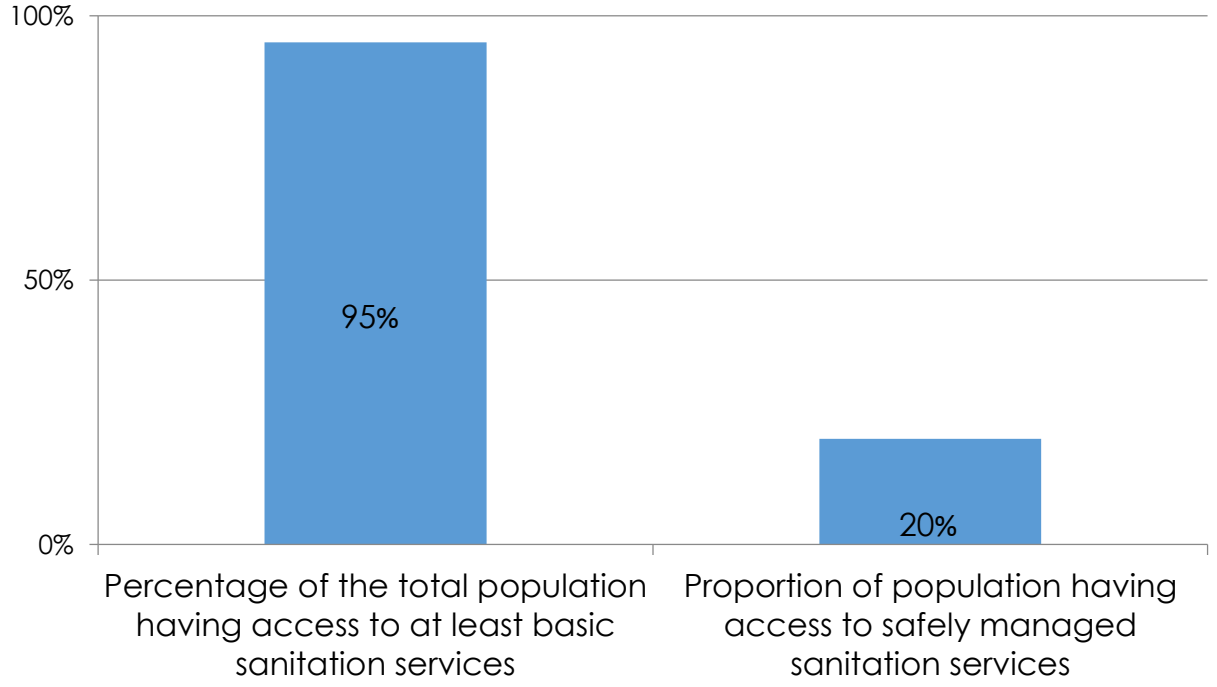
IRENA (2015), 'Renewable Energy in the Water, Energy & Food Nexus'

Status of the Water and Sanitation in Lebanon as of 2015

Status on Access to Safely Managed Drinking-Water Services



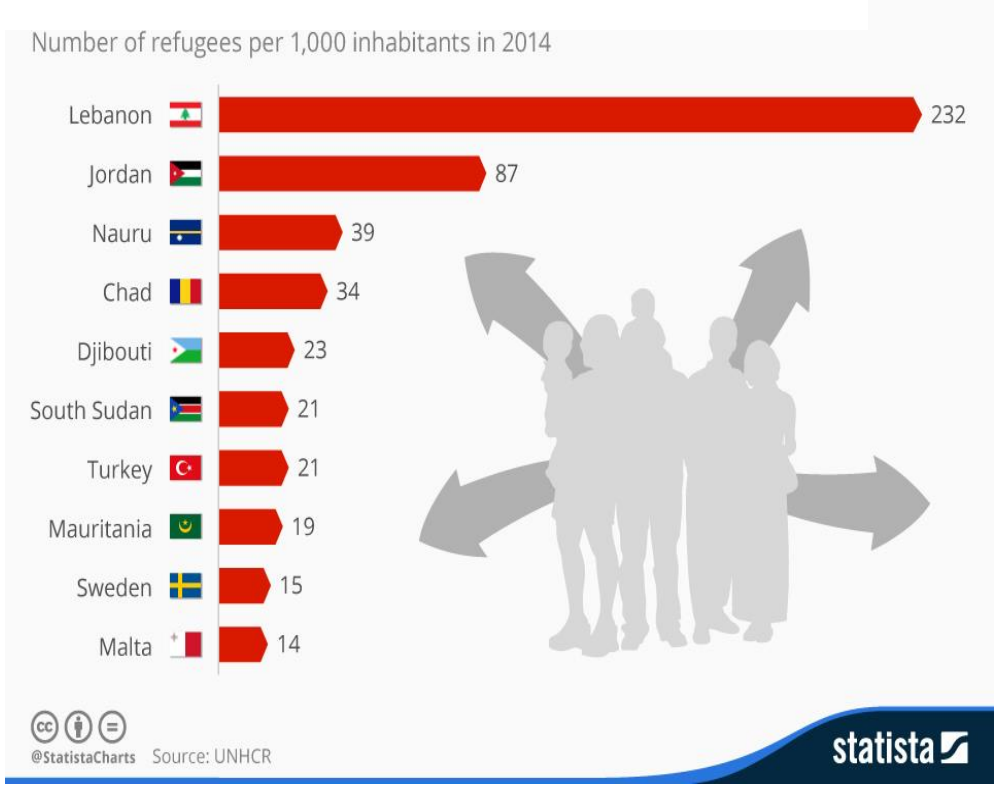
Status of Access to Safely Managed Sanitation Services



