

LULEÅ UNIVERSITY OF TECHNOLOGY

**WATER SCARCITY IN THE
CONTEXT OF CLIMATE
CHANGE.
MIDDLE EAST, EUPHRATES AND
TIGRIS BASIN**

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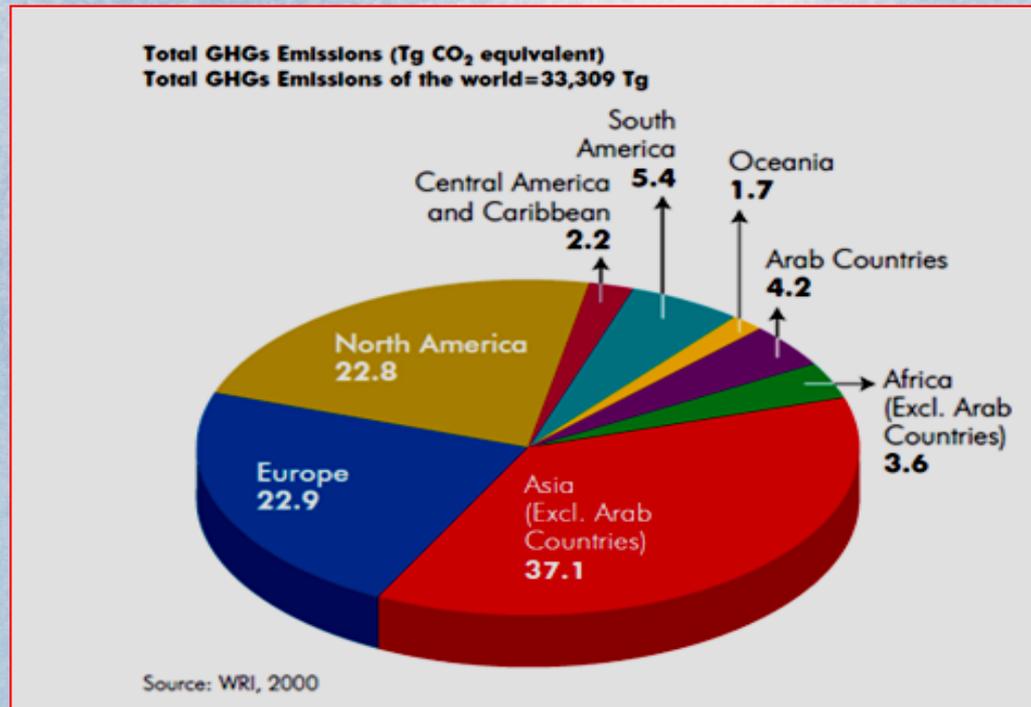


Why we have Global Warming?

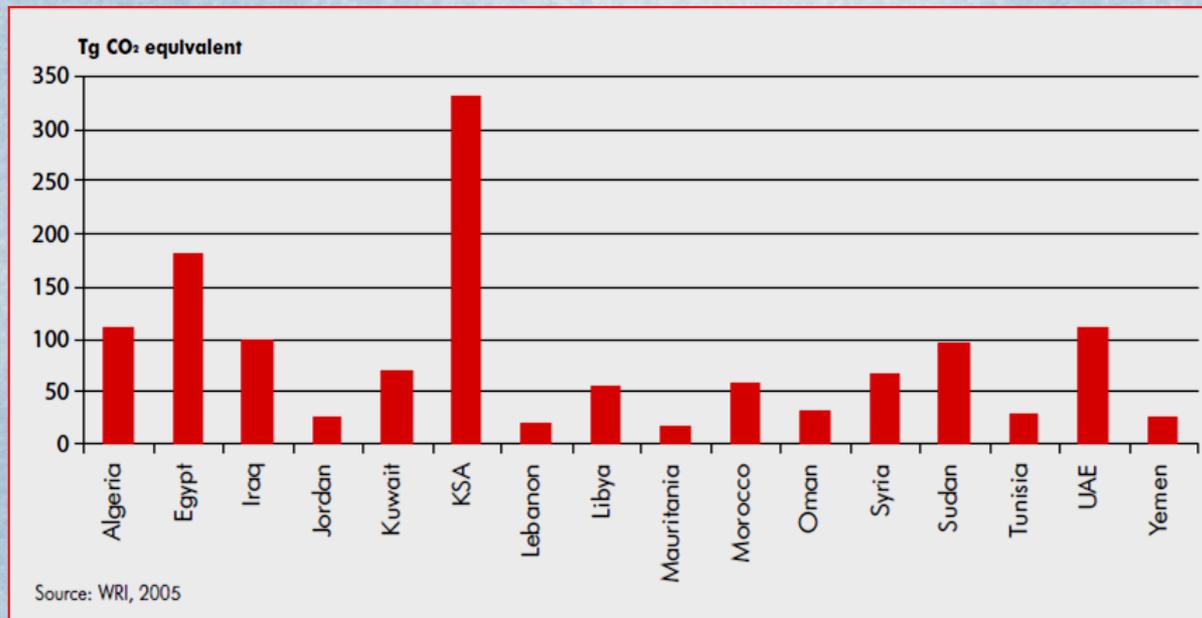
Greenhouse gases (GHGs) play an important role in the climate change, these gases such as **carbon dioxide, methane, nitrous oxide and others.**



- The world contribution was about **33 000 Tg** (teragram) in year 2000 (WRI, 2005).
- WRI, 2005 reported that the total global emissions grew 12.7% between 2000 and 2005, an average of **2.4% a year**.



MENA countries contributions of greenhouse gas emissions



Impacts of Climate Change on the Middle East and North Africa (MENA)



Impacts of Climate Change on the Middle East and North Africa (MENA)

Climate Change is affecting (MENA) region in many ways:

1. Migration and changes in **precipitation production** systems and fragile water regime. The Majority of rivers are affected such as the Nile, the Euphrates, the Tigris, Jordan and Yarmuk rivers.
2. Consequently charging of **ground water** aquifers in the region **is reduced**.
3. Resulting in **water shortages, droughts, loss of crops and increased desertification**
4. **Long term effects on coastal** areas (Gaza, Iraq, Kuwait) and deltaic areas (Shatt Al Shatt Al Arab and the Nile Delta)

Impacts of sea level rise(SLR) as consequence of climate change

According to the (IPCC) studies:

Average global sea level rise: 1961- 2003 was 1.8 mm/year

Average global sea level rise : 1993- 2003 was 3.1 mm/year

This is showing an accelerated rate of SLR in (1993-2003)

The most future vulnerable areas are the Nile delta in Egypt and Tigris and Euphrates delta in Iraq in addition to their coast lines (2009)

The East Mediterranean and Middle East Climate Zone (EMME)

Modeling studies for the 21st century suggest continued gradual and strong warming:

Near Future Period	(2010- 2039)-----	(1-3°C)
Med century period	(2040- 2069)----	(3-5°C)
End of Century Period	(2070- 2099) -----	(3.5-7°C)

The East Mediterranean and Middle East Climate Zone

Analysis of annual precipitation data base for the period (1901- 2006)) and projecting till the end of the 21st century **suggest sharp decline of water resources by (5- 30%)** relative to (1961- 1990).

