Satellite-Based Remote Sensing and GIS for Monitoring Energy Use for Groundwater in the Arab Region

5th international conference on the use of space technology for water resources management

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Importance of Groundwater

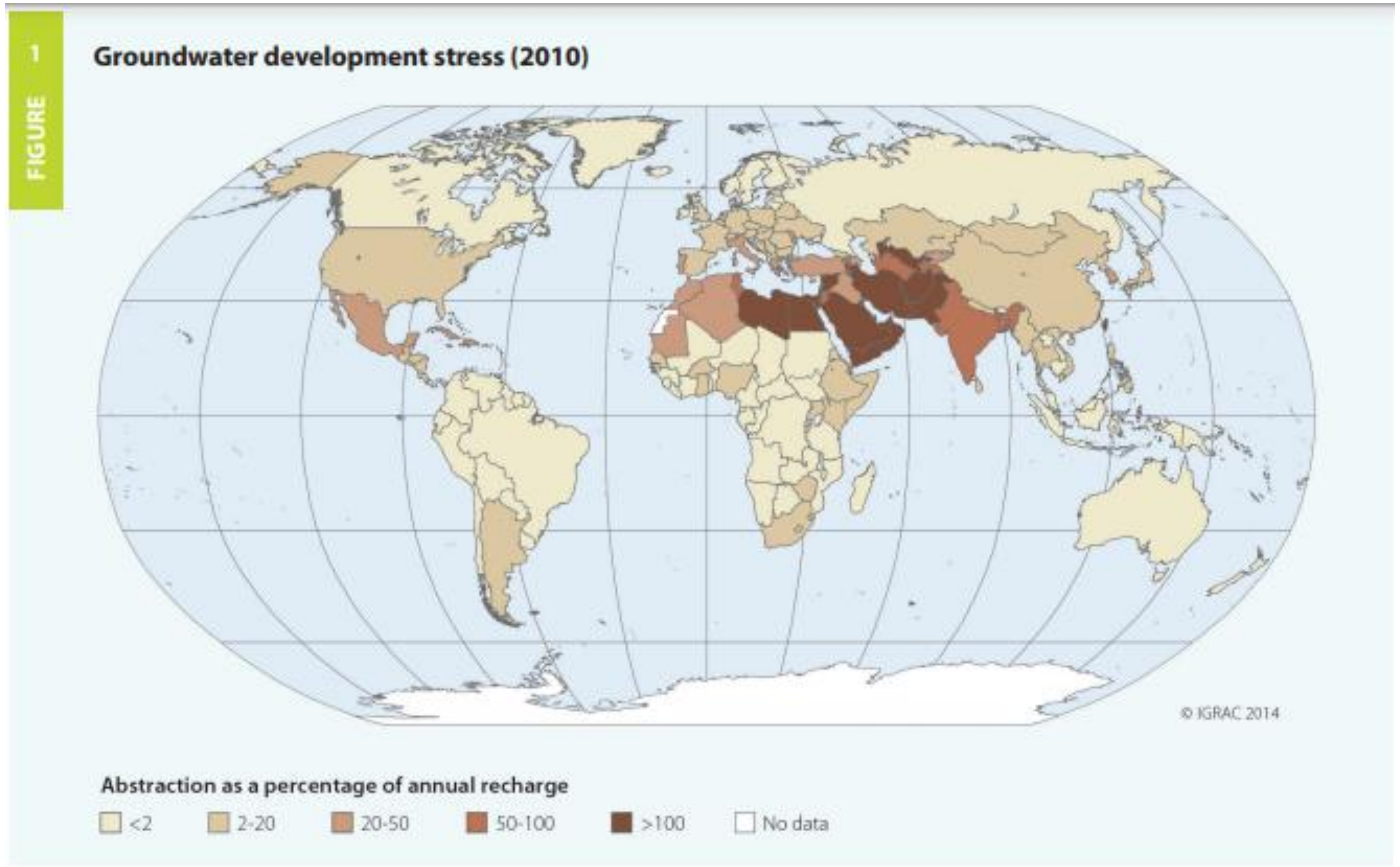
- Groundwater is of vital importance to many countries; as **more than 2.5 billion people**, countless farmers and many industrial facilities depend on its supply.
- About **50% of drinking water**, **40% of irrigation water**, and **35% of water for industries** globally are provided by groundwater.
- The accelerated development of groundwater - over the past few decades - has resulted in significant social and economic benefits through the provision of water supplies:

  - Low cost
  - Safe in terms of its exposure to drought, especially with the repercussions of climate change
  - High quality, in general
  - As for agricultural use, the value of groundwater is expected to be high

- The future use of groundwater will also be of vital importance to achieving the “Sustainable Development Goals” of the 2030 Development Agenda

