Addressing Climate Change and Natural Disasters

Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving the SDGs: Regional Policy Tool Kit

October 2016

Economic and Social Commission for Western Asia

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Climate Change Regional Overview

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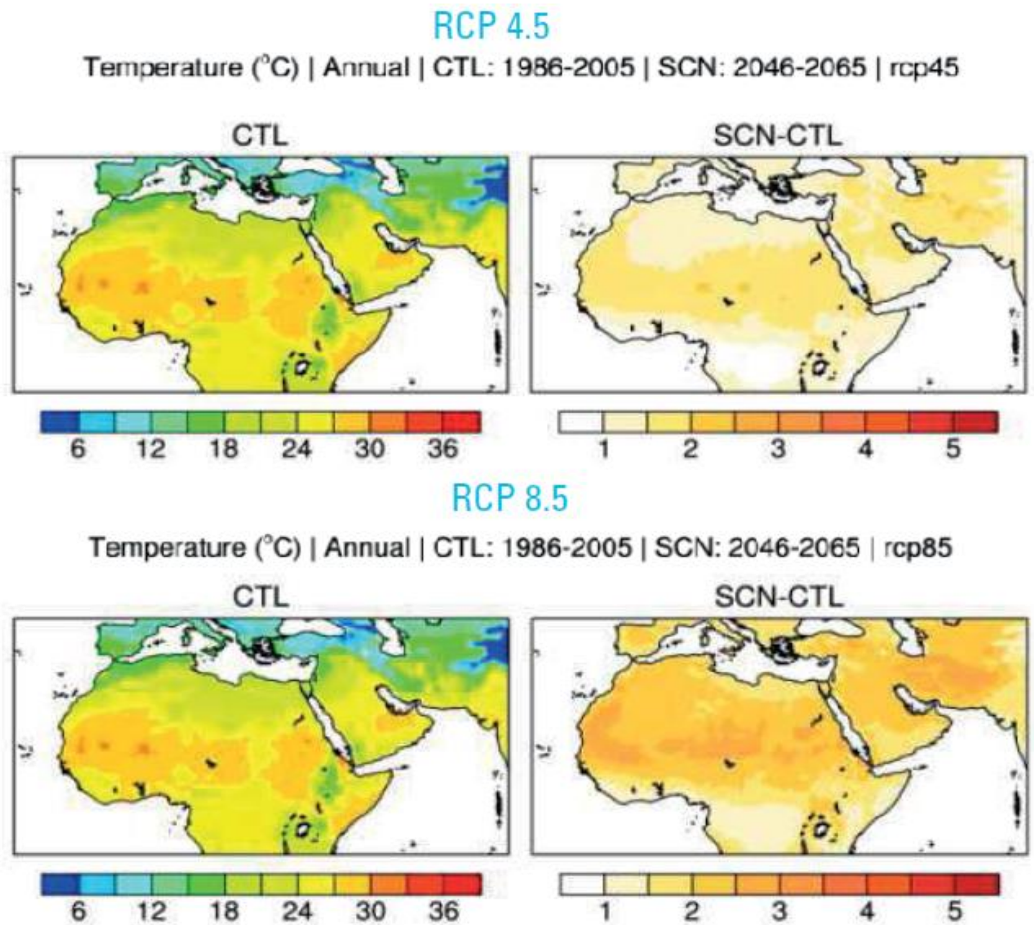
Projected Temperature range over parts of the Arab region

	Increase in annual average temperature range in °C	
Years	**Best scenario**	**Worst scenario**
2030	0.5-1.0	1-1.5
2070	1.0-1.5	2.0-2.5
2100	2.5-3.0	3.0-4.0

Source: IPCC, 2007

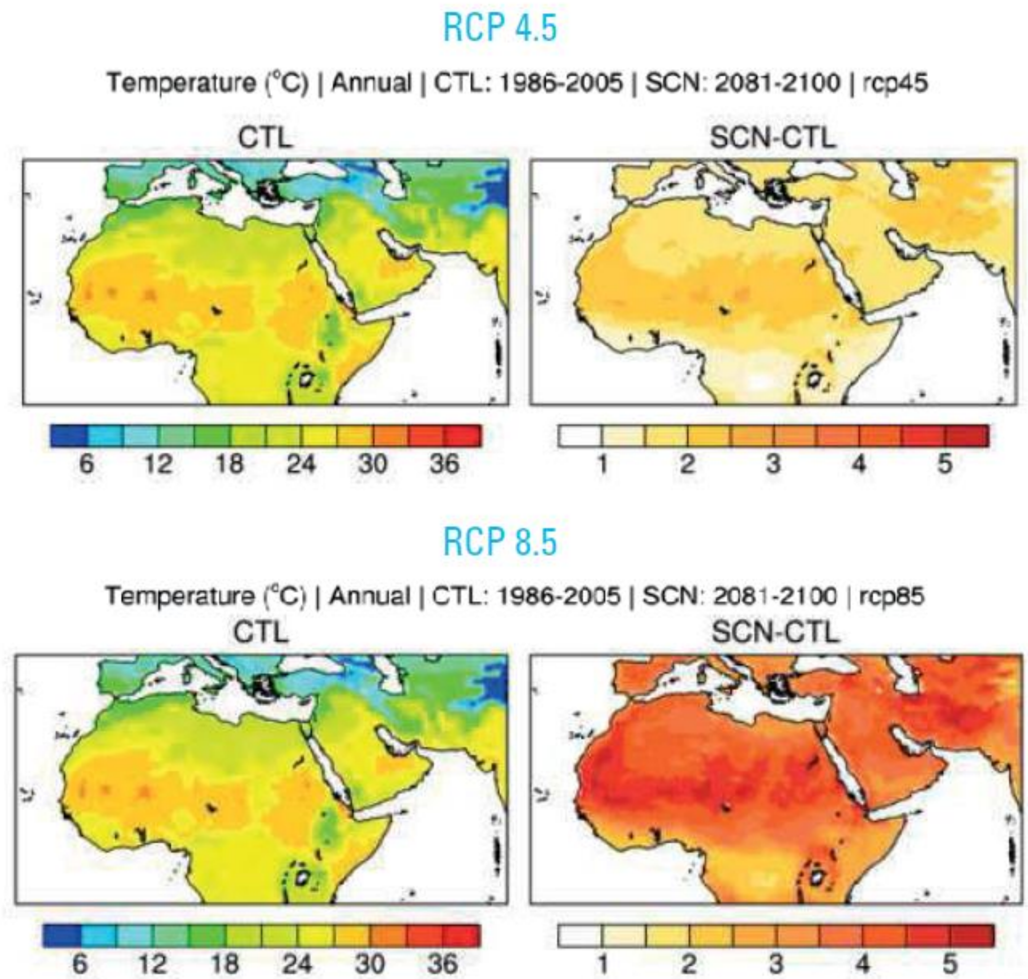
Regional Climate Model projections of the average temperature changes (° C) in the Arab Region. 2046-2065



Projections of average temperature changes(℃) in the Arab region for two different scenarios: medium (RCP4.5) and worst case (RCP 8.5). Time period 2046-2065 compared to the baseline 1986-2005.

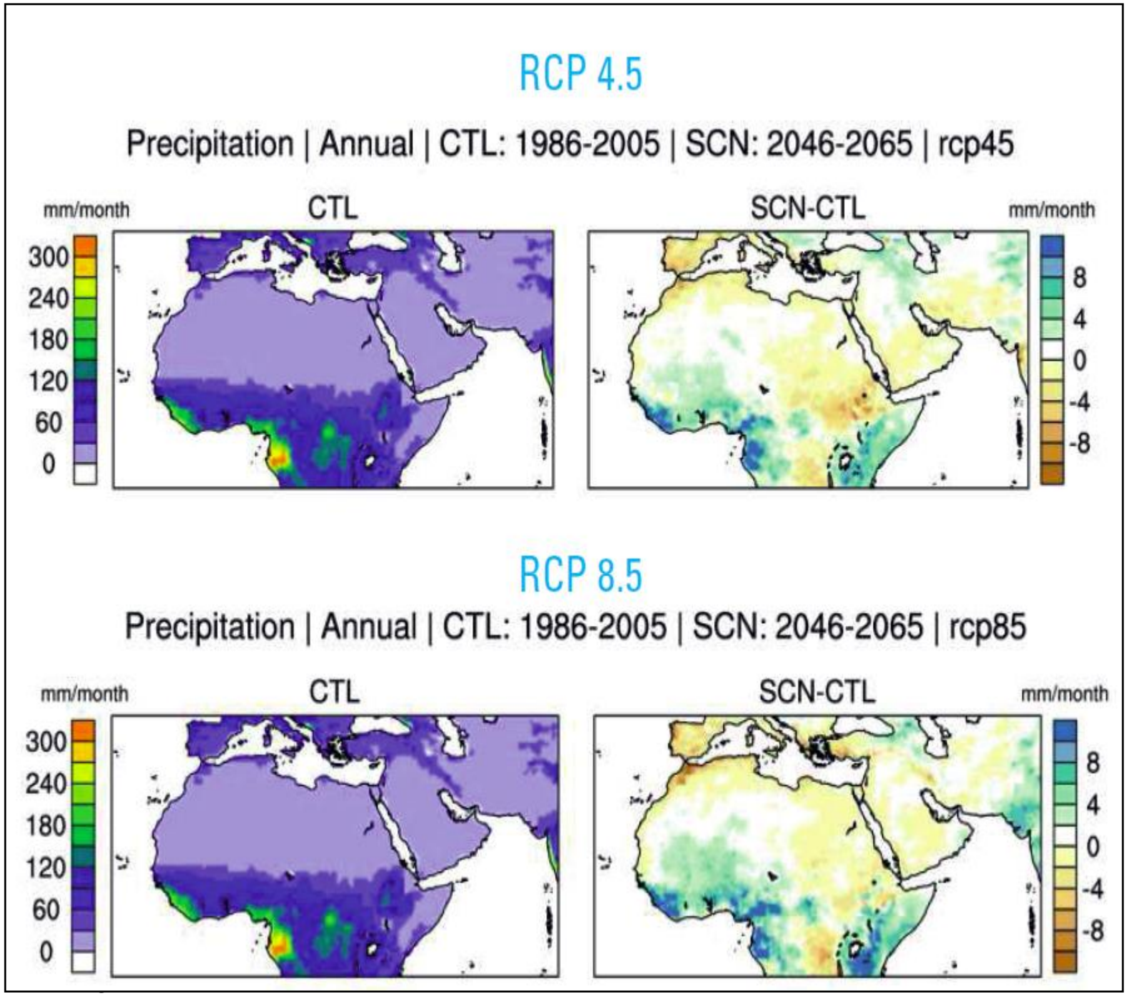
Source: RICAAR, 2015

Regional Climate Model projections of the average temperature changes (° C) in the Arab Region. 2081-2100