Other studies suggest that **the Euphrates River flow** will suffer reduction of **(29%- 73%)**. Jordan River will suffer similarly and the whole “Fertile Crescent” might disappear by the end of the century

Global Warming Negative effects on NAO and its Impacts on MENA Region

NAO , or the **North Atlantic Oscillation** is the fluctuation of atmospheric pressure at sea level over the **North Atlantic Ocean** caused by the difference of this pressure between the **Icelandic Low** and the **Azores' High**.

This fluctuation normally controls the strength and direction of westerly winds and strength of storms across the **North Atlantic**, **MENA** region.

IPCC modeling studies show that **precipitation over MENA** will decrease by **15- 25%** by the end of the century as a result of global warming which is negatively impacting **NAO**.

Tigris and Euphrates catchments will suffer from decline of their water resources accordingly being part of **MENA**

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Global climate change with special reference to Iraq

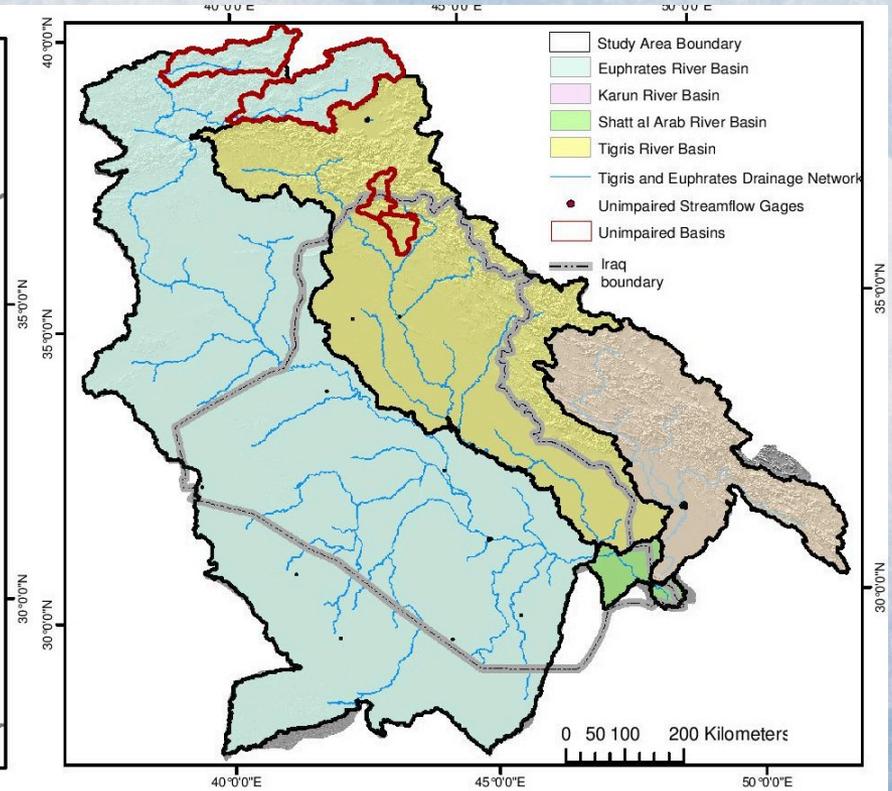
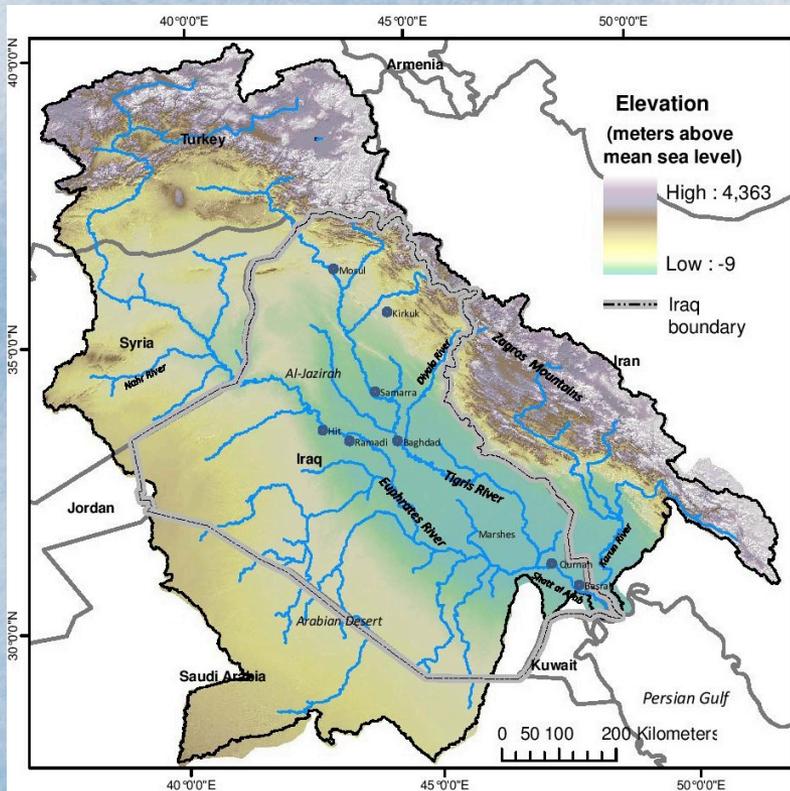
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Tigris and Euphrates Catchments