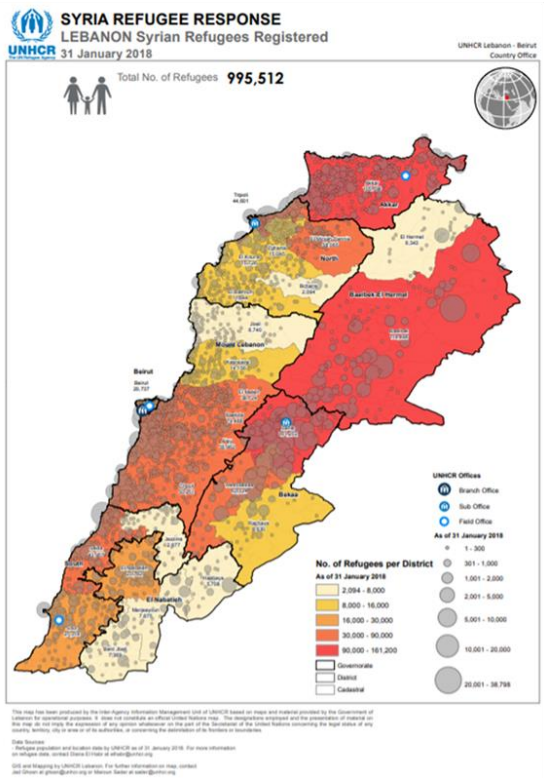
Ministry of Energy and Water, Lebanon

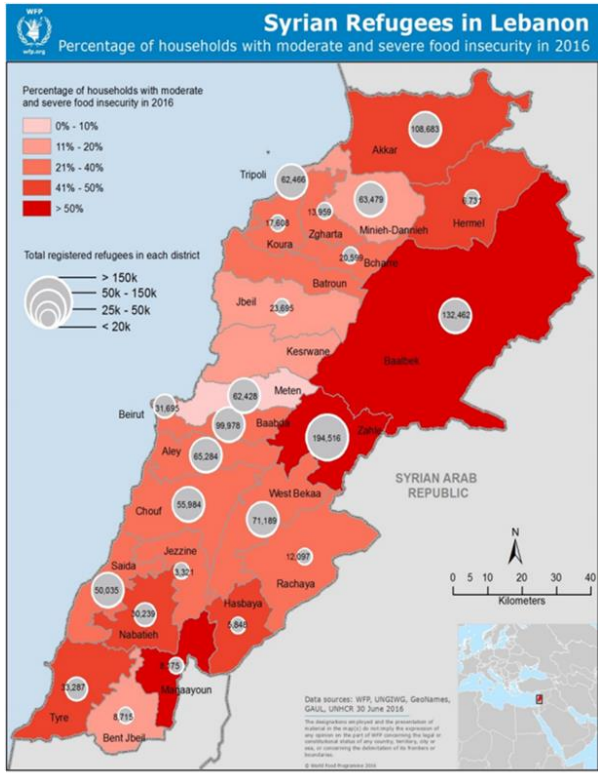
Human Migration In Lebanon

The Countries With the Most Refugees Per Capita

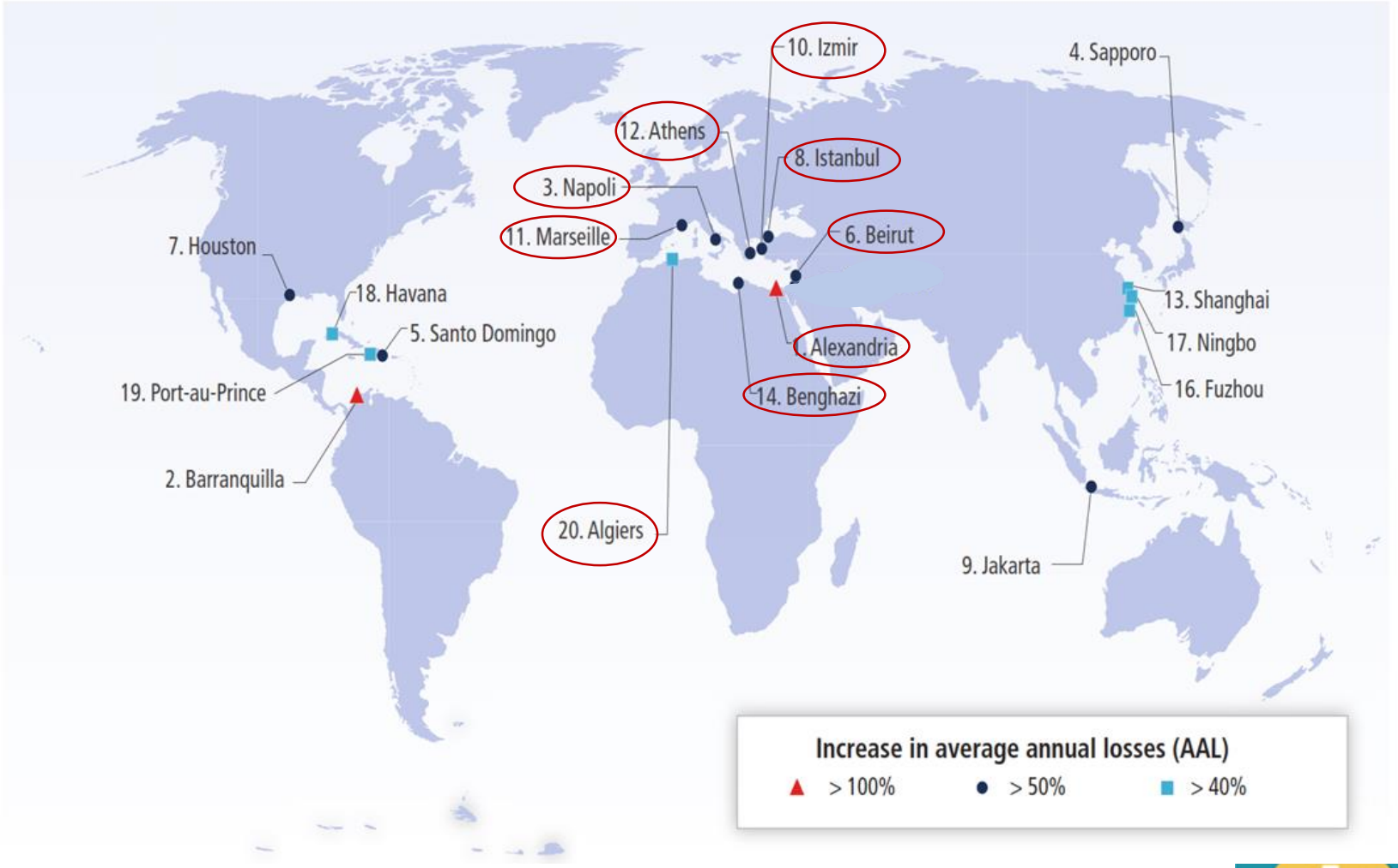


Distribution of Refugees in Lebanon in Numbers





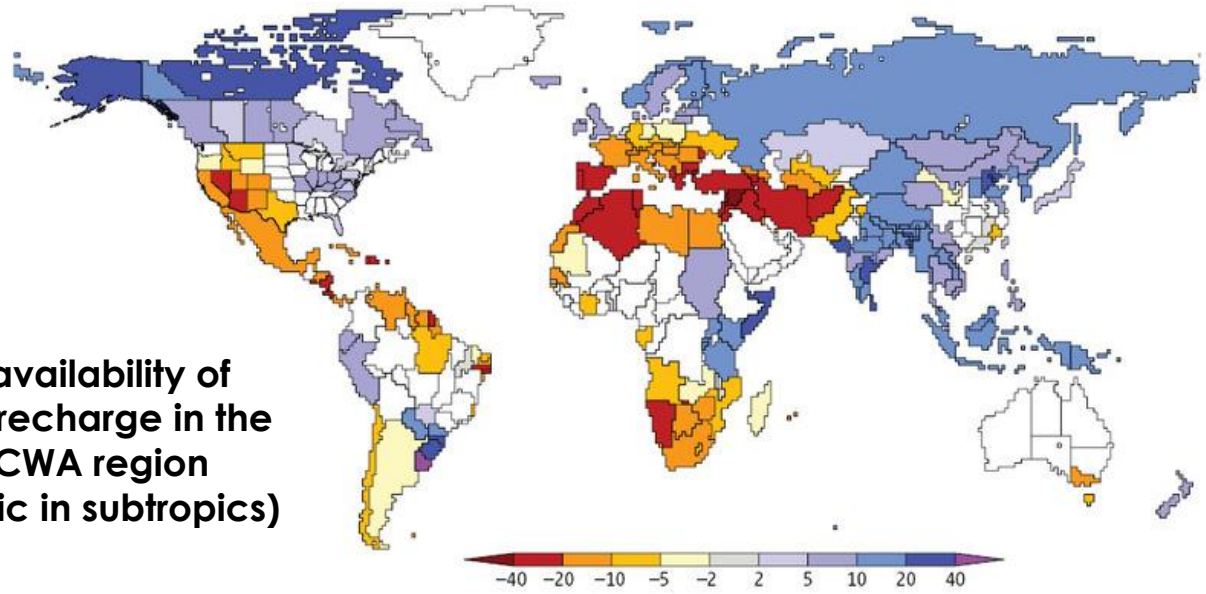
Coastal Cities where Annual Average Losses Increase due Sea Level Rise in 2050



Hallegatte, S., C. Green, R.J. Nicholls, and J. Corfee-Morlot, 2013: Future flood lossesin major coastal cities. Nature Climate Change,3, 802-806

Impact of Climate Change on Streamflow and Hydropower: Projections are for Altered River Flow

Reduction in availability of groundwater recharge in the bulk of the ESCWA region (most dramatic in subtropics)



Human influences. Dramatic changes in runoff volume from ice-free land are projected in many parts of the world by the middle of the 21st century (relative to historical conditions from the 1900 to 1970 period). Color denotes percentage change (median value from 12 climate models). Where a country or smaller political unit is colored, 8 or more of 12 models agreed on the direction (increase versus decrease) of runoff change under the Intergovernmental Panel on Climate Change's "SRES A1B" emissions scenario.