Projections of average temperature changes(℃) in the Arab region for two different scenarios: medium (RCP4.5) and worst case (RCP 8.5). Time period 2081-2100 compared to the baseline 1986-2005. Source: RICAAR, 2015

Projected changes in precipitation



Projections of average precipitation changes(℃) in the Arab region for two different scenarios: medium (RCP4.5) and worst case (RCP 8.5). Time period 2046-2065 compared to the baseline 1986-2005.

Source: ESCWA, 2015

Paris Agreement 2015: Main targets

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

- Mitigation of CC effects (reducing emissions);
- Creation of a **transparency** system globally that will account for climate action;
- Movement towards **adaptation** (strengthening ability of countries to deal with climate impacts);
- Building **resilience** in vulnerable areas (loss and damage – strengthening ability to recover from climate impacts); and also
- Providing **support** (including finance) for nations to build clean, resilient futures.

SDG 13 : Climate Action

- Strengthening resilience and adaptive capacity to climate-related hazards and natural disasters (13.1),
- Integrating climate issues into policy making and **national strategies** (13.2),
- Raising awareness and **building capacity** in institutions (13.a),
- Promoting climate-change related planning and management in **vulnerable countries**, and focusing on gender and youth issues, poverty and other local needs (13.b).

(UNDESA, 2015.)

Climate Change and the Water-Energy Nexus

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Climate change impact on stream flow

Most dramatic in subtropics region where ESCWA countries are located

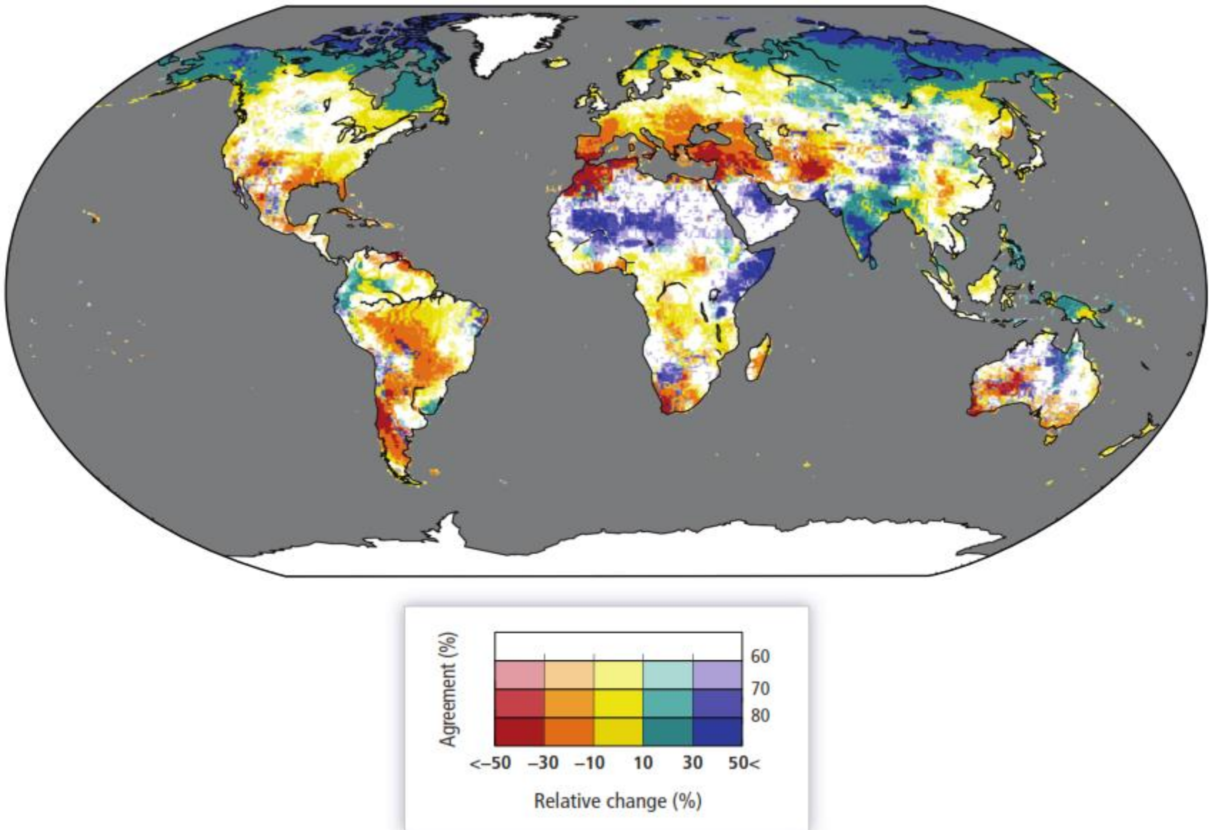
There is a reduced availability of groundwater recharge in the bulk of the ESCWA region, which affects surface and subsurface water resources:

River flow reduction impacts water supply
Reduction in stream flow impacts soil moisture availability
Reduction impacts food production and adds pressure to compensate through irrigation to maintain production

Climate change impact on stream flow (continued)

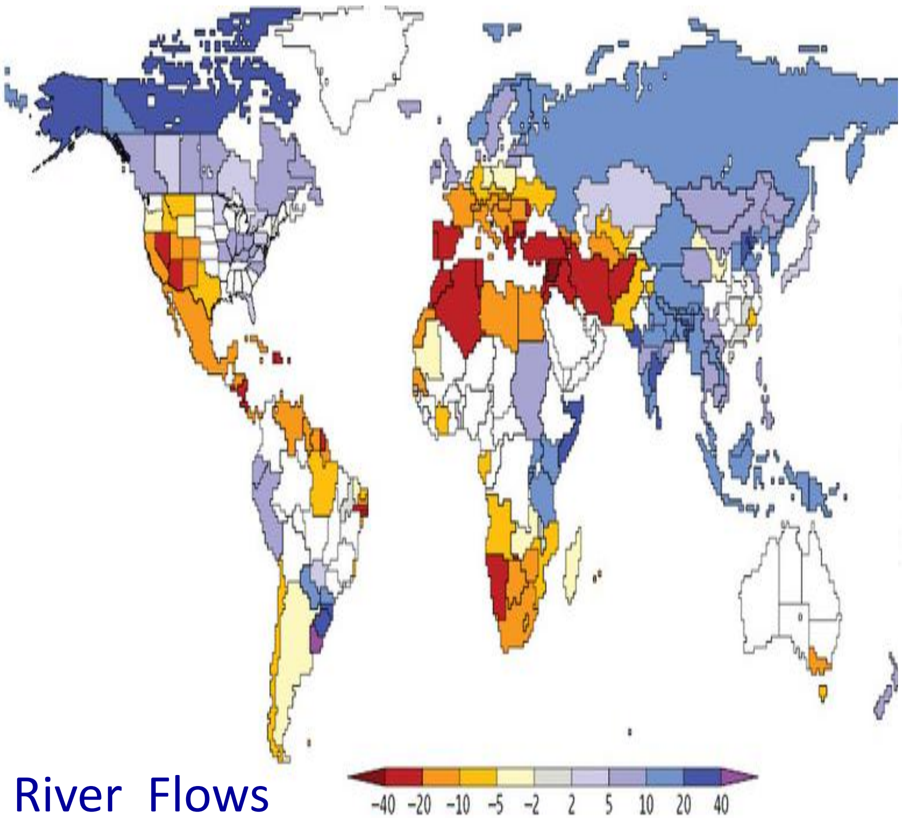
This negatively impacts hydropower generation potential in some ESCWA countries where hydropower plays role in energy portfolio