Total Catchments in EMME

Sub-Catchments in Riparian Countries

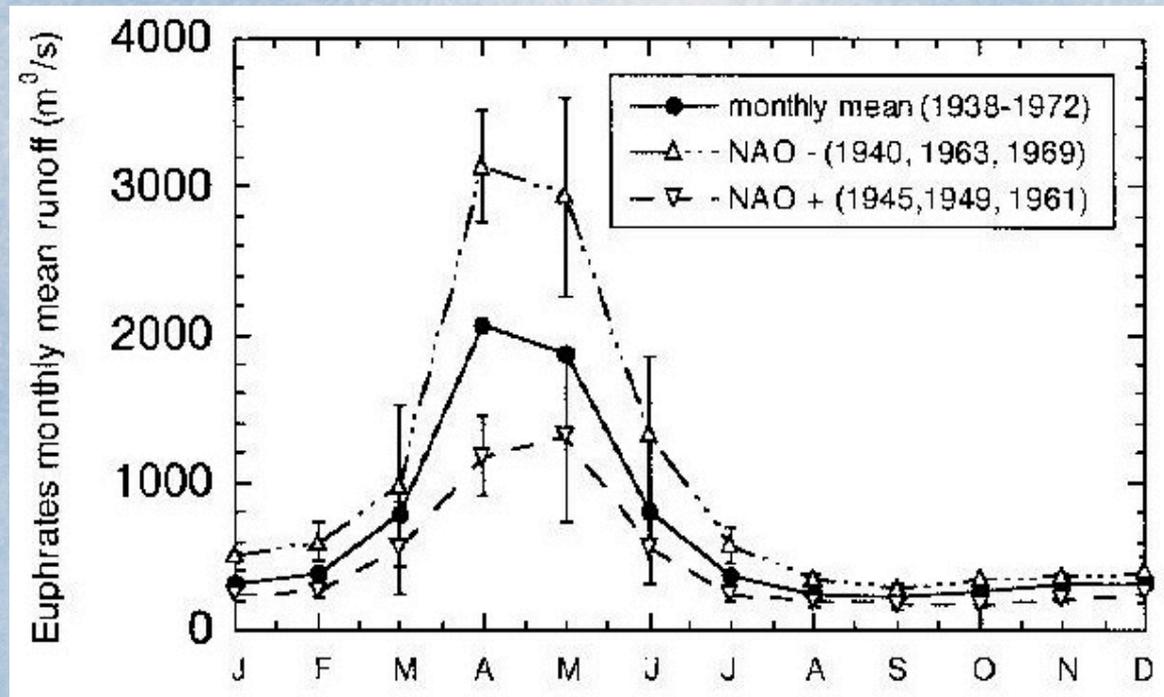


A Study Shows Tigris and Euphrates Water Resources Correlates well with NAO Changes

Cullen et al. (2000) analyzed climatic and stream flow data available from Turkey for discharge stations in the Euphrates and Tigris River basins in addition to Tigris stream flow at Baghdad. The results of this study confirmed that the stream flow of the Tigris and Euphrates Rivers are associated with the North Atlantic Oscillation (NAO), which governs the path of the Atlantic mid-latitude storm track and precipitation in the Eastern Mediterranean.

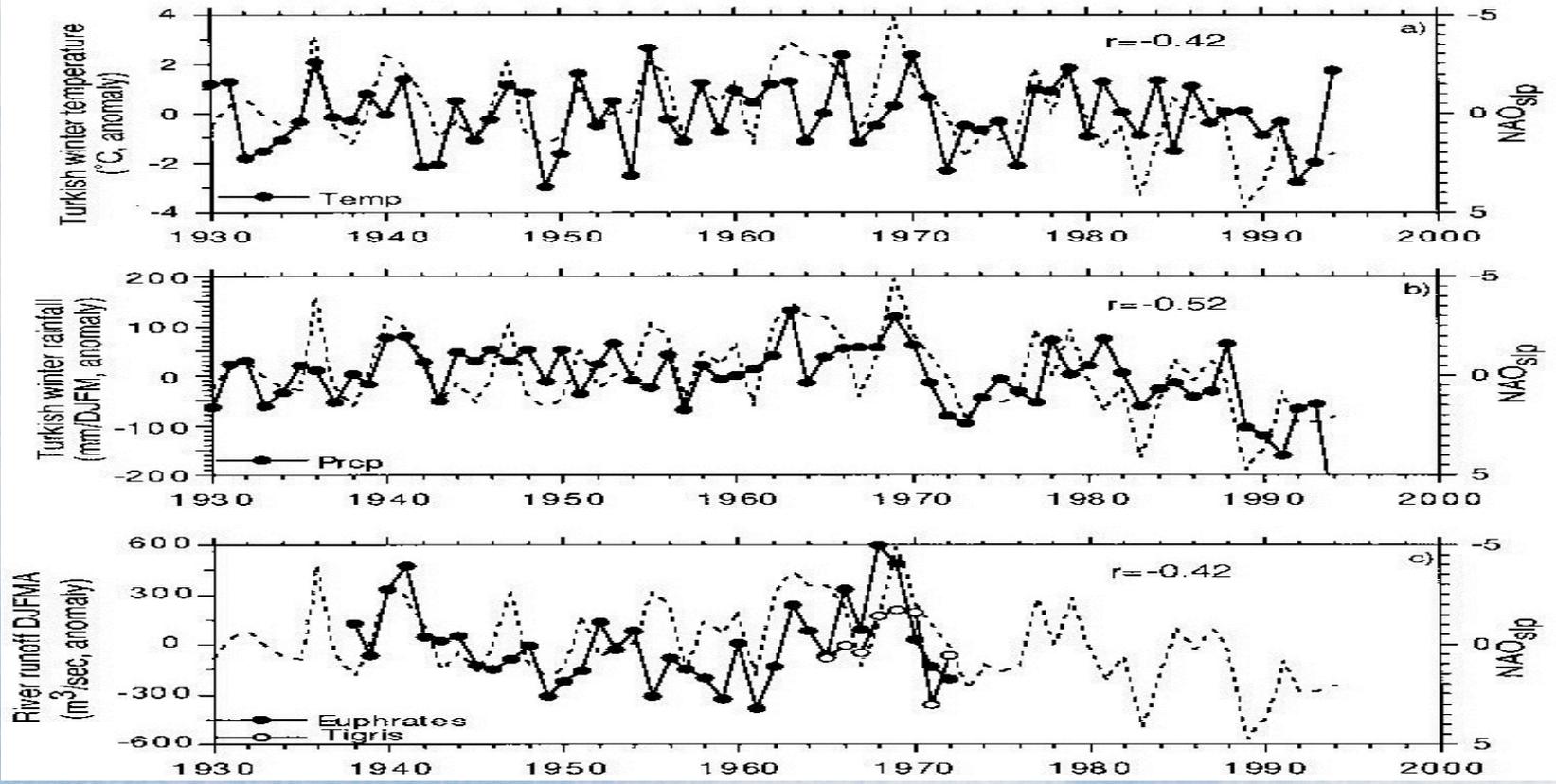
Monthly flow of the Euphrates River measured at Keban, Turkey (35-year mean). **(solid line)**

Monthly averages for the three lowest NAO years (1940, 1963, 1969; **(Upper dashed line)**) and monthly averages of the highest NAO years (1945, 1949 and 1961; **(Lower dashed line)**)



What is NAO_{slp}

NAO_{slp} is a statistical index calculated from the differences between normalized mean- variance of NAO values at different locations, and it is used as the signature of NAO in these locations