- Surface and subsurface water resources are affected: *River flow reduction impacts water supply; Stream flow Reduction impacts soil moisture availability.*
- This negatively impacts:
  - Food production and adds pressure to compensate through irrigation to maintain production
  - Hydropower generation potential in some ESCWA countries where hydropower plays role in energy portfolio
- This impact is not quantified, but must be included in future studies of the impact of climate change on water and energy nexus

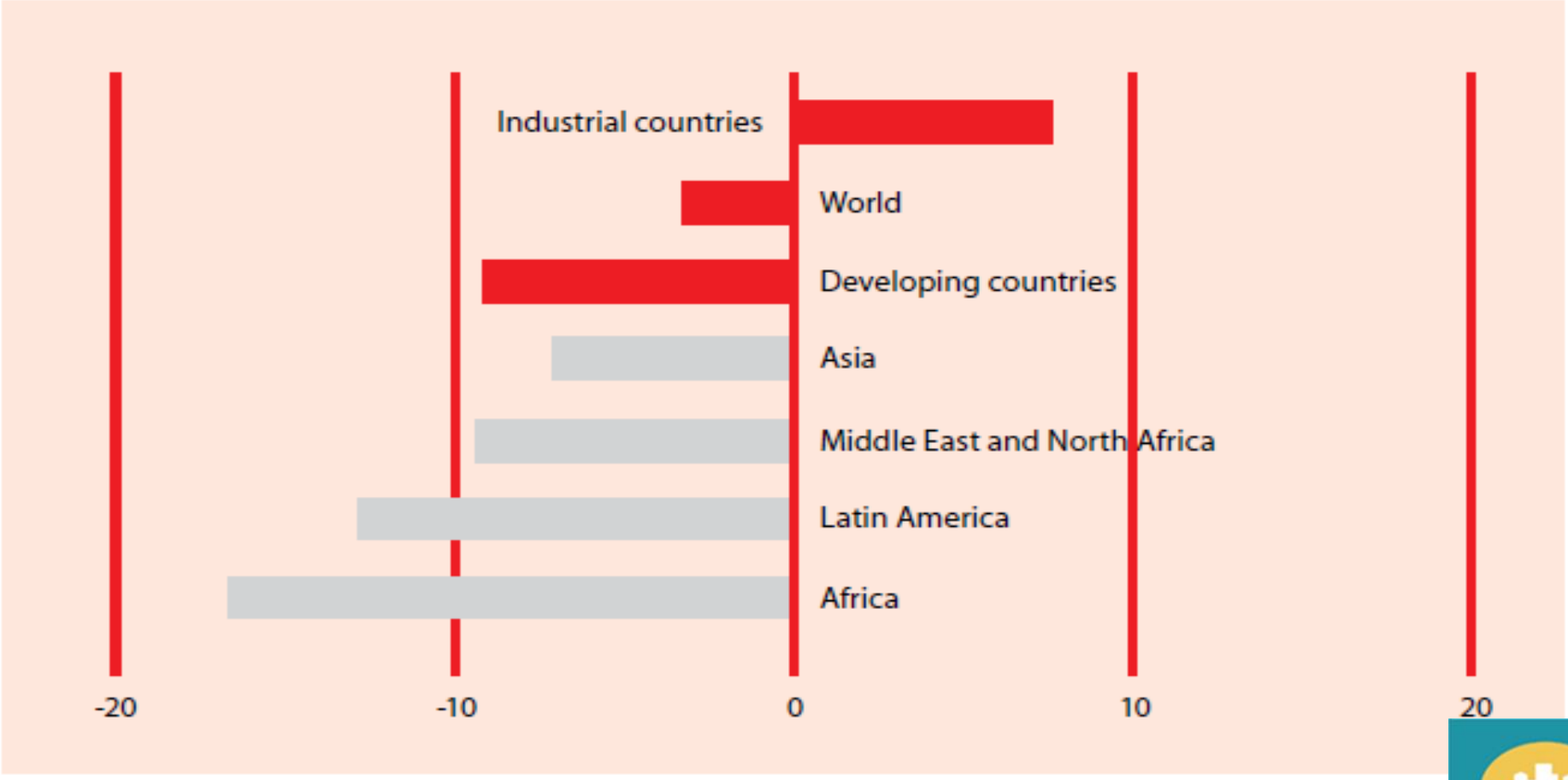
What you see is non-stationarity: the future is not like the past

Less water in Lebanon region

Milly P.C.D., Betancourt J., Falkenmark M., Hirsch R.M., Kudzewicz Z.W., Lettenmaier D.P., and Stouffer R.J. Climate Change: Stationarity is Dead: Whither Water Management? Science 2008;319:573-74

Impacts of Climate Change and Natural Disasters on Food Security

Agricultural output will decrease 21% by 2080, with peaks of an almost 40% decrease in countries like Algeria and Morocco



Cline, W. R. (2007). Global warming and agriculture: Impact estimates by country. Peterson Institute.

Other Impacts Climate Change and Natural Disasters

- Dust storms frequency and intensity
- Changing agricultural zones and water management
- Human mobility

UN-ESCWA (2016). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals, Regional Policy Toolkit

Towards Adaptation and Resilience: Challenges and Opportunities

Human Development

Activities that impact development, regardless of climate change impacts, For example, activities that target: *Poverty, Literacy, Gender, Pollution*

Response Capacity-building

Target the strengthening and/or building of institutions

Includes technological approaches and tools

Examples of measures are *Reforestation to combat landslides, Integrate resource management systems, Weather monitoring stations*

Managing Climate Risk

Implementation of activities that can decrease the risk of certain climate change events

For example, *Drought resistant crops, Climate proofing, Development of disaster response programs*