Change of mean annual streamflow for a global mean temperature rise of 2C

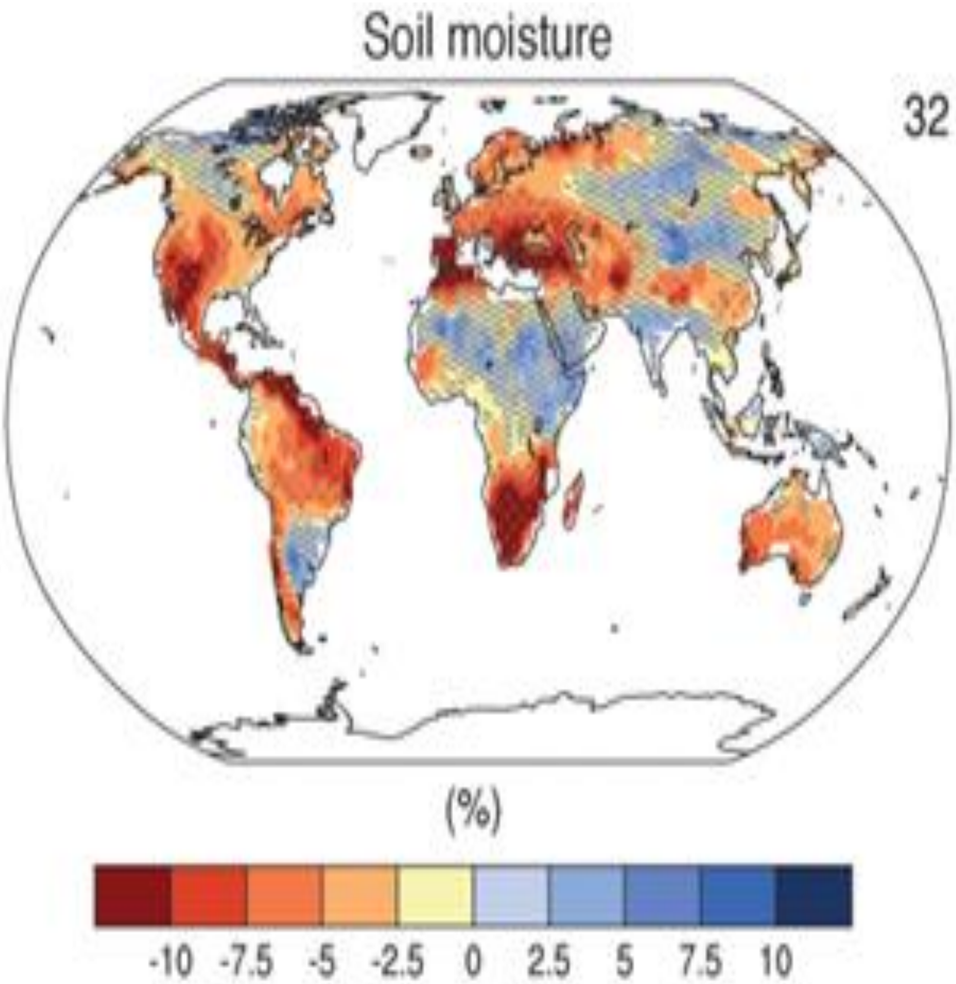


Percentage change of mean annual streamflow for a global mean temperature rise of 2° C above 1980–2010 (2.7° C above pre-industrial). Color hues show the multi-model mean change across 5 General Circulation Models (GCMs) and 11 Global Hydrological Models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM–GCM combinations (percentage of model runs agreeing on the sign of change) (Schewe et al., 2013).

Projected changes in river flows and soil moisture

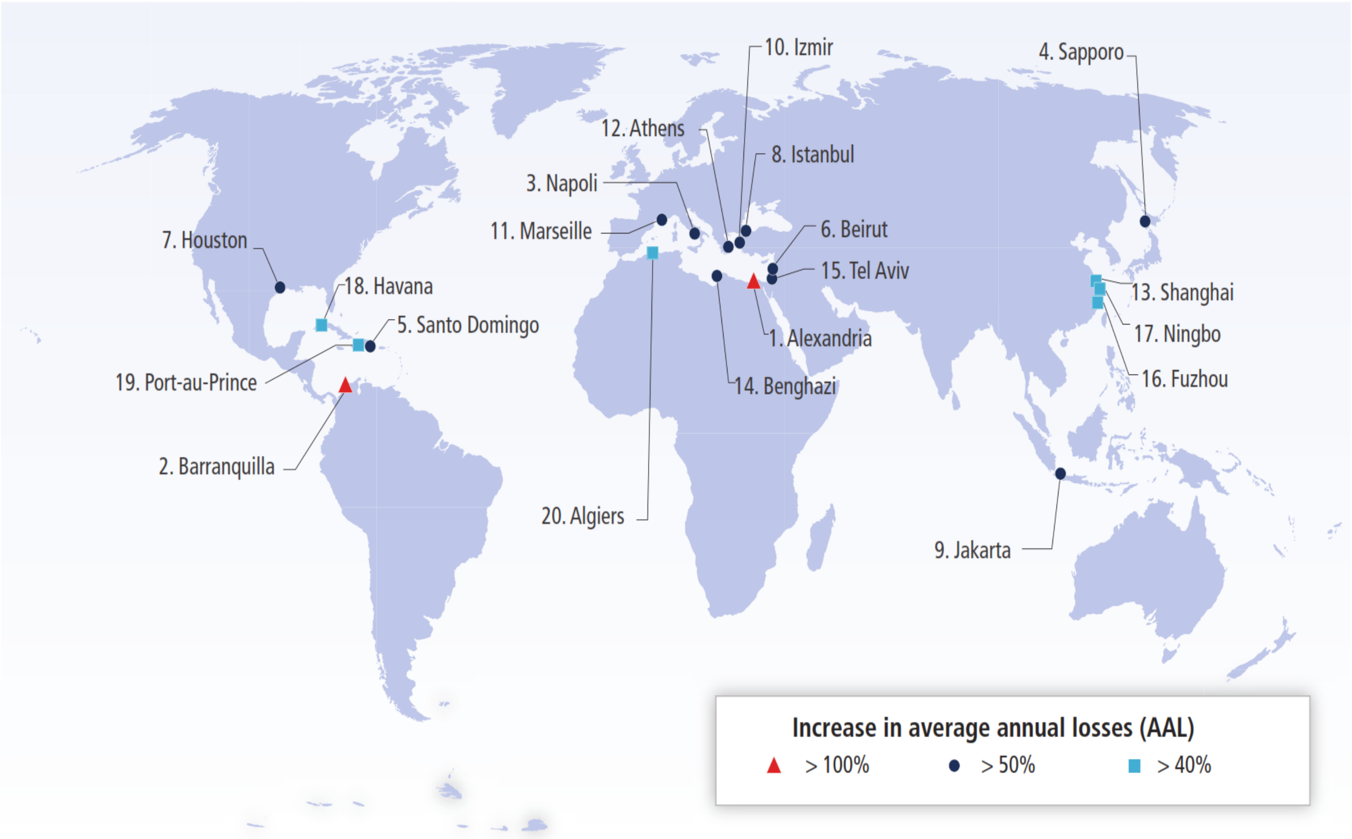


River Flows



Milly P.C.D., et al 2008

20 coastal cities where AALs increase most in the case of optimistic sea level rise



Coastal cities where average annual losses (AALs) increase most (in relative terms in 2050 compared with 2005) in the case of optimistic sea level rise, if adaptation maintains only current defense standards or flood probability (PD) (Hallegatte et al., 2013).

So what is being projected?

- More intense, frequent and longer heat waves
- Sea level rise
- Decrease in subtropics precipitation
- Increase in precipitation intensity but longer periods between rain events

So what is being projected? (continued)

- Greater plant water needs
- Greater city water needs
- Less fresh surface water in places
- More pests and diseases
- Diminished water quality
- Higher priced energy

Impacts of Climate Change and Natural Disasters in the different sectors

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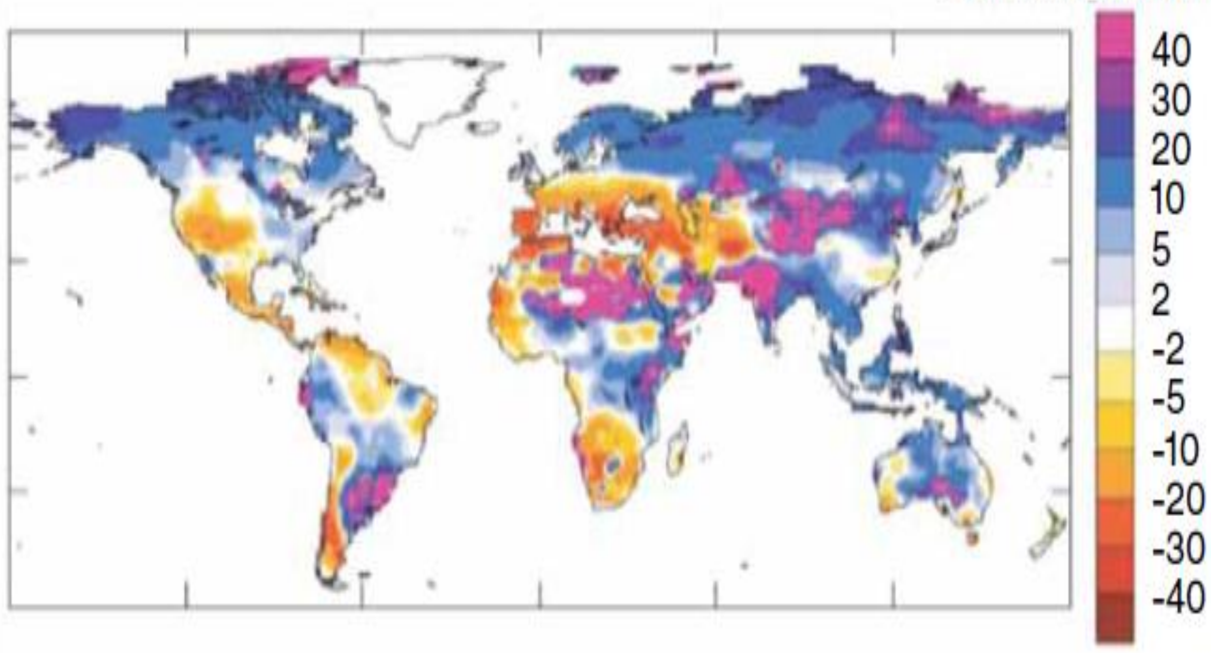
Impacts On Water Security: Decrease in run-off



Run-off is projected to drop by 20 to 30% in most of MENA by 2050

Source: Milly et al., published in Nature.