Global Groundwater Situation

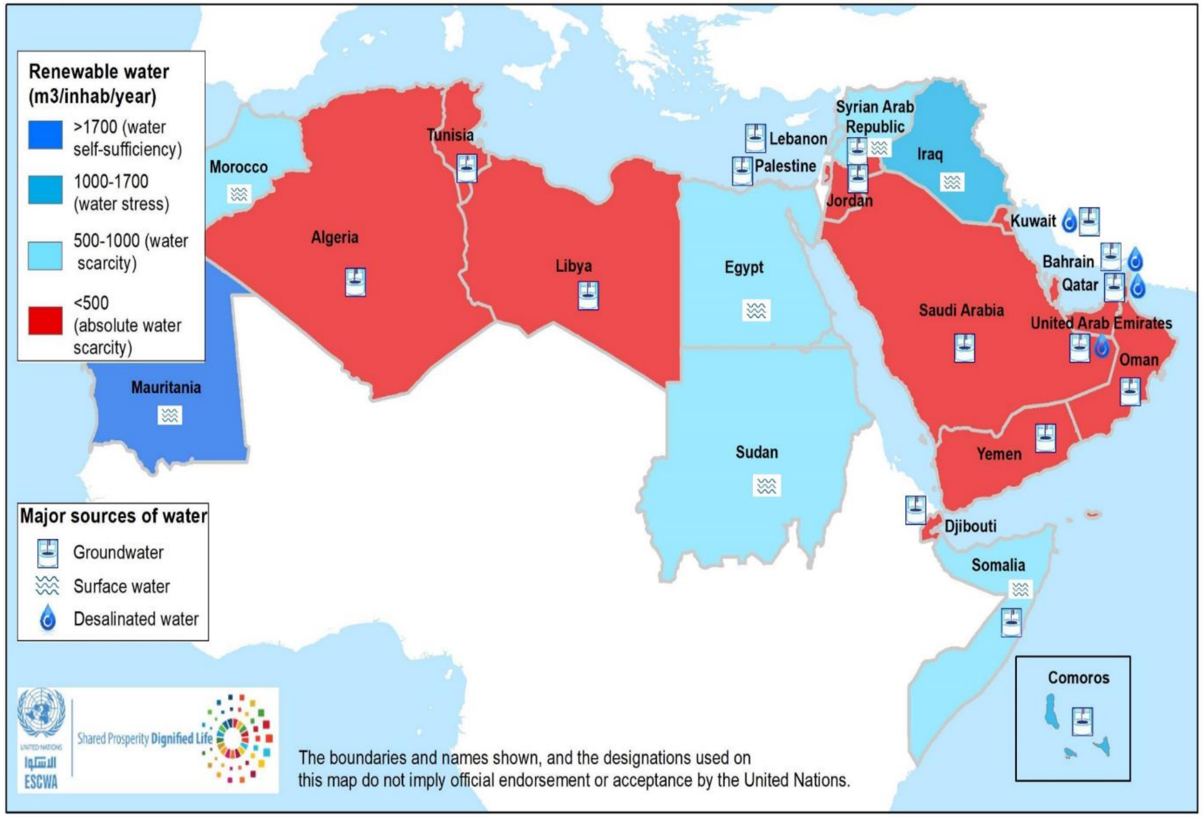
- The regions experiencing the highest groundwater stress are North Africa, West and Central Asia