CORRELATION BETWEEN THE NAO_{SLP} INDEX, AND
 (A) TURKISH WINTER **TEMPERATURE** INDEX,
 (B) TURKISH WINTER **PRECIPITATION** INDEX
 (C) DJFMA AVERAGE **STREAM FLOW** OF THE EUPHRATES (FILLED CIRCLES)
 AND THE TIGRIS RIVERS (OPEN CIRCLES) (NOTE: THE NAOSLP INDEX HAS
 BEEN MULTIPLIED BY 1



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GLOBAL CLIMATE CHANGE IMPACTS ON THE ENVIRONMENT OF IRAQ

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Negative impacts on Iraq's Environment

Iraq's geographical location makes it one of the most vulnerable counties of the world to climate change. The foreseen impacts are:

- 1. Water Scarcity**
- 2. Droughts, extended desertification and more frequent sand storms**
- 3. Sea level rise damage to costal and deltaic areas**
- 4. Socio- economical negative impacts**

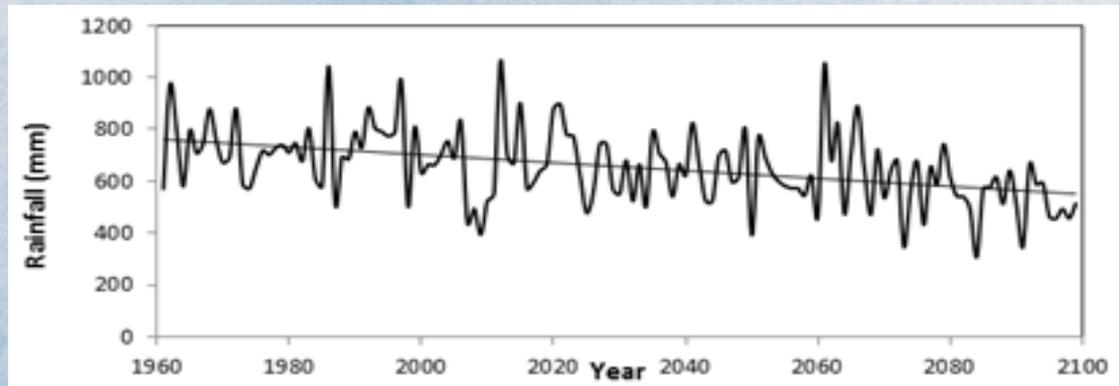
Water Scarcity Due to Climate Change and its Impacts on Iraq

Water Scarcity will increase in Iraq by the end of the 21st century due to:

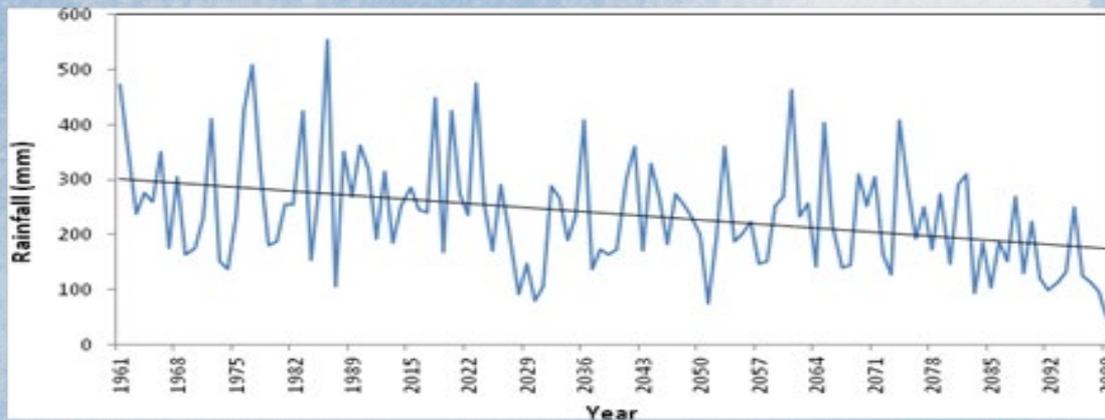
- 1. (15-25%) reduction in precipitation quantities coupled with comparable increase in transpiration**
- 2. (29- 73%) reduction in total surface water resources for the (Euphrates and Tigris and its tributaries)**
- 3. Grave depletion of ground water resources due to heavy dependency and reduced replenishment**

Water Scarcity will impact Agriculture, Municipal water supply, Sanitation, Industry and life quality

Decreasing Rainfall



Sulaimaniyah



Sinjar

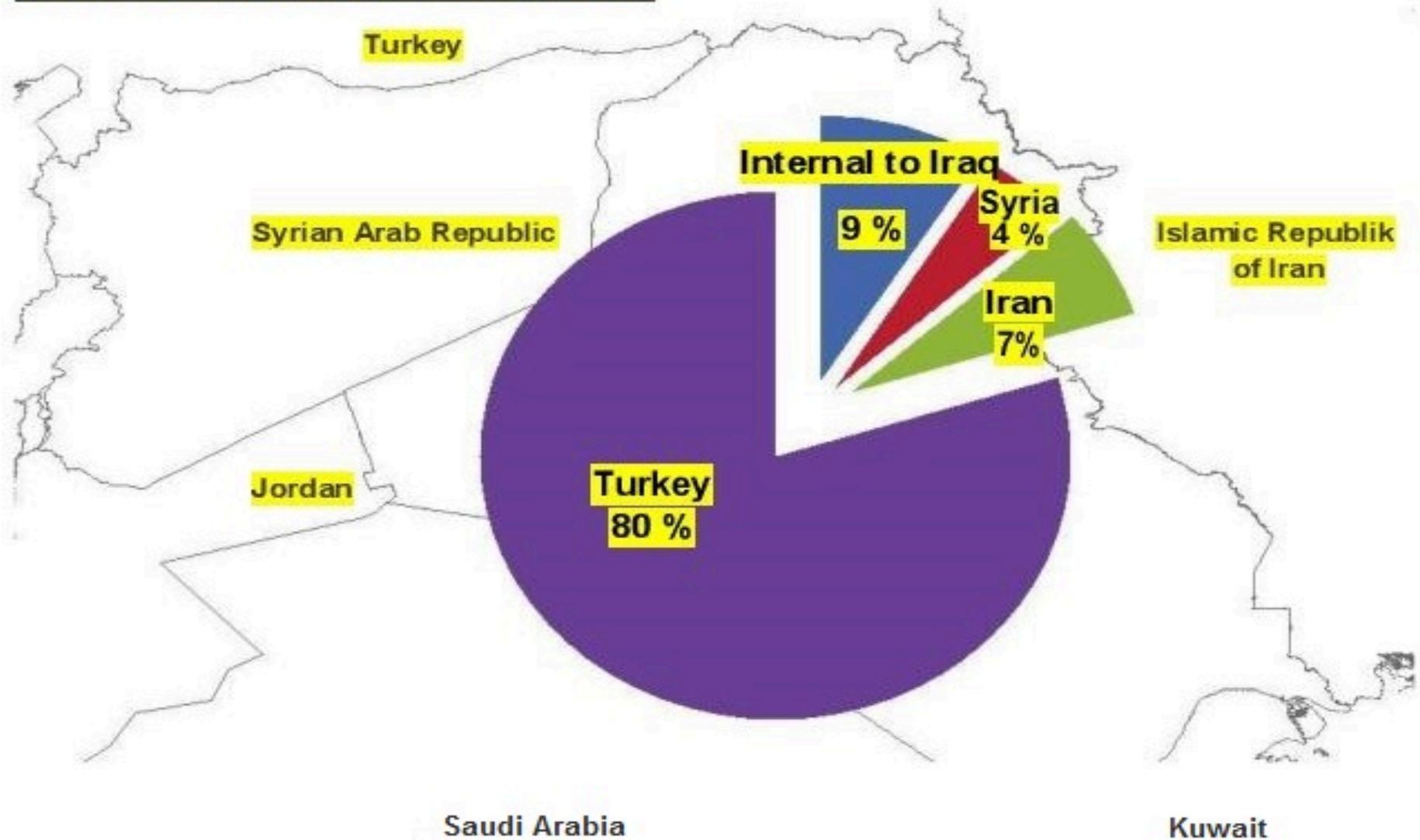
More Scarcity of Water is Due to Riparian Countries Actions and Climate Change