Impacts on the Energy Sector: power requirements

- Higher summer and winter temperatures impact energy requirements:
  - Savings can be gained through technological advances that require infrastructure and technological investment that may lack in the Arab region

- Increase in energy requirements for groundwater abstraction, desalination, treatment, transfer and distribution

- Overall warming of air and water is expected to affect efficiency, operation and the development of new power plants

Impacts on the Energy Sector: efficiency

- Overall warming of air and water is expected to affect efficiency, operation and the development of new power plants

Impacts on the Energy Sector: renewable energy

- Climatic changes are expected to impact renewable energy infrastructure:

1. Decreased river runoffs
2. Changes in wind conditions
3. Solar energy production
4. Heavy reliance on hydroelectric power

Impacts on the Energy Sector (continued)

- Projected increases in the activity of extreme weather events could lead to downing of power transmission towers and lines
- Sea level rise and wave surges affects many power plants in the Arab region

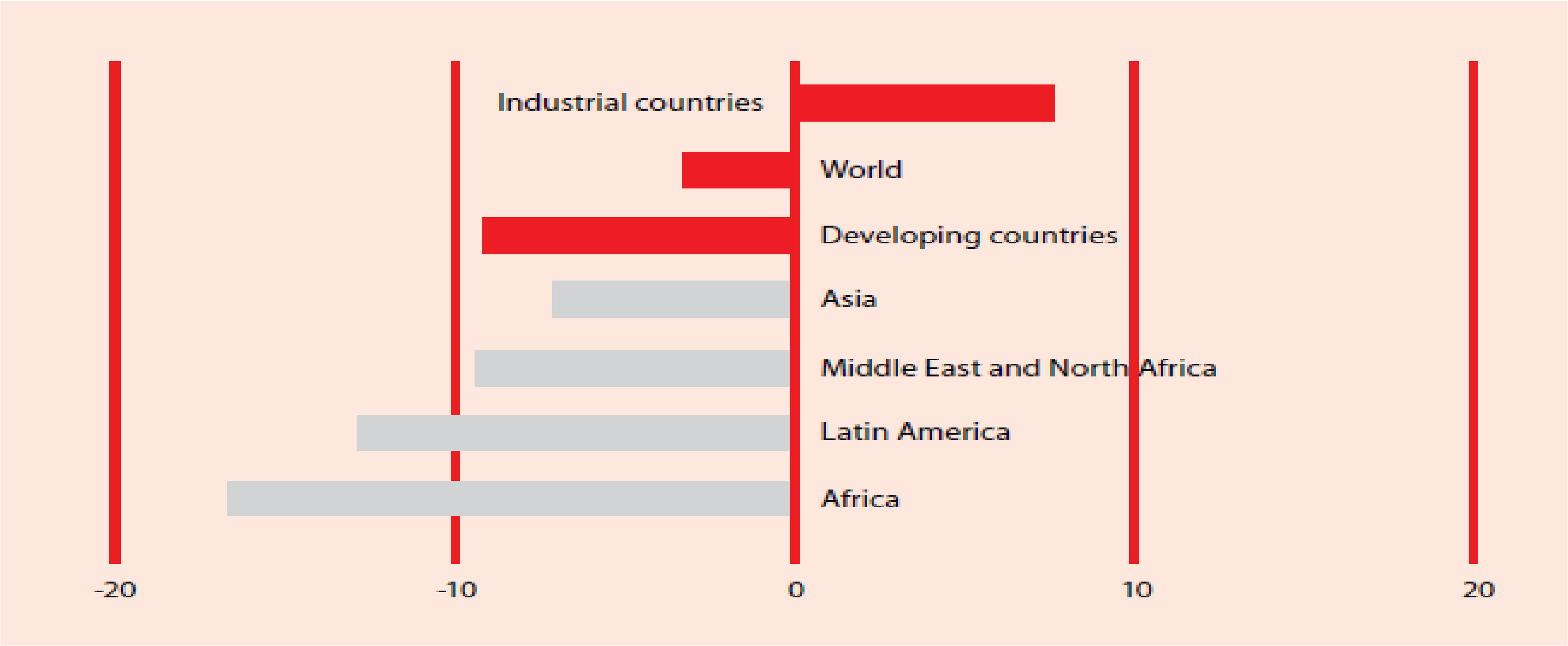
Climate adaptation in the Energy Sector

- Enhancing adaptive capacity of the energy infrastructure can be achieved through an integrated approach that involves utilizing technological advances to:

1. Improve power plant efficiency
2. Demand management
3. Decentralization of power generation
4. Storm planning for power plants and refineries
5. Build strategic fuel reserves

Impacts on Food Security

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



Source: Cline, 2007.

Change in agricultural output potential (2080s as % of 2000 potential)

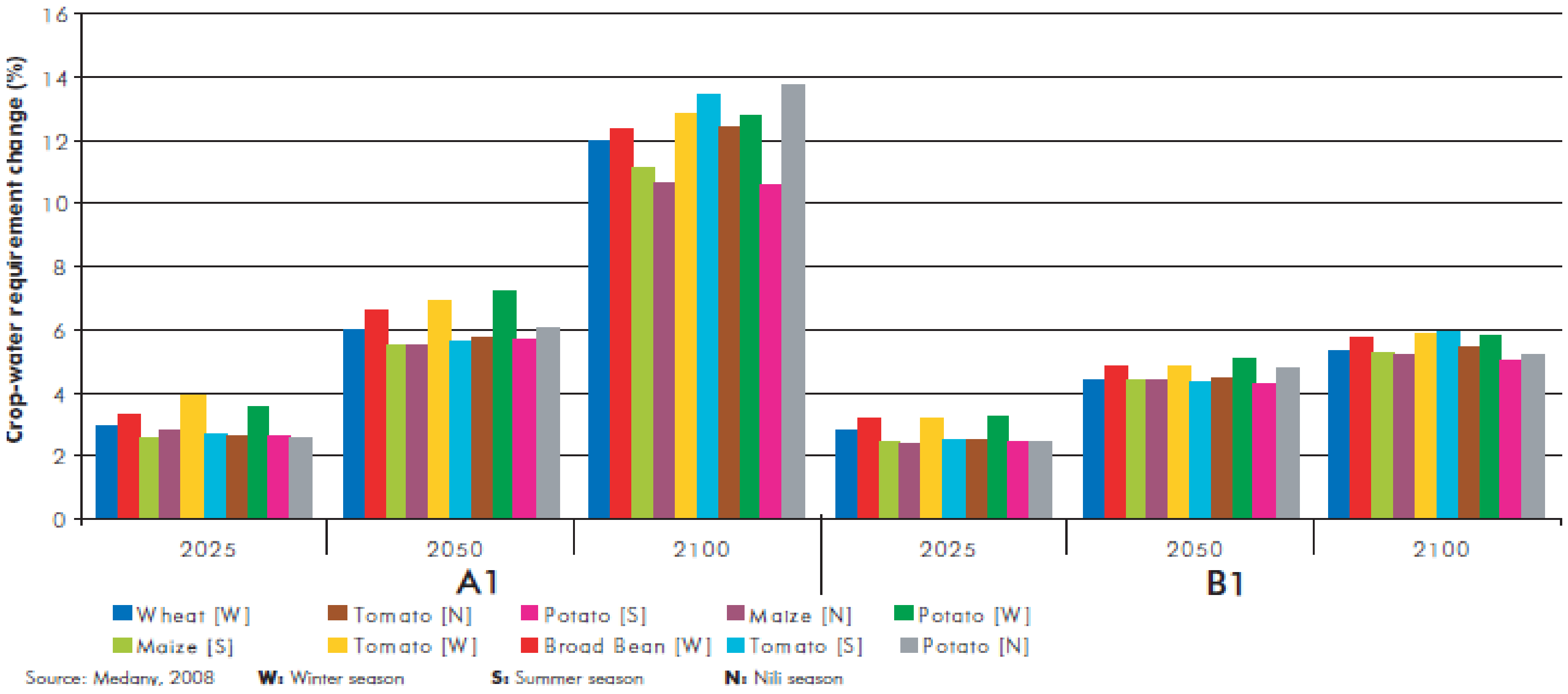
Impacts on Food Security: yields

Crop	Change in %	
	2050s	2100s
Wheat	-15% *	-36% **
Rice	-11%	
Maize	-14% to -19%	-20%
Soybeans	-28%	
Cotton	+17% *	+31% **
Potato	-0.9 to -2.3 %	+0.2 to +2.3%

* Temperature increase by 2°C; ** Temperature increase by 4°C

Projected changes in crop production of some major crops in Egypt under climate change conditions. Source: Fahim et al, 2013.