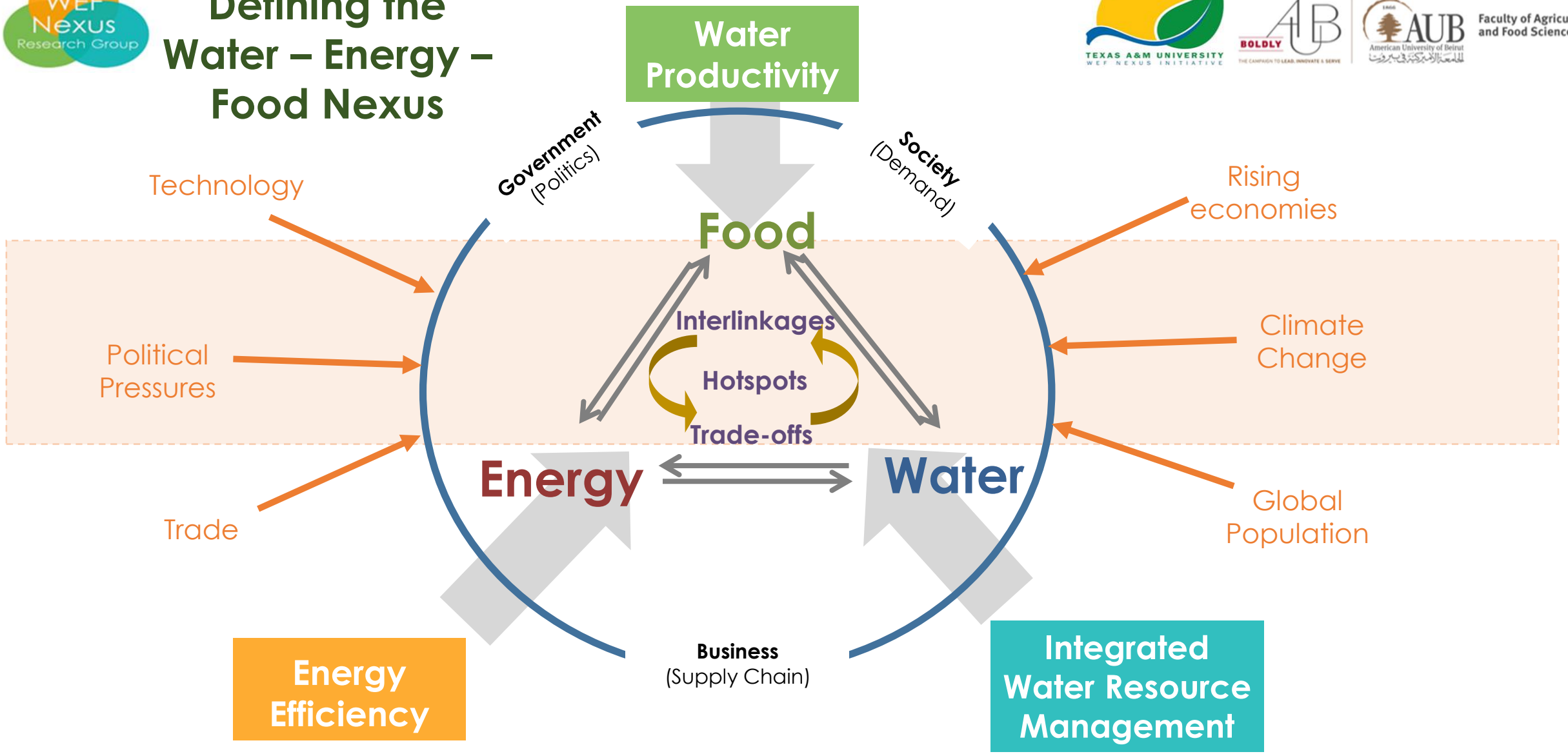
Climate Change Impacts Activities

Measures that aim at alleviating the effects of climate events

For example, *Relocation of communities, Repairs of damaged infrastructure*

UN-ESCWA (2016). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals, Regional Policy Toolkit