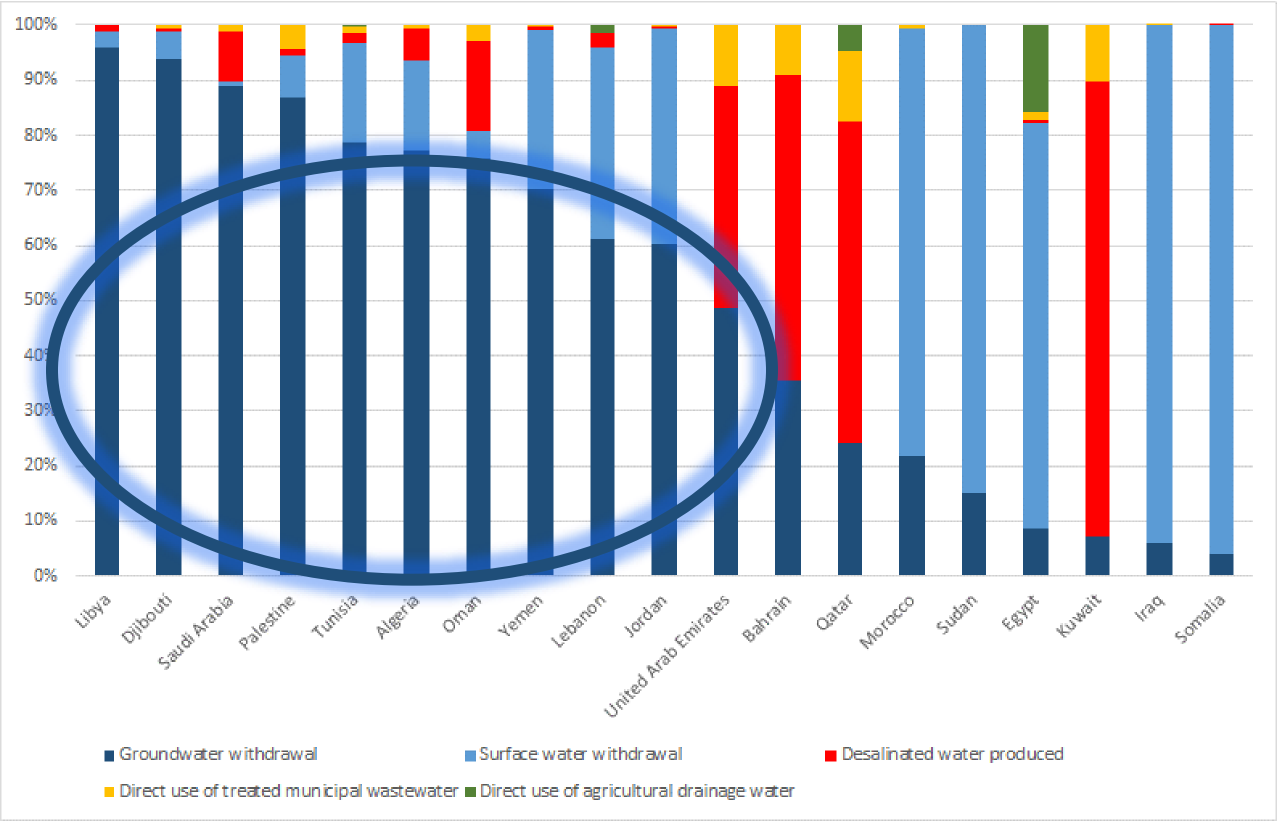


Source: IGRAC (2014).
IGRAC (International Groundwater Resources Assessment Centre). 2014. Information System. Global Overview application. Delft, Netherlands, IGRAC. http://ggmn.e-id.nl/ggmn/GlobalOverview.html (Accessed December 2014). © IGRAC 2014.

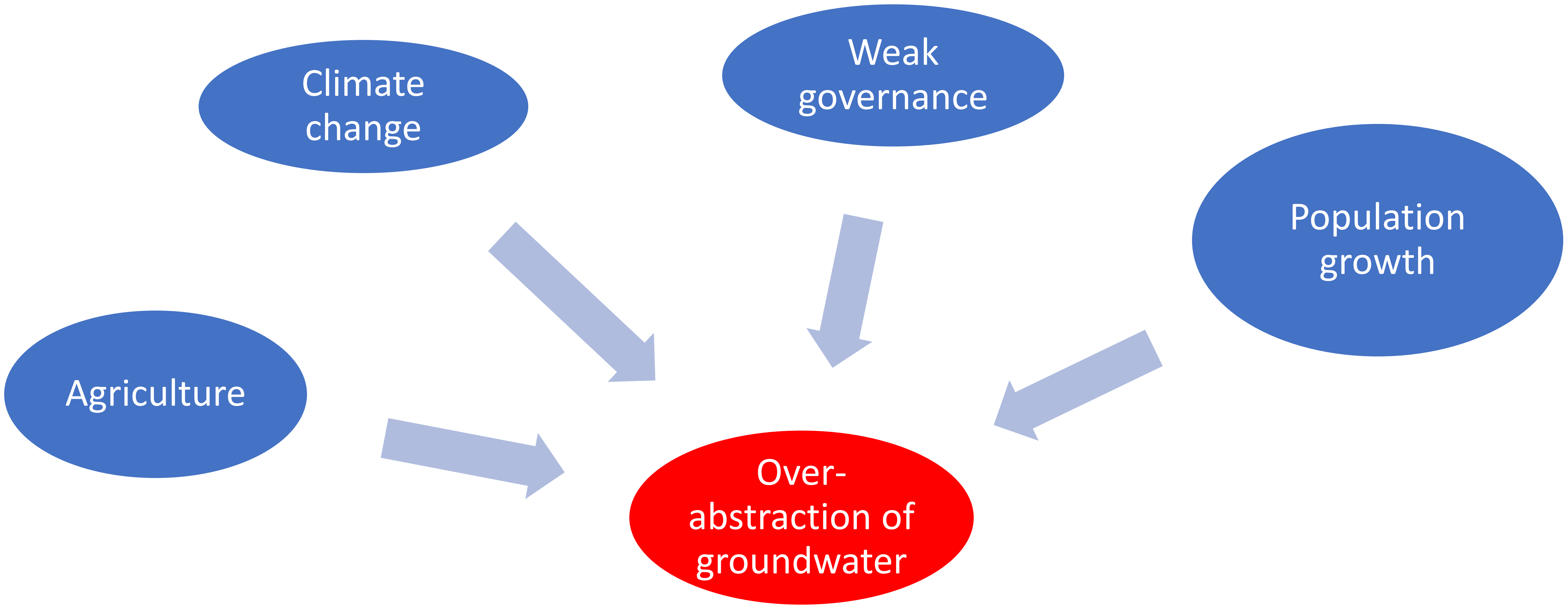
Groundwater Significance for the Arab Region

- The Arab region is one of the most water scarce regions in the world
- More than half of the Arab States rely heavily on groundwater.