Impacts on Food Security: water requirements of crops



Change between current and future values (for years 2025s, 2055s and 2100s) at national level seasonal crop-water requirements of some field and vegetable major crops

Other impacts

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

Towards Adaptation and Resilience: Challenges and Opportunities

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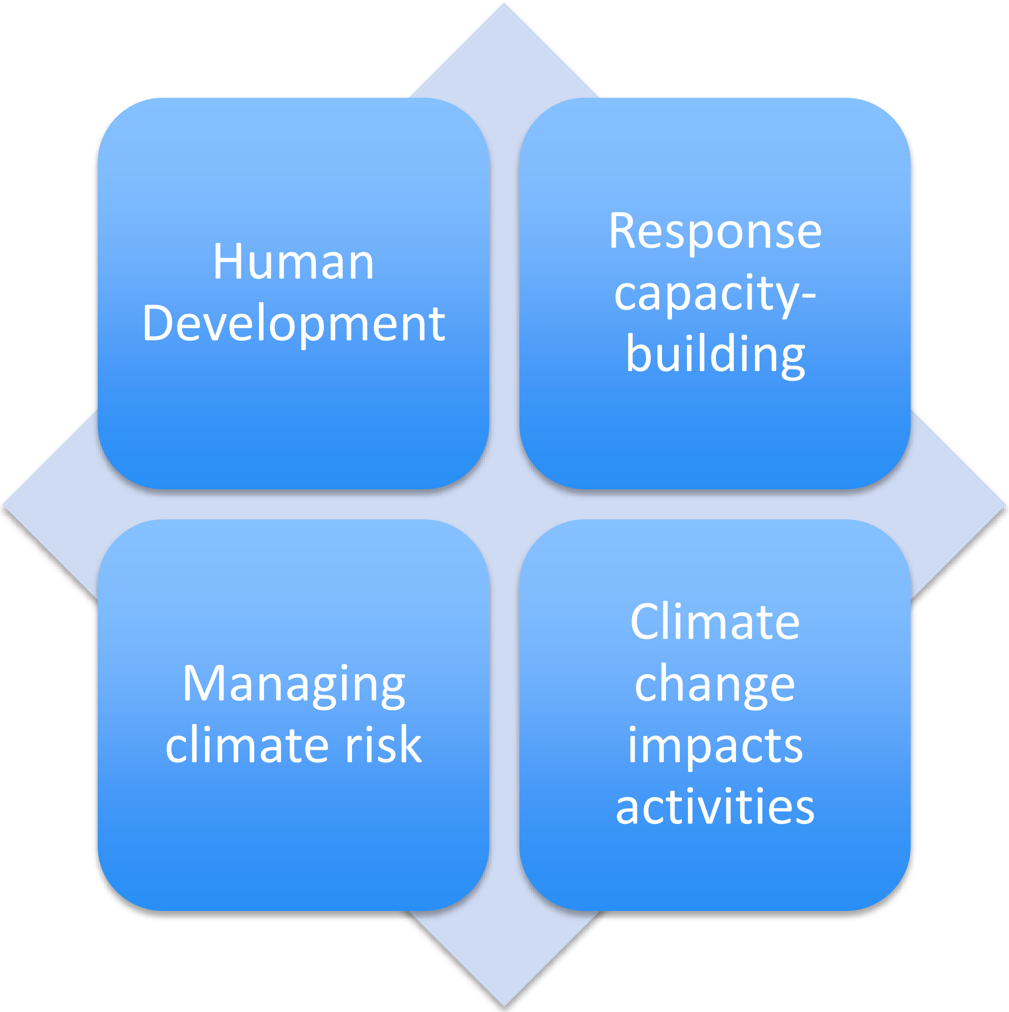
Adaptation Strategies



Adaptation Strategies: *Human Development*

Activities that impact development, regardless of climate change impacts.

For example, activities that target:
- Poverty
- Literacy
- Gender
- Pollution

Adaptation Strategies: *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

Adaptation Strategies: *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

Adaptation Strategies: *Climate Change Impact Activities*

Measures that aim at alleviating the effects of climate events.

For example,

- Relocation of communities
- Repairs of damaged infrastructure

Four-step approach to assessing adaptation actions

1. Identify current and future vulnerabilities
2. Identify adaptation measures
3. Evaluate and select adaptation options
4. Monitor and evaluate outcomes of adaptation measures

Governance of Climate Change Adaptation and Mitigation

Knowledge gaps:

- Resource use and availability gap
- Impacts gap
- Scaling/Modeling gap
- Scientific gap
- Awareness gap

Case Study: Bridging the Texas Water Gap

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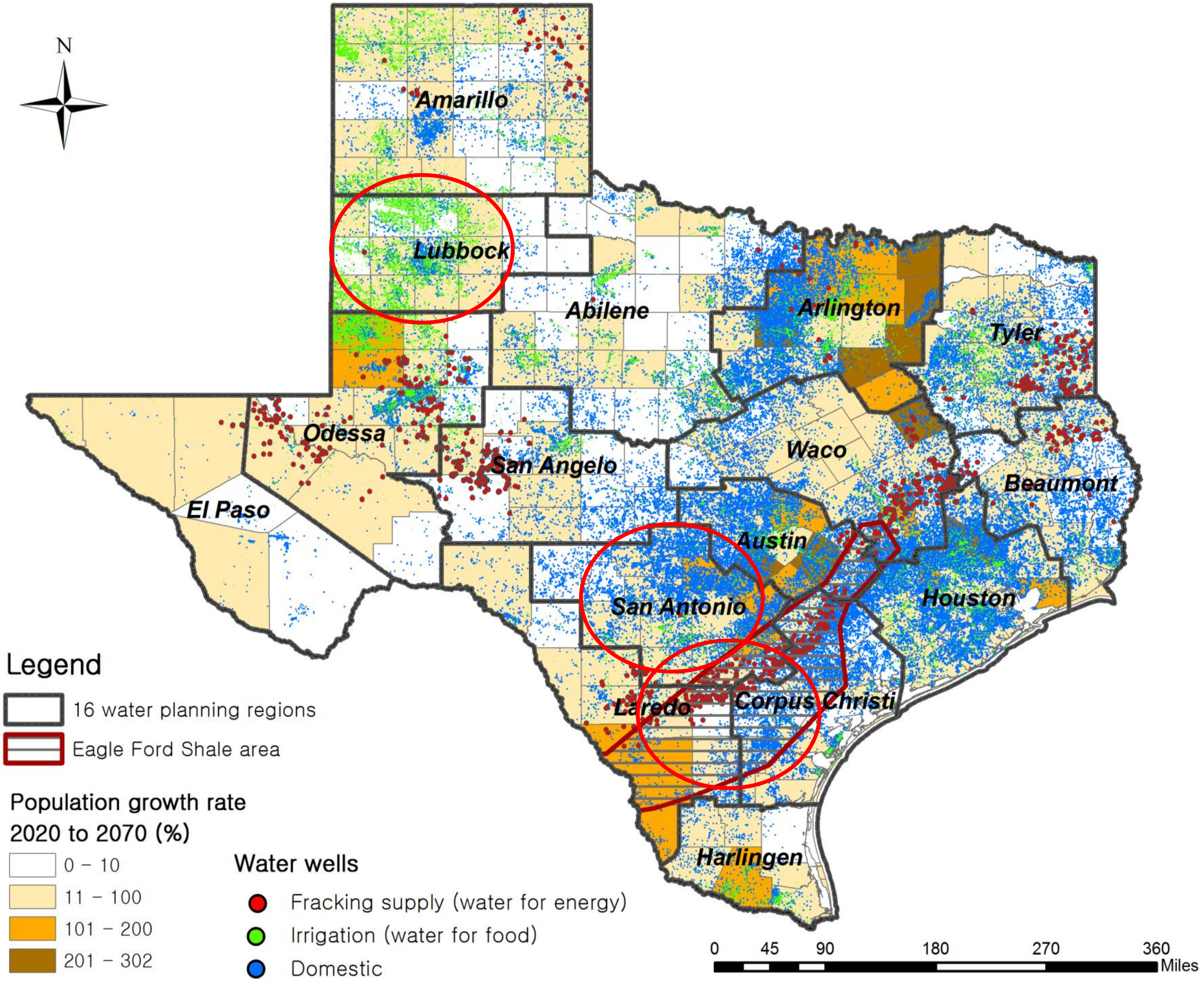
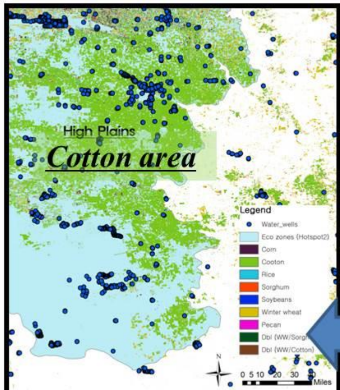
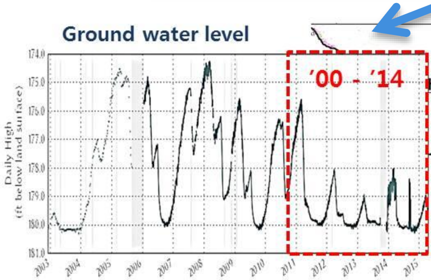


N
Amarillo
Lubbock
Abilene
Arlington
Tyler
Odessa
San Angelo
Waco
Beaumont
El Paso
Austin
Houston
San Antonio
Laredo
Corpus Christi
Harlingen
Legend
16 water planning regions
Eagle Ford Shale area
Population growth rate
2020 to 2070 (%)
0 – 10
11 – 100
101 – 200
201 – 302
Water wells
Fracking supply (water for energy)
Irrigation (water for food)
Domestic
0 45 90 180 270 360
Miles

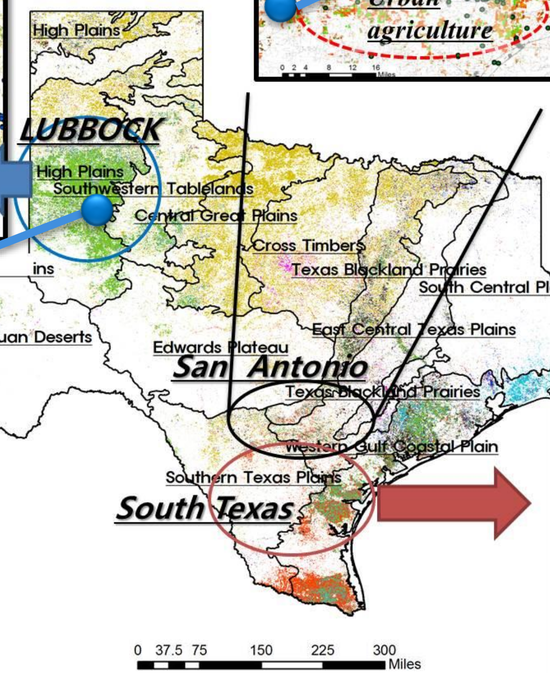
Hotspot Characteristics in Texas

Hot spot 1 : Lubbock
Agriculture vs. Water

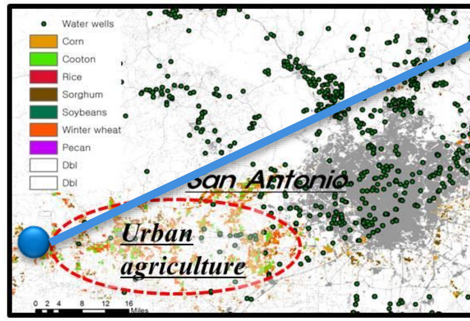


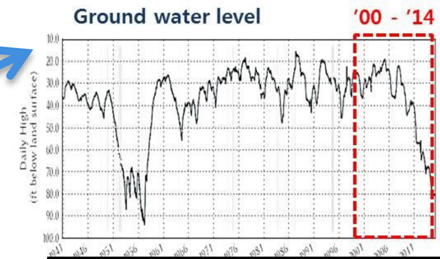


County	Hale
Aquifer	Edwards-Trinity (High Plains)
Period of Record	2002-12-05 to present
Entity/Cooperator	Texas Water Development Board