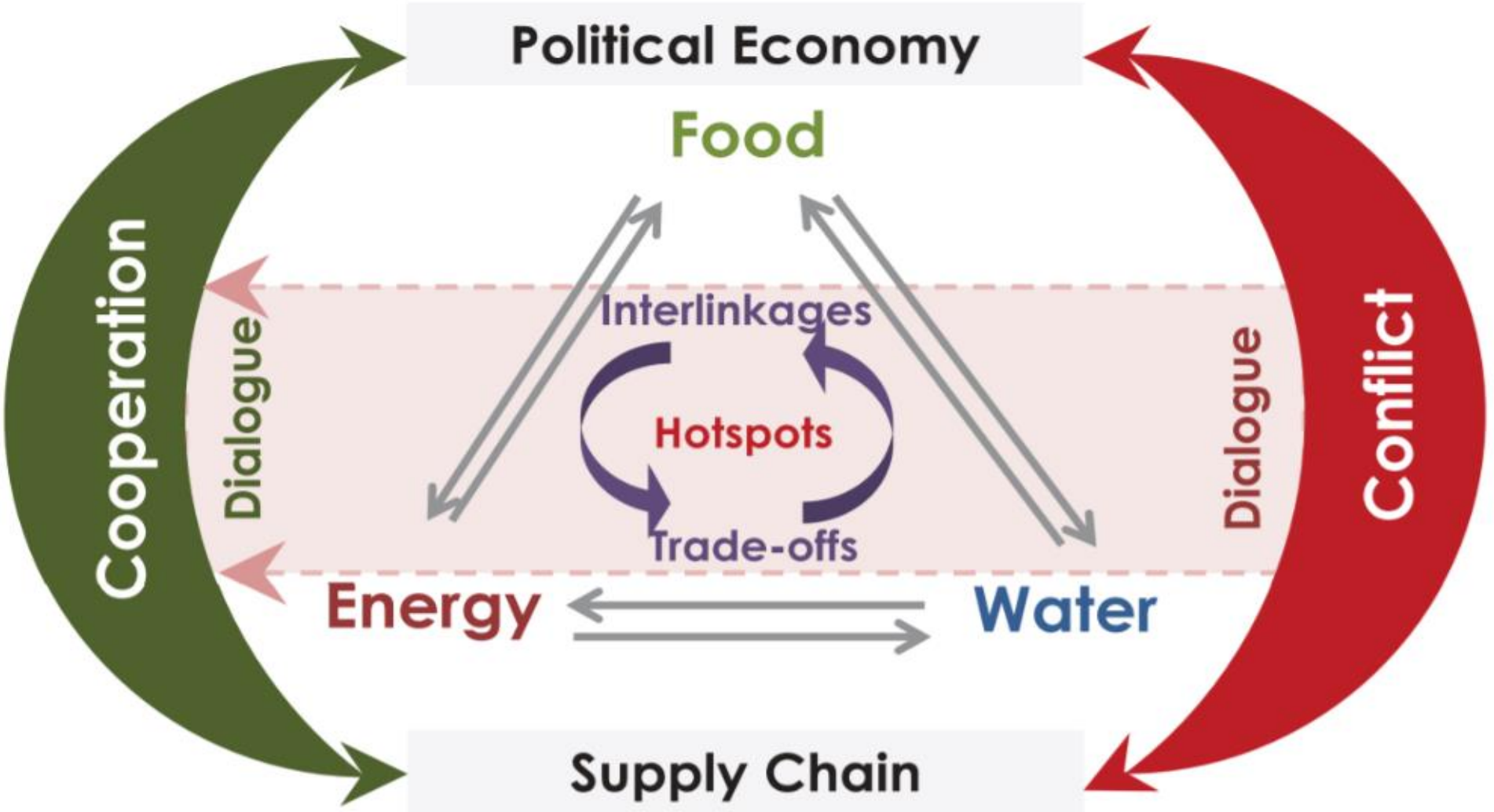
Defining the Water – Energy – Food Nexus



Rabi H. Mohtar (2011). An Integrated Sustainability Index for Effective Water Policy. in *Water security : the water-food-energy-climate nexus* World Economic Forum Water Initiative, Dominic Waughray. Editor. Island Press. Washington, Covelo, London. 271 pages

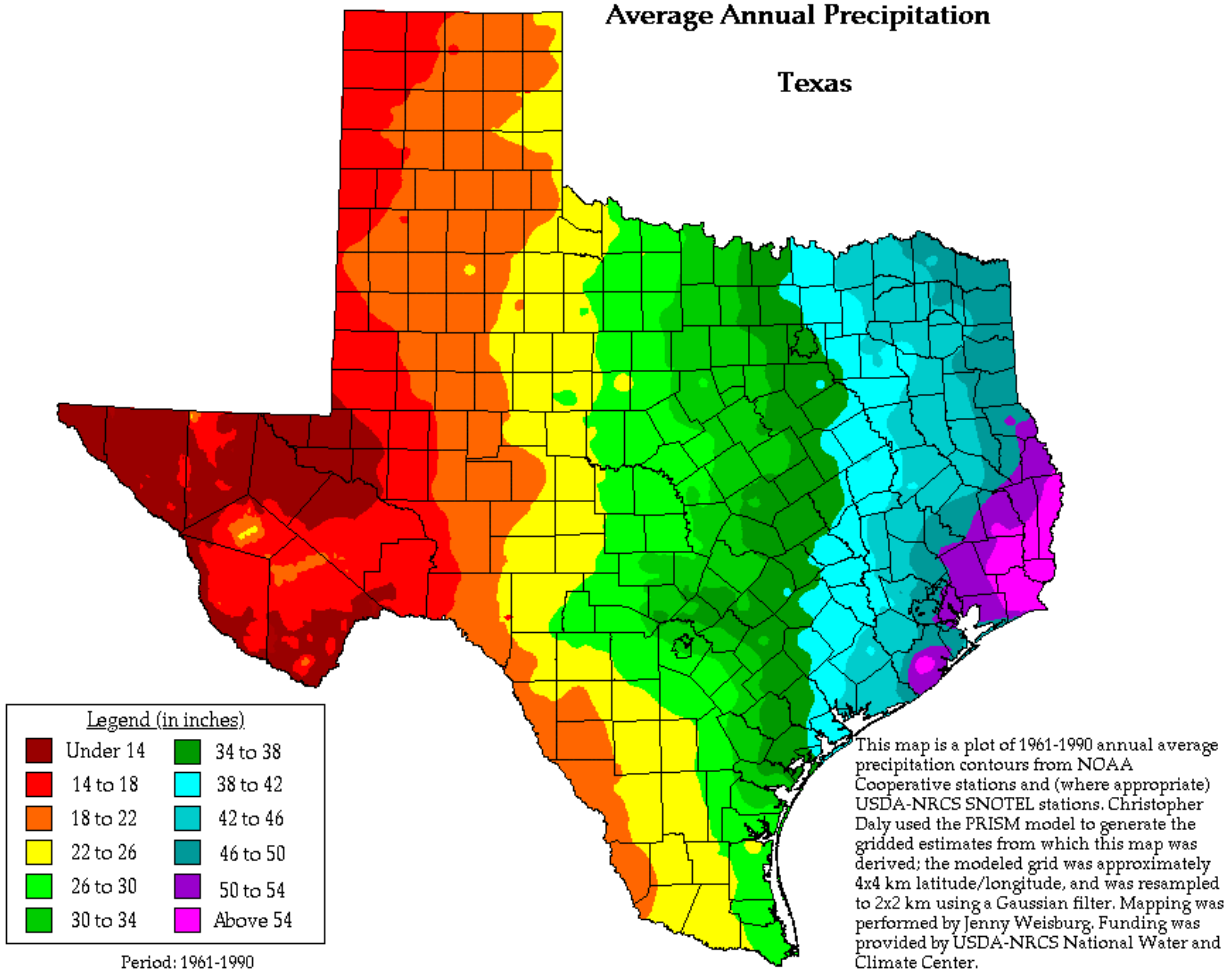
Rabi H. Mohtar and Bassel T. Daher (2012). Water, energy, and food: The Ultimate Nexus, Encyclopedia of Agricultural, Food, and Biological Engineering, Second Edition. DOI: 10.1081/E-EAFE2-120048376.