Increased water shortage in the Euphrates and Tigris natural flows are already felt in Iraq due to dams construction in **Turkey, Iran and Syria.**

Demand on water in these countries due to continuous development and water shortages resulting from Climate Change **will increase withdrawals** . This is critically straining water resources in Iraq now and show more in the future.

Iraq is heavily dependent on the inflow from these countries as shown in the next slide

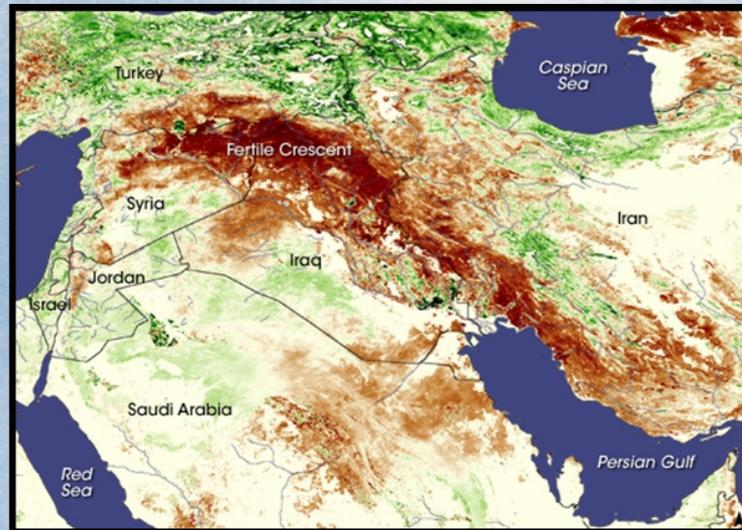
Water Supply by Country



Source: Ministry of Water Resources Iraq 2010

Droughts, extended desertification and more frequent sand storms

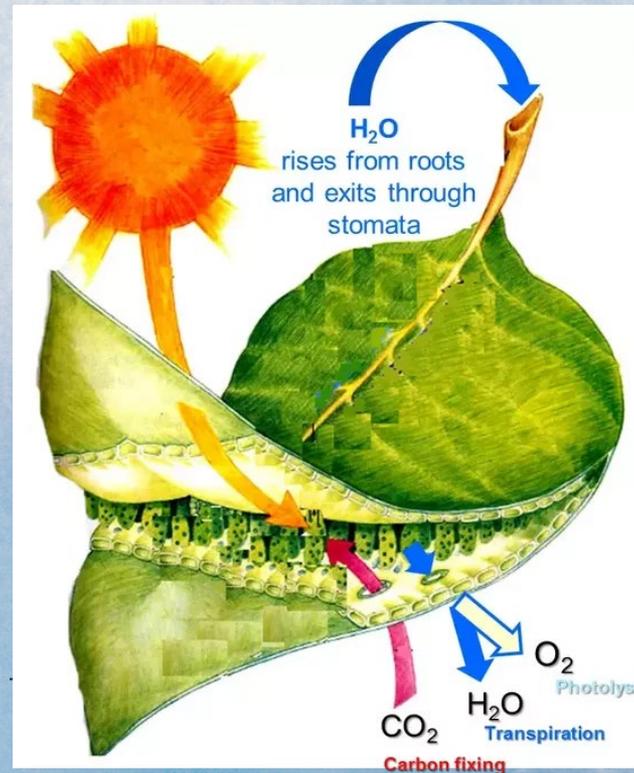
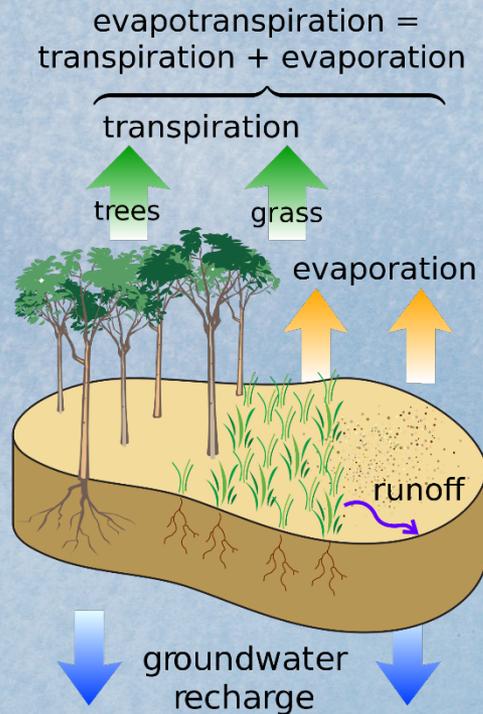
Climate change impacts on Iraq as well as other Middle East Countries will lead to the disappearance of the “**Historic Fertile Crescent**) which we mentioned before .