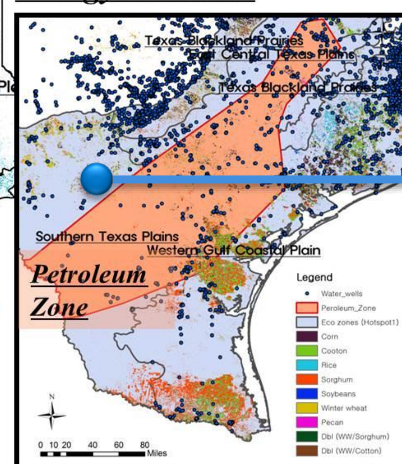
Hot spot 2 : San Antonio
Urban Agriculture vs. Water

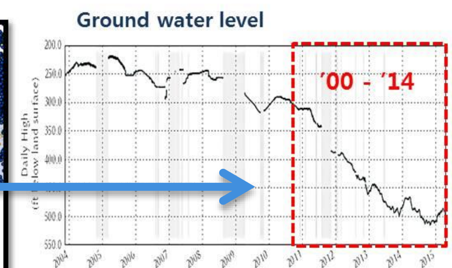




County	Uvalde
Aquifer	Edwards (Balcones Fault Zone)
Period of Record	1940-10-24 to present
Entity/Cooperator	Edwards Aquifer Authority

Hot spot 3 : South Texas
Energy vs. Water





County	La Salle
Aquifer	Carrizo-Wilcox
Period of Record	2003-11-16 to present
Entity/Cooperator	Texas Water Development Board

Case Study 1: Lubbock

- **Economy** highly reliant on **agriculture**
- **Two surface water sources**: Lake Meredith and Lake Alan Henry;
- **One groundwater source**: Ogallala aquifer.
- The city sources approximately **65% of its water from groundwater** sources (City of Lubbock, 2013).

Lubbock Scenarios

Possible alternatives for bridging the region's water gap by investigating scenarios that use:

1) Different water sources

- Reclaimed Water; GW; Surf. Water; Water Cons.

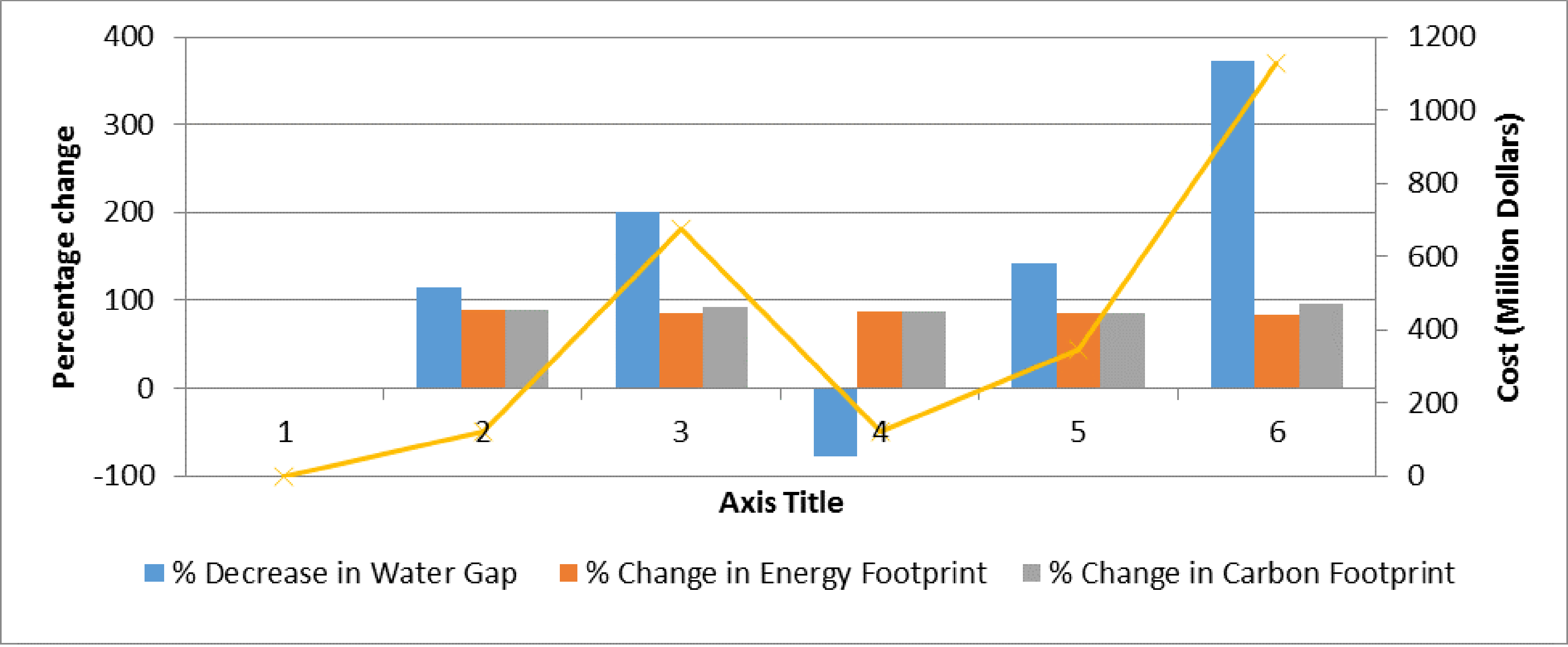
2) % Dryland agriculture

- cotton, sorghum, wheat

3) % Energy sources

- natural gas, wind

Lubbock: Results



<u>**Scenario 2**</u>

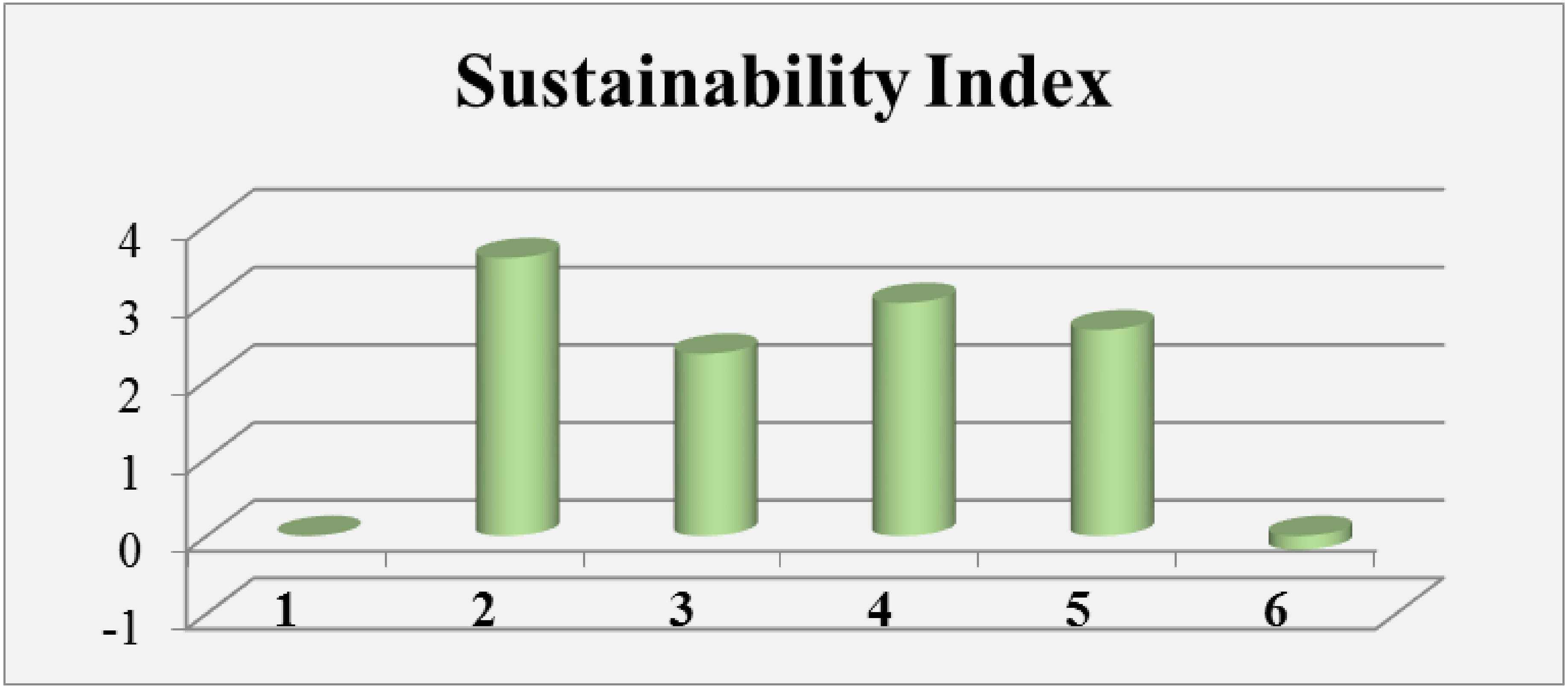
Potential of bridging 100% the Lubbock water gap (11,743,729 m3) **through a combination of:**