WEF Framework

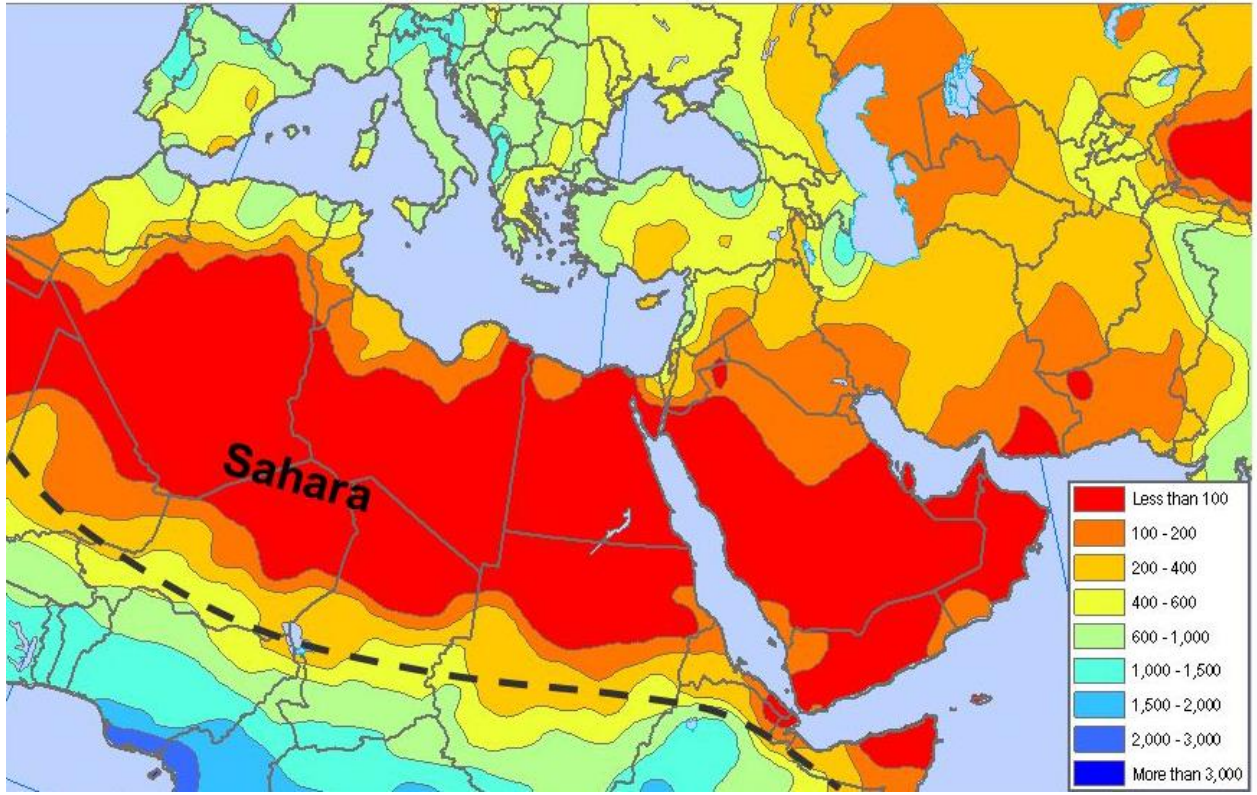


Rabi H. Mohtar & Bassel Daher (2016): Water-Energy-Food Nexus Framework for facilitating multi-stakeholder dialogue, Water International, DOI: 10.1080/02508060.2016.1149759

Rain and Climate Variability



North Africa / Middle East, Mean Annual Precipitation (mm)



Impact of WEF Nexus Approach

Faculty of Agricultural and Food Sciences

WET Tool

Quantify the interrelations and trade-offs between the water, energy, and transportation sectors under different scenarios:

1. Increasing (or decreasing) production
2. Changes in oil and gas market price
3. Different lateral lengths
4. Amount of reused water
5. Varying modes of transport for water/oil/gas

Matagorda County, Texas

Annual income could increases by as much as $32 million over the current "business as usual" mainly addressing the agricultural sector, which currently suffering from lack of water.