Droughts, extended desertification and more frequent sand storms

Decreased precipitation ,increased temperatures, reduced surface and ground water will result in:

1. Increased transpiration



2. Reduction of total arable land area and hit agriculture



3. Decrease of the natural vegetative cover

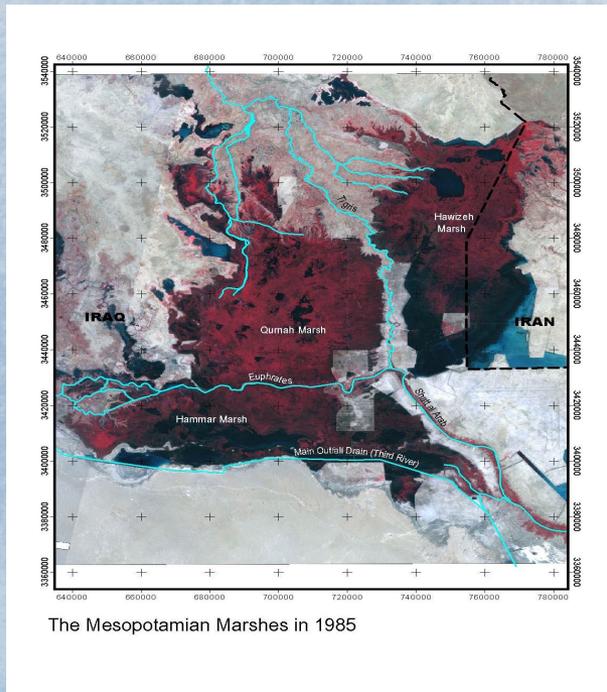


4. Reduction of total area of lakes and other natural water bodies

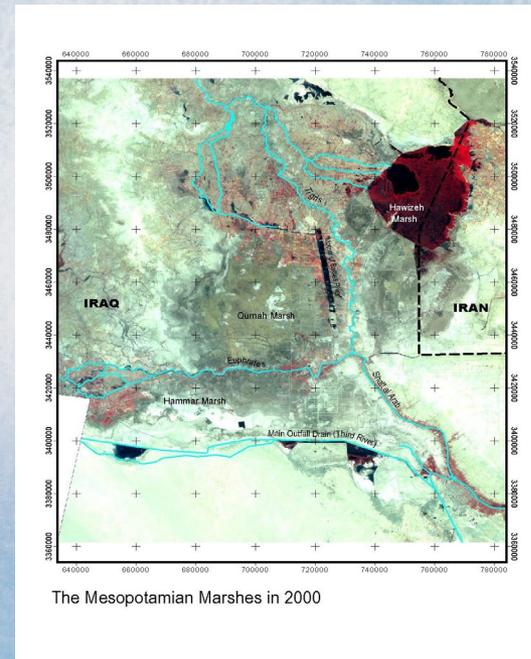


5. Hamper efforts to restore Iraq's Southern Marshes which may disappear all together

1985



2000



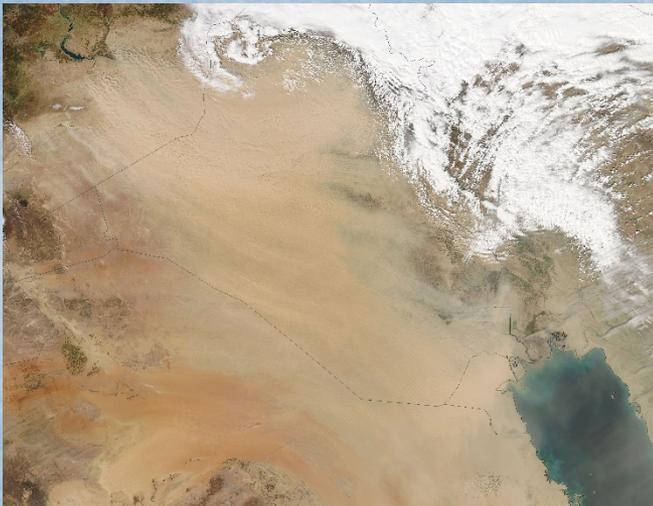
6. Extended Desertification due to above causes



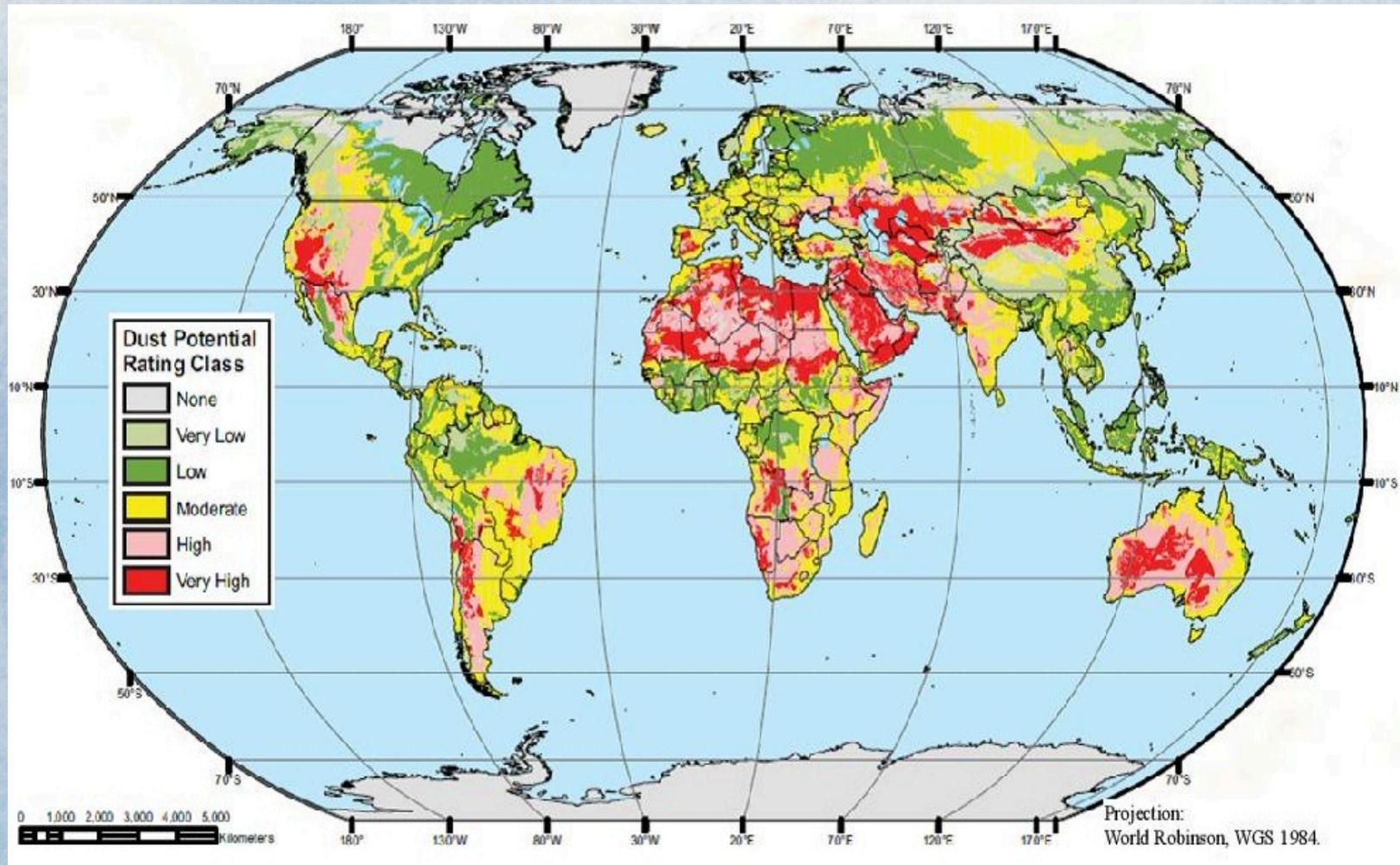
7. Reduction of soil moisture leading together with loss of vegetative cover to Chemical and Physical Destruction of soil structure leading to Intensive and Violent Dust Storms