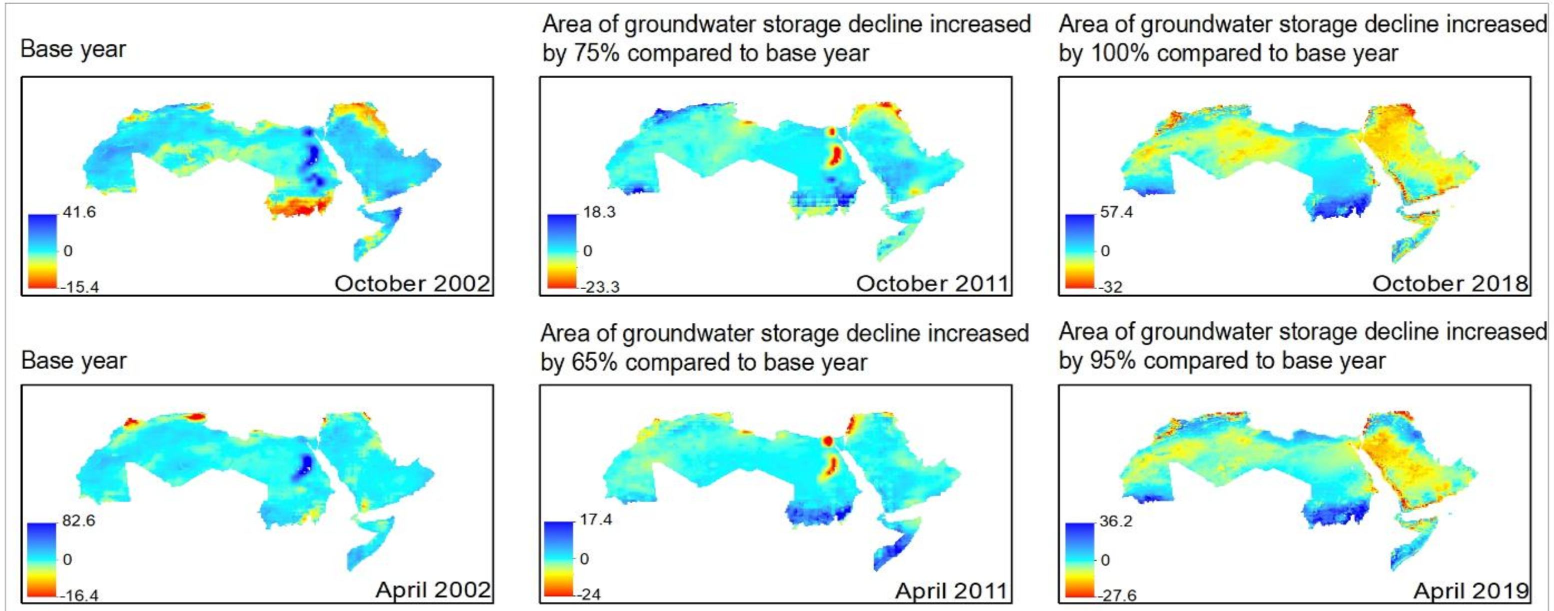


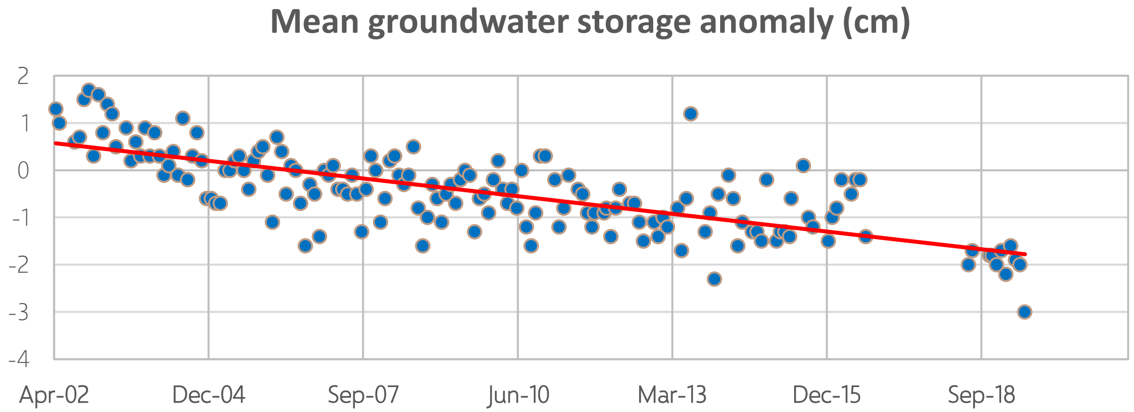


Groundwater pressures in the Arab region



Groundwater storage change-GRACE mission