Monfar & Basset Daher (2018). Water-Energy-Food

Energy Portfolio Assessment Tool (EPAT)

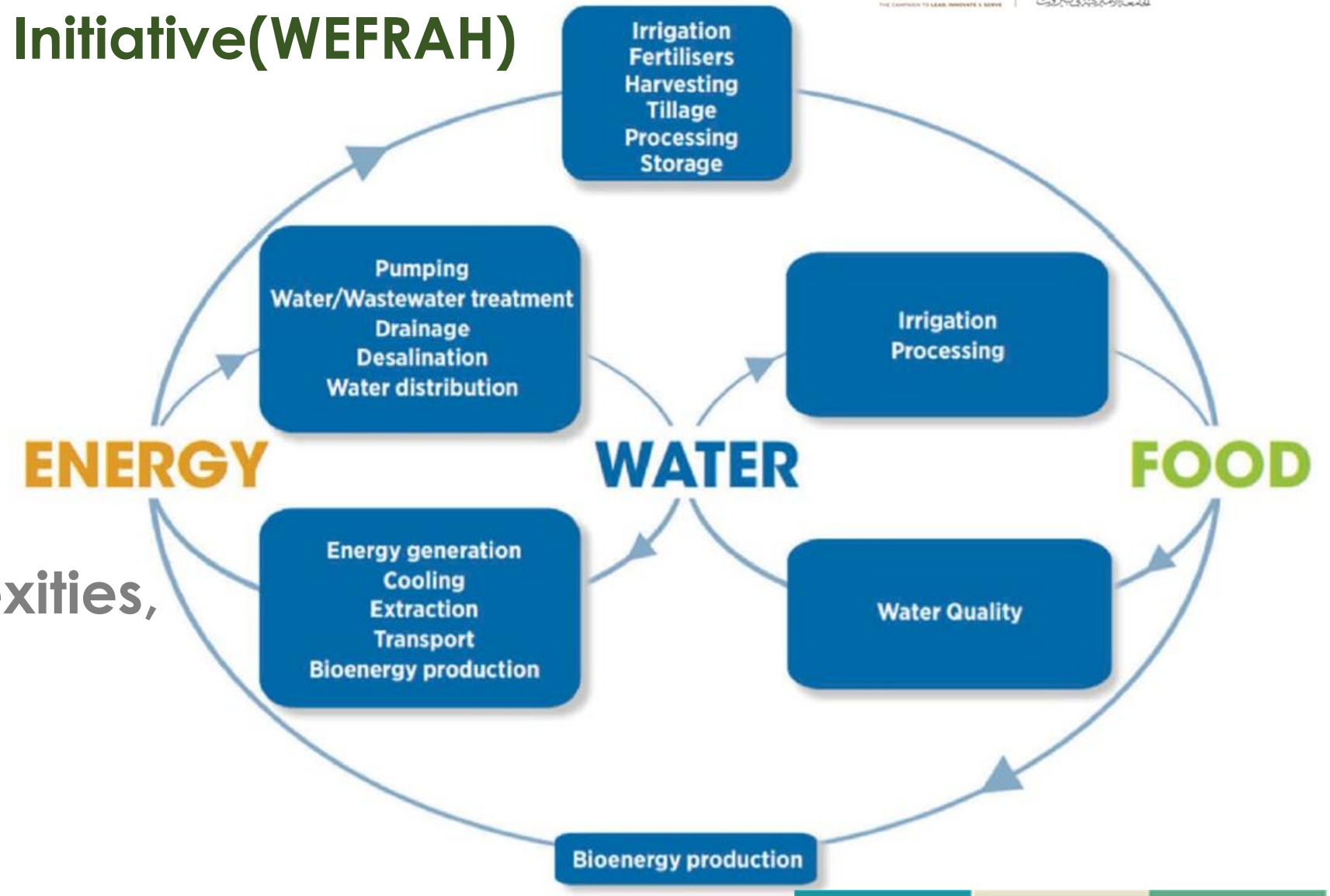
Texas Energy Portfolio

(Business as usual) **2015** → EPAT The Sustainable Energy Planning Tool → (CPP policy) **2030**

H_2O	35%	Water Withdrawal
H_2O	5%	Water Consumption
CO_2	0%	CO_2 Emissions
	143%	Land Use
$	18%	Cost of Generation

EPAT shows that the **CPP policy succeeds in mitigating the carbon emissions** by sustaining same level even after capacity increase, and in **decreasing the water withdrawal volumes in generation by 35%.** On the other hand, the **CPP policy increases water consumption by 5%, land use by 143%** and **cost by 18%.**

Water – Energy – Food – Health Nexus: Renewable Resources Initiative(WEFRAH)



Goals

1. Understand complexities,
2. Reduce interdependencies
3. Increase resilience

http://www.aub.edu.lb/fafs/wefrah/Pages/default.aspx

Key Messages

1. Climate change impact on water, energy & food are significant; a nexus multi-stakeholders / scale approach is needed.
2. WEF Nexus Tools are useful to assess economic, social & environmental sustainability of technologies or policies.
3. Account for the spatial and temporal attributes of resources and for hotspots of resource demand
4. Build capacity across public, private, academic, utilities, farmers, operators, and consumers
5. Integrated approaches can be achieved through creation of regional cooperation & community of practice

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WEF Nexus Research Group

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Thank You