- full use of reclaimed water (100%) from the city for agriculture
- Increase in dry land agriculture for major crops; - Investing in RE

→This would require financial investment (~121 million) for scenario 2

→This would potentially allow for reducing pressure on surface and GW

Lubbock: Sustainability Index



Weights

% Decrease in Water Gap = 0.3

% Change in Energy Footprint =0.2

% Change in Carbon Footprint = 0.05

% Cost =0.45

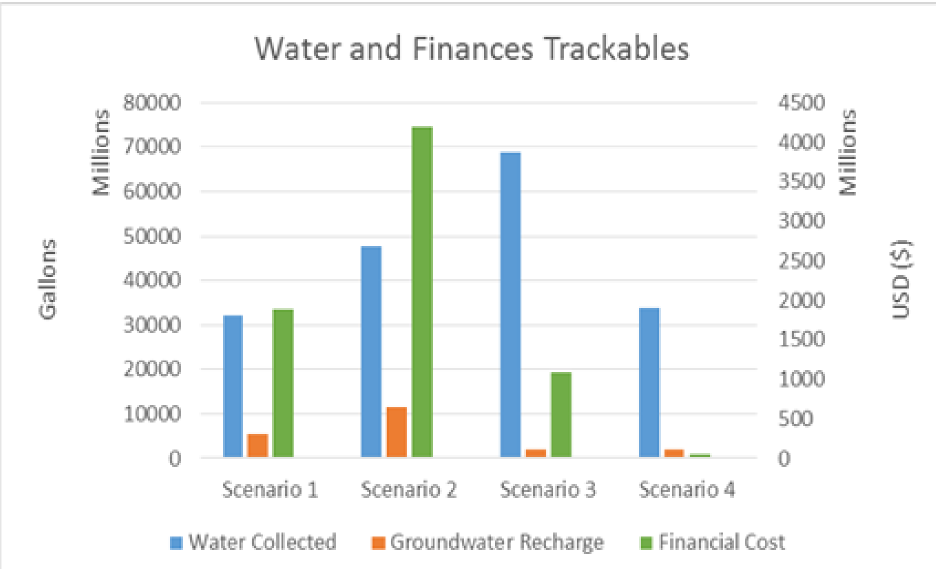
Case Study 2: LIDs in San Antonio

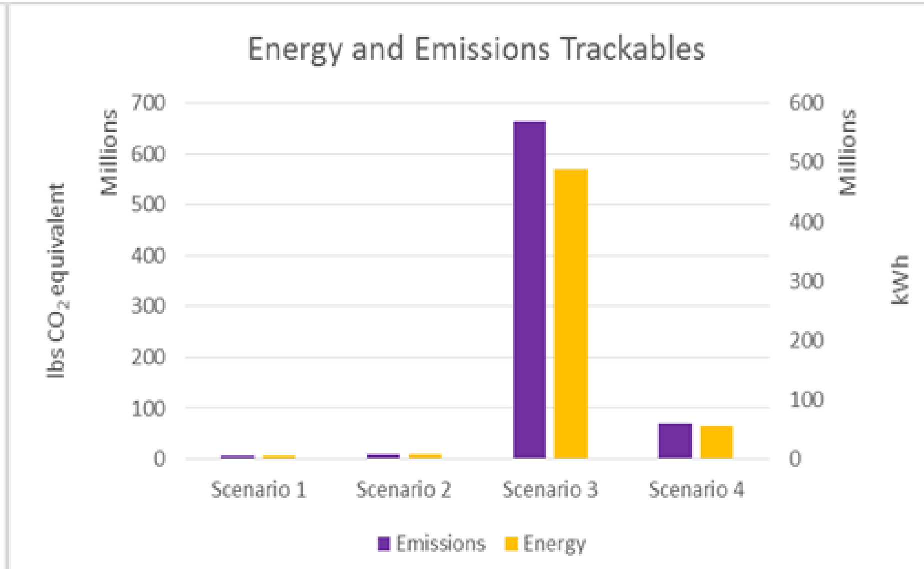
Objective:

- assess the **trade-offs** associated with implementing **different types of LIDs** as a means for collecting water to be used as **supplementary irrigation** at farms.
- A holistic nexus perspective will be taken to assess different scenarios through quantifying **potential of collected water**, **GW recharge**, **financial cost**, **energy requirement**, and **carbon emissions** associated with each.

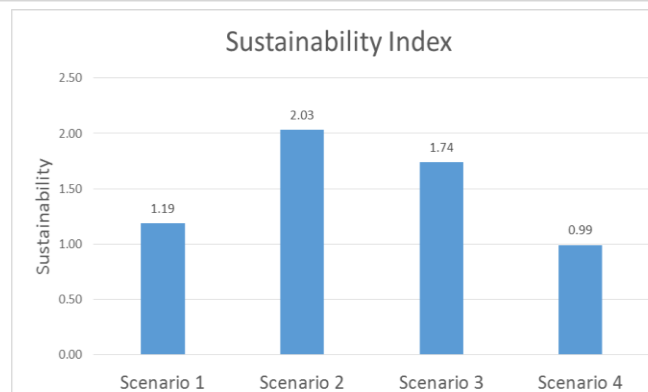
Case Study 2: Scenarios Analysis

	% BRB	% PP	% RWH	% CNV	Transport	Treatment
Scenario 1	50	20	70	0	Pipeline	No
Scenario 2	100	100	100	0	Pipeline	No
Scenario 3	0	0	0	100	Pipeline	Yes
Scenario 4	0	0	0	100	None	None

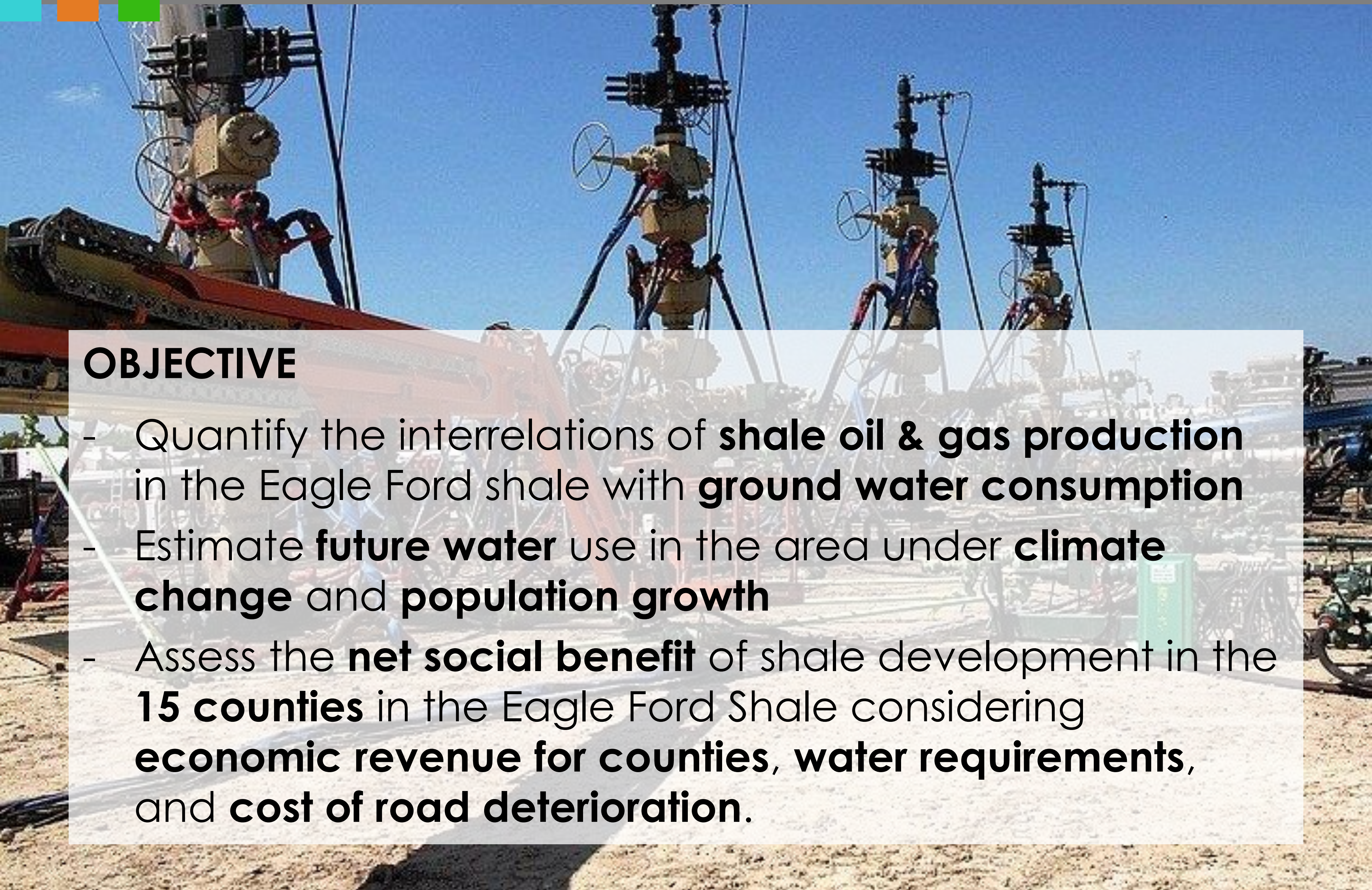




Scenario 2 would supply an additional **47 billion gallons** (146,688 ac-ft) to the agricultural water supply in the San Antonio region every year.
- by implementing 100% of each of the LIDs in San Antonio for a cost **> 4Billion Dollars**