- According to UN report based on Iraq's Ministry of Environment Information indicates Occurrence of **122 Dust Storms and 283 dusty days in 2012**

- According to the report of the Desert Research Institute DRI (2013) Iraq is located in one of the **Highest Dust Potential Parts** of the World (see next two slides)



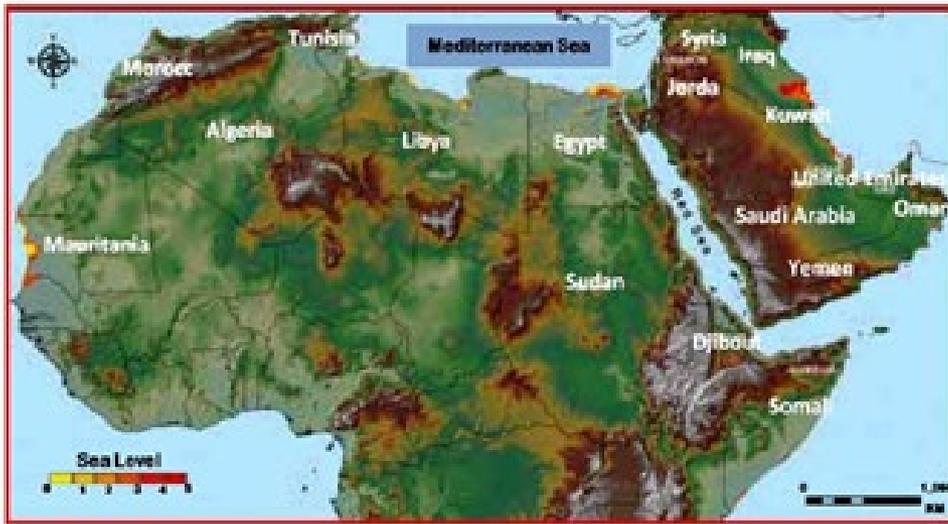
Global Dust Potential



Impacts of Sea level Rise (SLR)

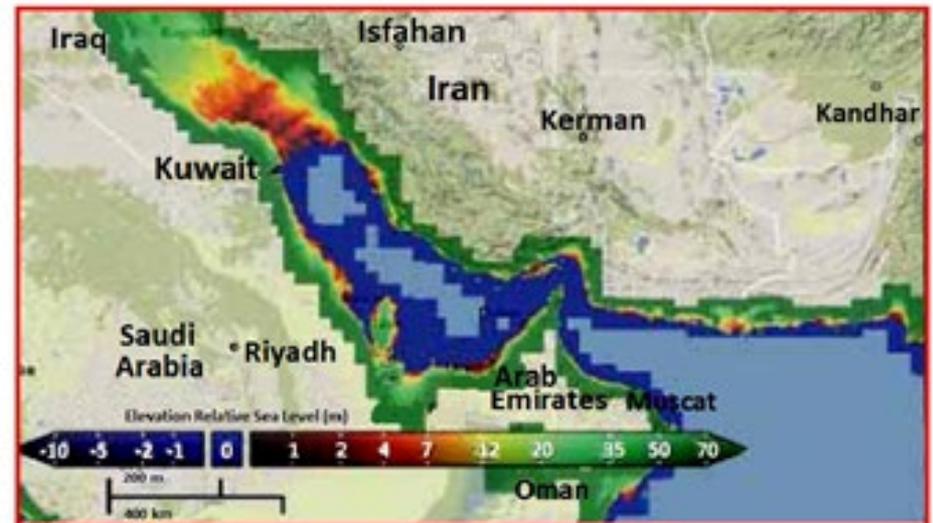
Sea level Rise due to **North Pole** ice melting is affecting numerous parts of the world including **North Africa and the Middle East** as indicated **in the next slide**

Modeled scenarios of future impacts of (SLR) due to Climate Change show severe impacts on the Coastal areas of **Egypt and Iraq** while the **Nile Delta and the Euphrates and Tigris Deltas** will suffer **irreversible damages** unless protective actions are taken



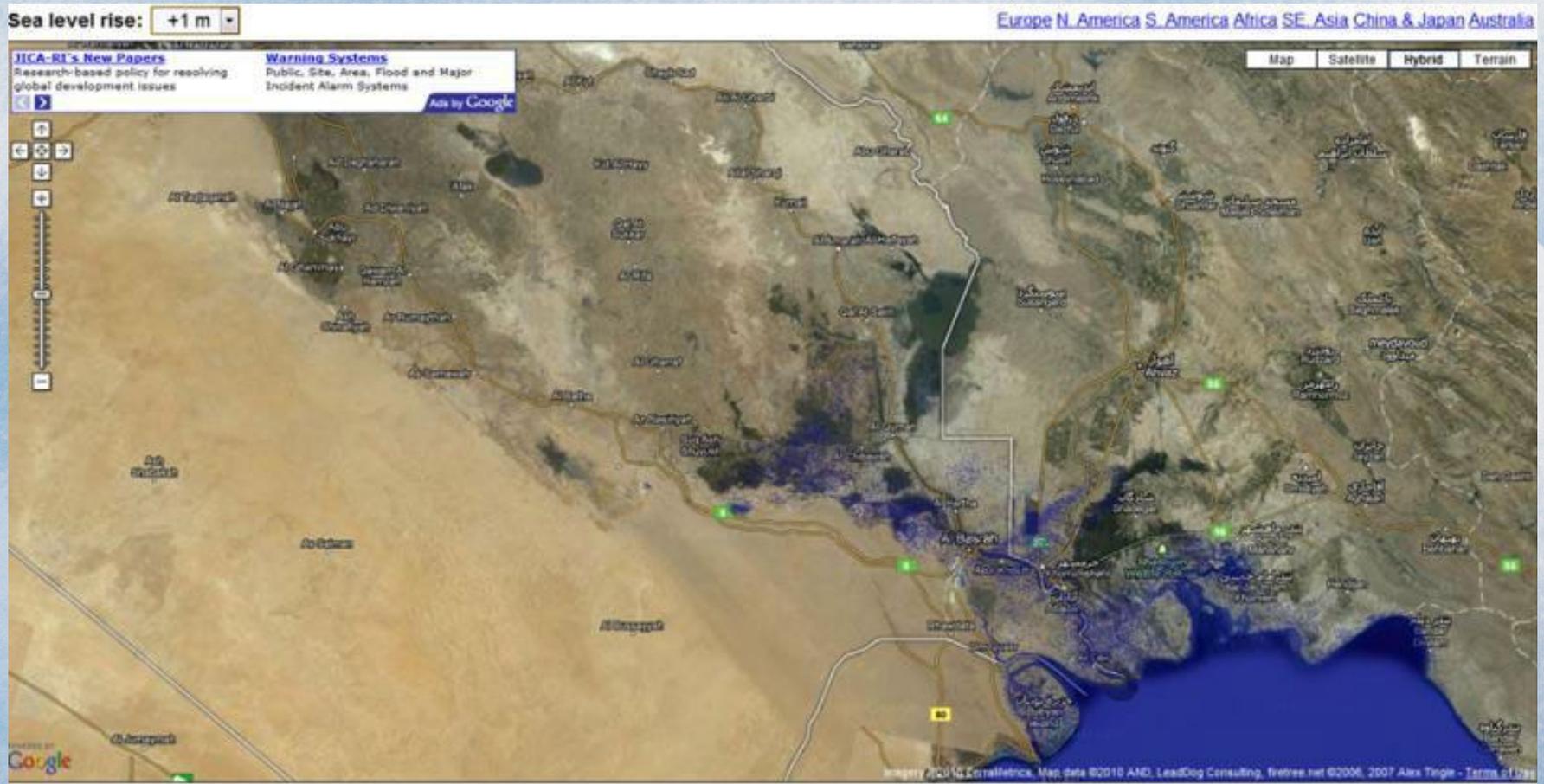
The situation of the sea level rise for Egypt (Nile River delta) and Iraq (Tigris and Euphrates delta) [33].