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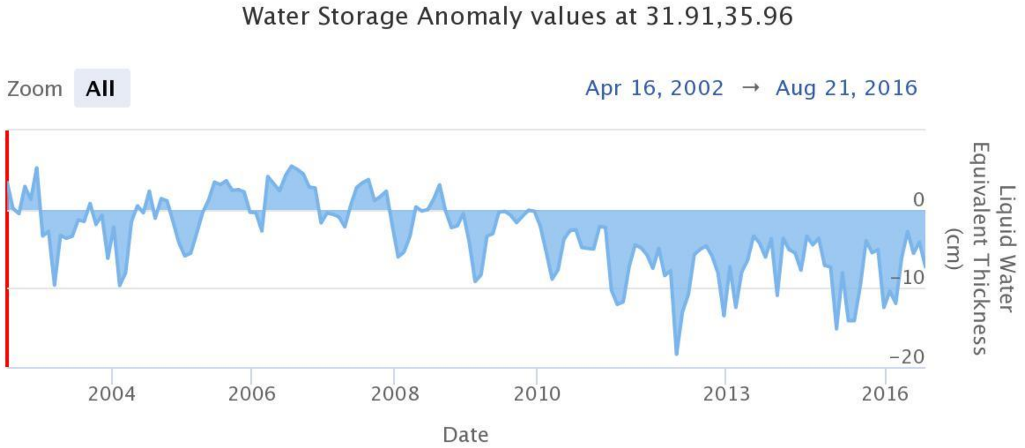
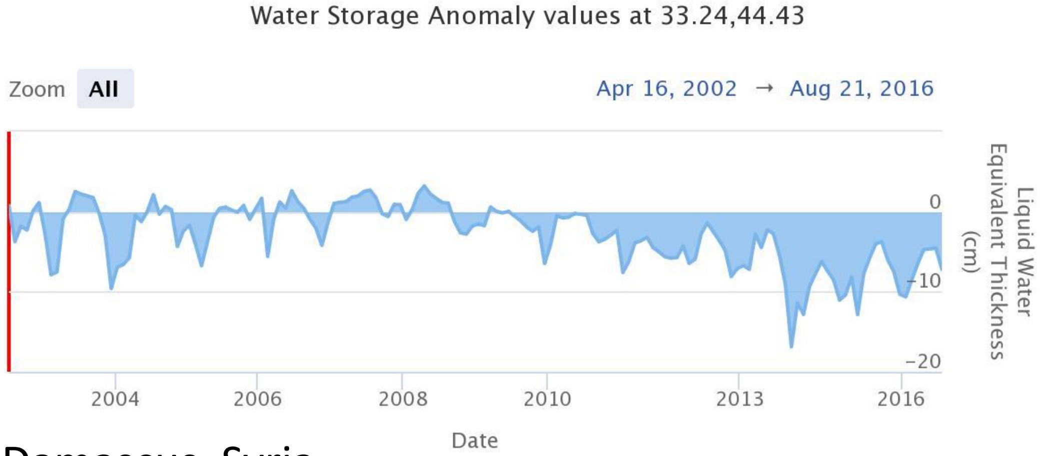
Groundwater storage change-GRACE mission