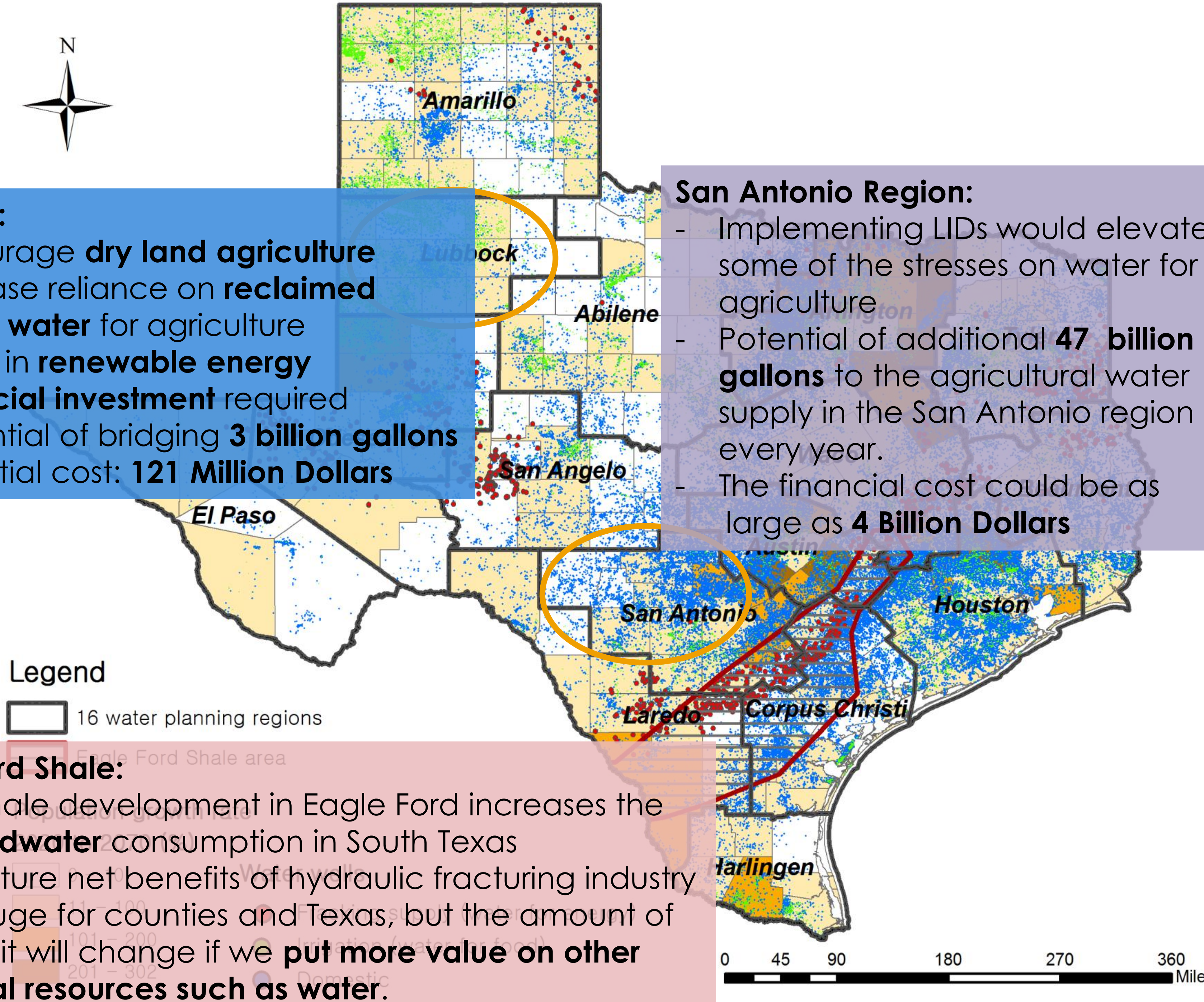


Case Study 3: Eagle Ford



OBJECTIVE

- Quantify the interrelations of **shale oil & gas production** in the Eagle Ford shale with **ground water consumption**
- Estimate **future water** use in the area under **climate change** and **population growth**
- Assess the **net social benefit** of shale development in the **15 counties** in the Eagle Ford Shale considering **economic revenue for counties**, **water requirements**, and **cost of road deterioration**.



Lubbock:

- Encourage **dry land agriculture**
- Increase reliance on **reclaimed waste water** for agriculture
- Invest in **renewable energy**

→ **Financial investment** required

→ Potential of bridging **3 billion gallons**
Potential cost: **121 Million Dollars**

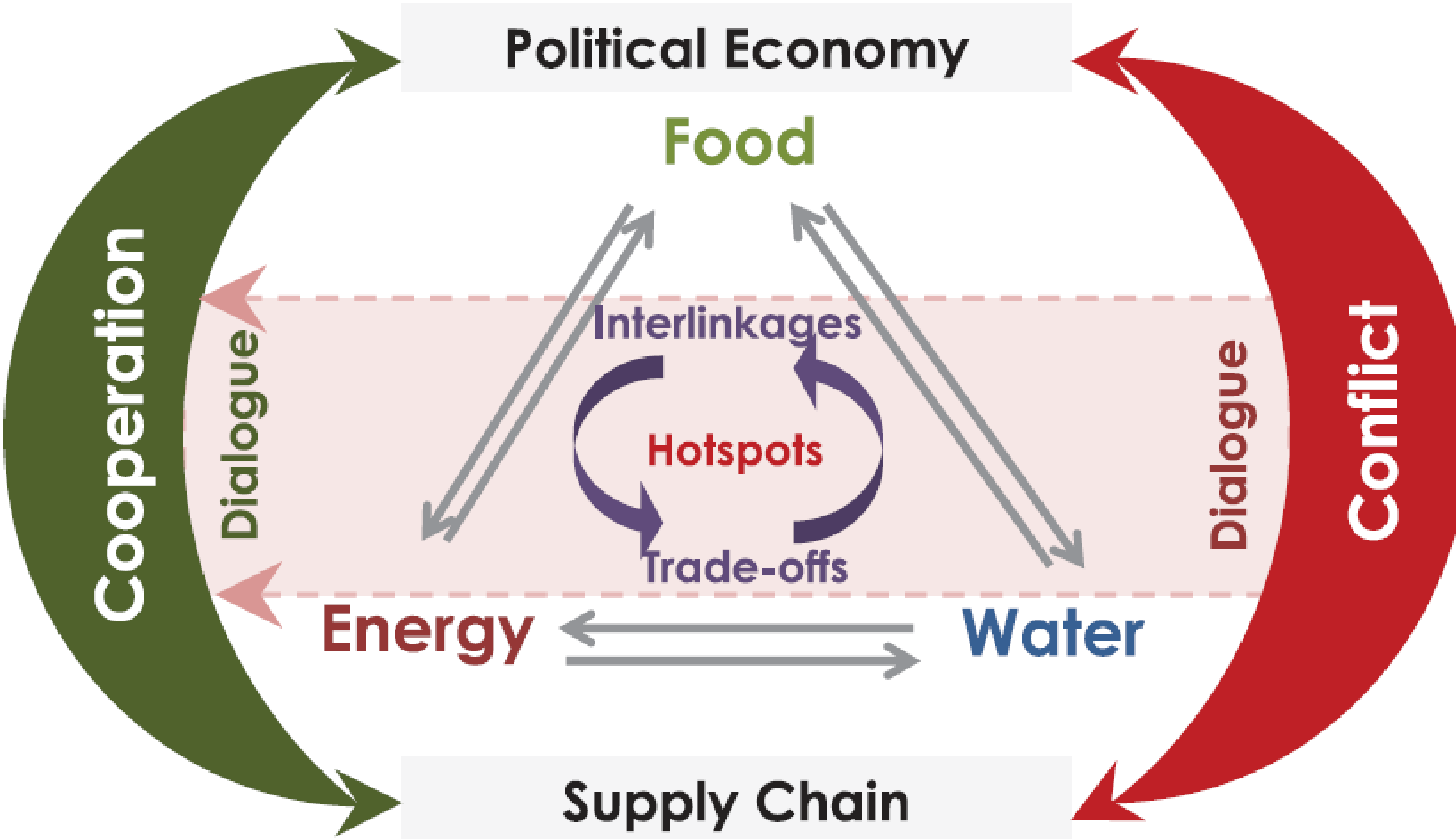
San Antonio Region:

- Implementing LIDs would elevate some of the stresses on water for agriculture
- Potential of additional **47 billion gallons** to the agricultural water supply in the San Antonio region every year.
- The financial cost could be as large as **4 Billion Dollars**

Eagle Ford Shale:

- The shale development in Eagle Ford increases the **groundwater** consumption in South Texas
- The future net benefits of hydraulic fracturing industry are huge for counties and Texas, but the amount of benefit will change if we **put more value on other natural resources such as water**.

From Science to Policy



(Mohtar & Daher, 2016)

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

Concluding Remarks on the Case Study

Bridging the water gap requires:

- multi-stakeholder approaches
- accounting for the spatial and temporal distribution of resources
- accounting for interconnections between water, competing resource systems, and growing stresses
- proper communication of trade-offs between resource systems associated with different growth trends among water demanding sectors
- Governance challenges: **who pays for it**!

Holistic yet **localized** solutions

Key Messages

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Key Messages

1. More intense, more frequent and longer heat waves are being projected for the ESCWA region. These will have significant economic, health and environmental consequences

2. Climate change impact on water, energy and food security are significant, therefore, a nexus approach to adaptation and mitigation is needed.

3. Tools can be used to assess the economic, social and environmental sustainability of technological or policy solutions towards climate adaptation.

Key Messages (continued)

4. Addressing climate change and its impact on water and energy requires a multi-stakeholder and multi-scale policy making.

5. Such an integrated approach can be achieved through creation of a regional cooperation and community of practice

Thank you

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