Simulated Sea Level Rise in North Africa and Middle East showing Mostly Affected Areas

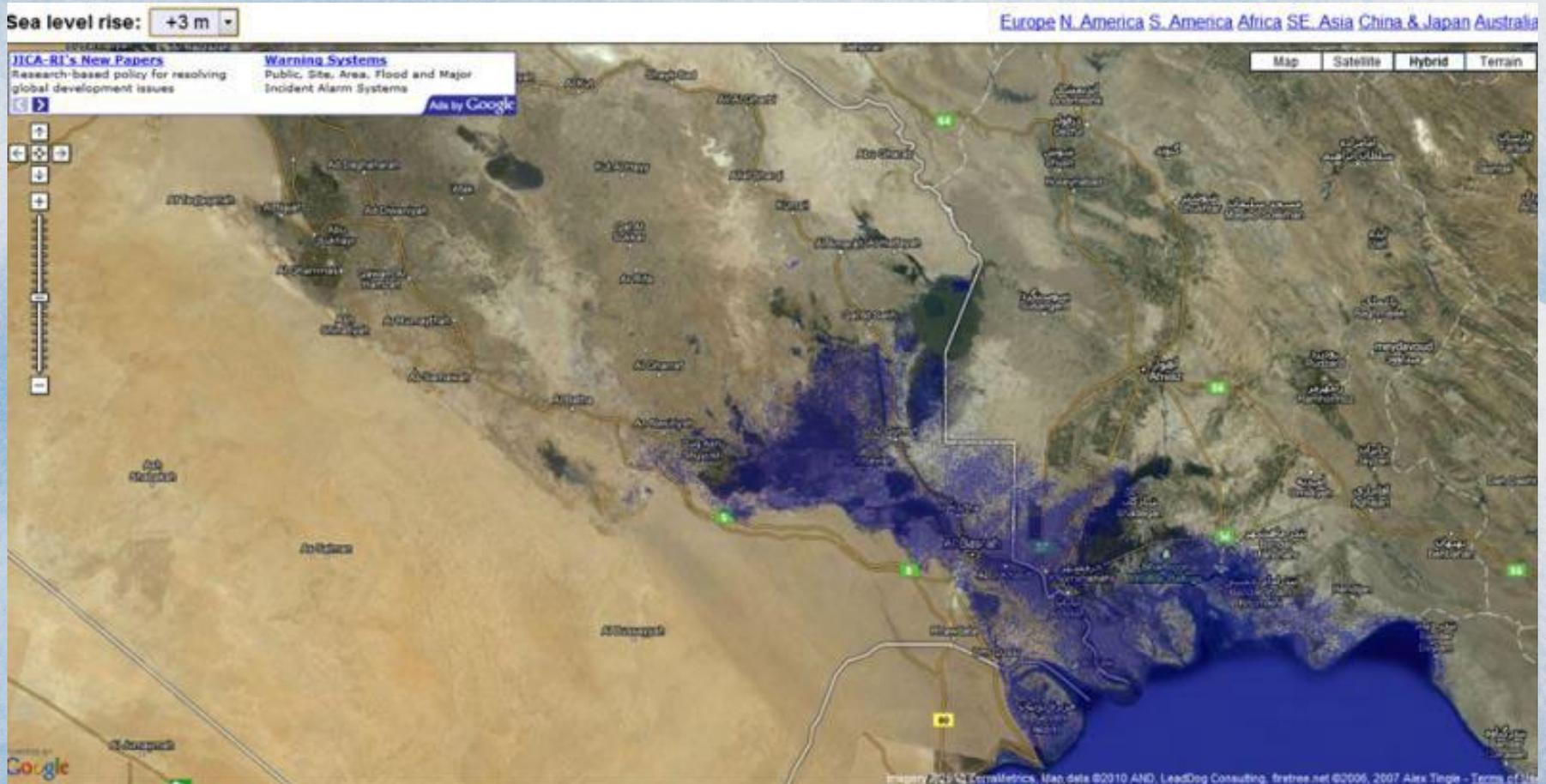


Effect of sea level rise on Iraq and Kuwait [35].

Predicted Sea Level Rise Extent within Euphrates and Tigris Rivers Delta as predicted by (+1m) SLR Scenario



Predicted of Sea Level Rise Extent within Euphrates and Tigris Rivers Delta as predicted by (+3m) SLR Scenario



Iraq's Coastline along the Arab Gulf



Necessary Actions Required From the Government of IRAQ

Apart from the National Responsibility of the Government to promote all actions to improve Sharing Common Water Resources with Riparian Countries(Turkey, Iran and Syria), This Government has also the National and Moral duty to mitigate the Negative Climate Change Impacts within IRAQ by:

A- Adopting New Water Management Policies

B- Development of New Sources of Water and improving existing water resources

C- Improving Agricultural Practices

D- Improving Land Use

E- Combating Sea Level Rise Expected Problems

F- Actions on the International Level

*Thank
you*