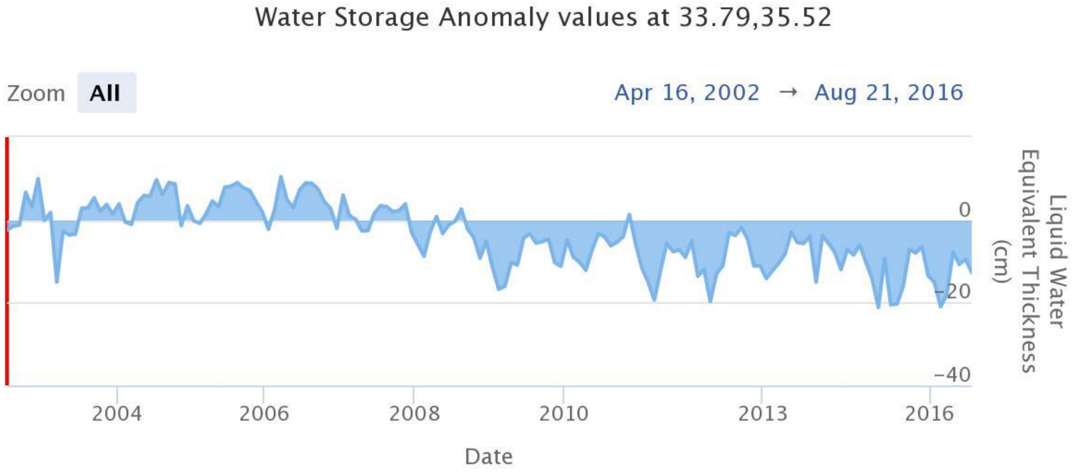
Amman, Jordan



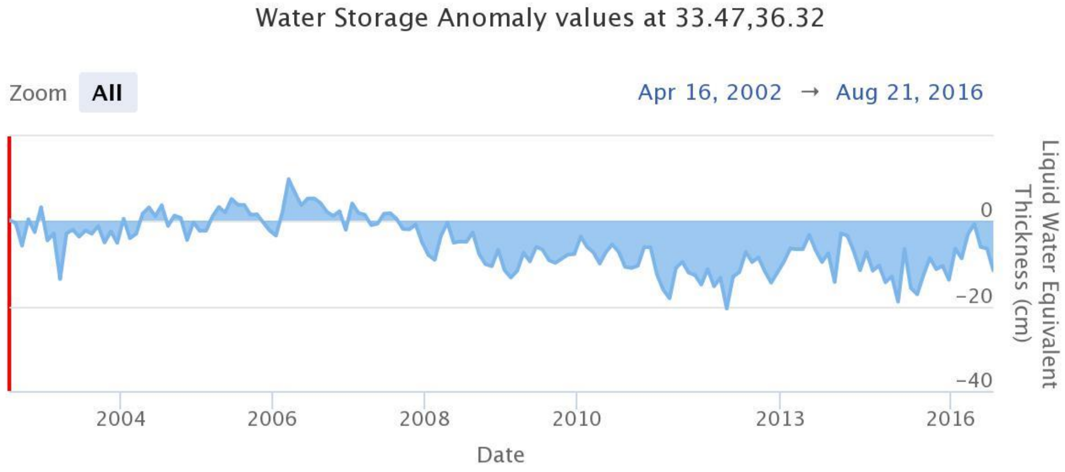
Baghdad, Iraq



Beirut, Lebanon

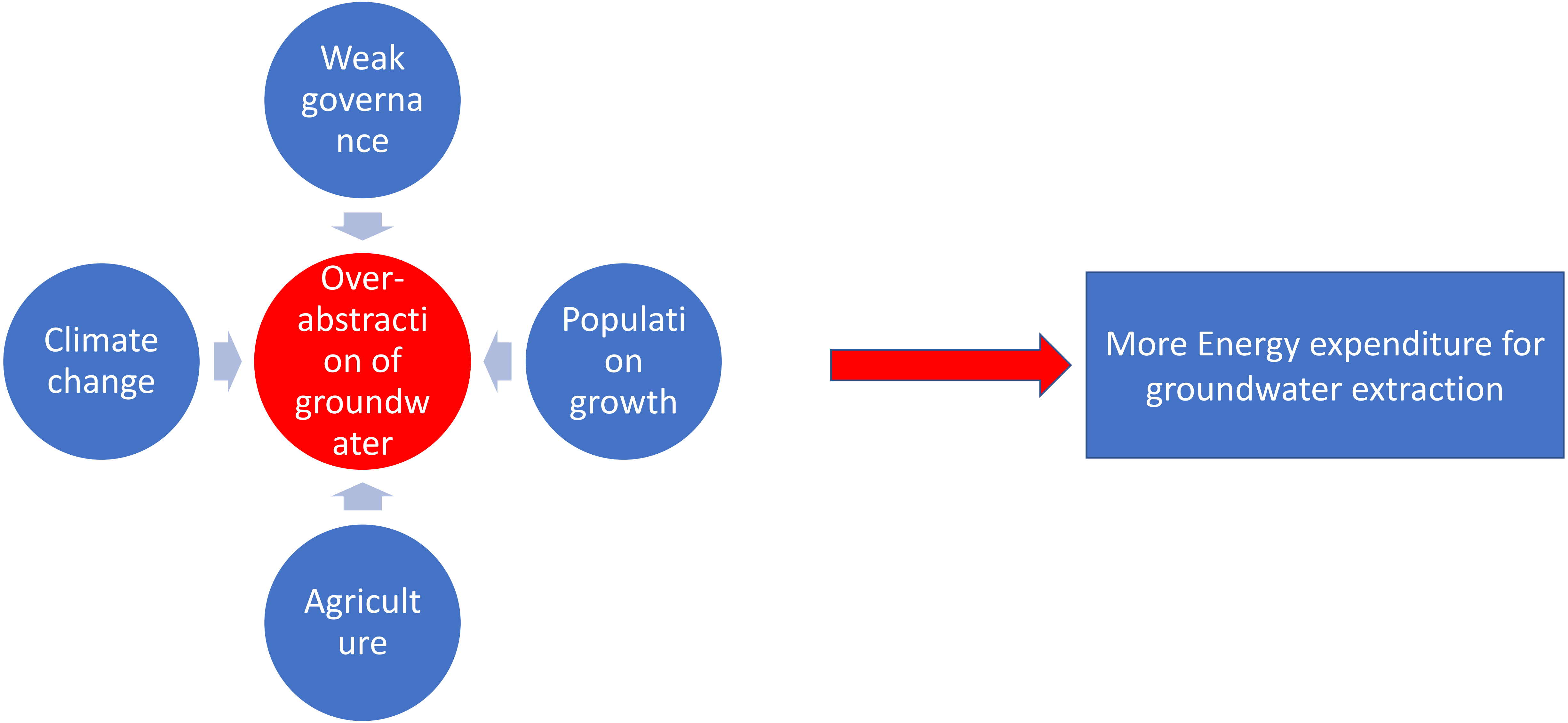


Damascus, Syria



https://tethys2.byu.edu/apps/newgrace/global-map/

Groundwater pressures in the Arab region



Groundwater and Energy

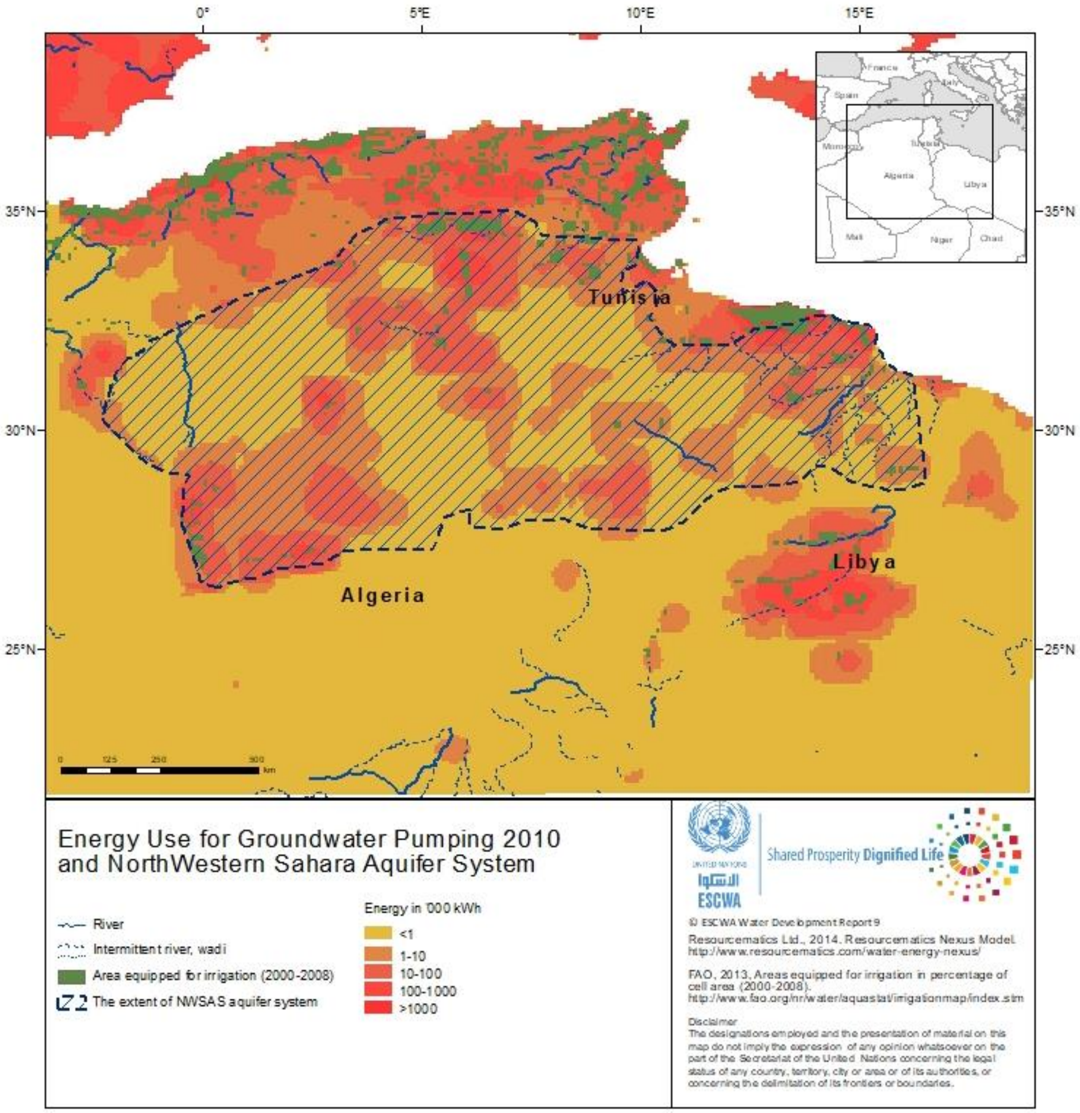
- Groundwater exploitation is energy intensive and has been subsidized in many Arab States for decades, leading to over-abstraction of groundwater
- More energy is needed to extract deep fossil water, and the more these resources are mined, the lower the groundwater table gets, and the more energy intensive water extraction becomes, making extraction cost prohibitive for small farmers.
- Renewable energy is becoming more recognized in the Arab region especially among farmers and agricultural cooperatives that are investing in solar energy and pumping technologies to reduce pollution and energy costs.
- Unfortunately, these green energy solutions have added to the already existing groundwater stress, as access to low-cost energy allows more water pumping without the same economic constraints

GIS-based analysis on Groundwater and Energy

The Case of the North-Western Sahara Aquifer System (NWSAS)

- The region depends on the NWSAS which is a transboundary aquifer considered non-renewable due to the limited recharge received through scarce rainfal
- Up to 90% of water extracted in Libya, 86% in Tunisia and 60% in Algeria is used for irrigation.
- The highest energy use is found around the groundwater irrigated areas which highlights the intensive energy demand needed to extract deep groundwater for irrigation.

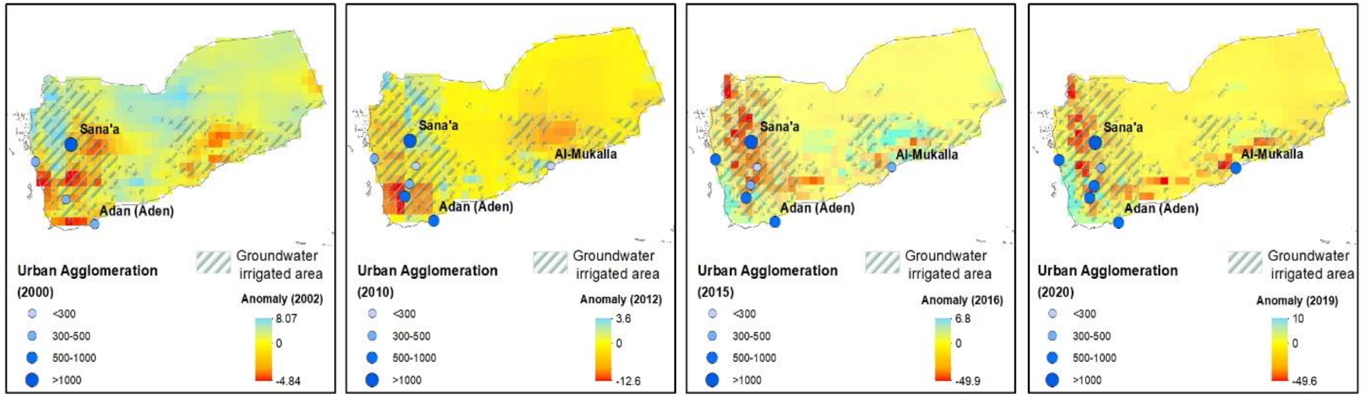
The depletion of the NWSAS is predicted if groundwater exploitation continues to increase, and socioeconomic and environmental impacts will be greatly felt before the potential exhaustion of the resource.

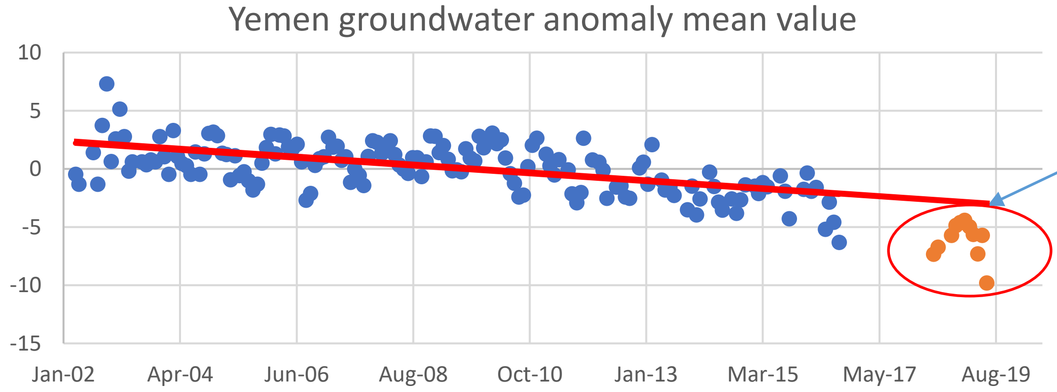


Satellite based analysis on Groundwater and Energy

The case of Yemen

- Solar power has seen a significant rise in Yemen since 2016, with more than half of the population having access to it
- This extremely low-cost energy comes with a downside in the form of a water crisis.
- Groundwater storage decrease in Yemen as depicted by GRACE data, especially after the introduction of solar power in 2016.
- The hotspots of depletion (in red) coincide with groundwater irrigated areas (hatched) and urban agglomerations (blue circles).





Accelerating decline in storage with the onset of the use of renewable energy for groundwater pumping

Conclusion and Recommendations

-The water, energy and food sectors are intrinsically linked and hence policy measures taken in either the agricultural and/or energy sectors can have a direct influence on groundwater extraction quantities and patterns. -Often, policy signals are deployed by modifying input subsidies such as the diesel fuel subsidy and crop procurement price support.

-It is recommended to use solar power for groundwater pumping in areas where water scarcity is not an issue or to connect solar panels to a network grid that can be monitored.

-Another suggestion would be governance and law enforcement for the use of solar pumps, prioritization of groundwater monitoring, and assessment of groundwater availability, yield, and stress based on extensive regional and pilot studies.

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Thank You