The Sustainability of Saudi Arabia's Water Resources from the Past Decade: A Remote Sensing Approach*

Arya Pradipta[1], Mohammad H. Makkawi[2], Hatim Sharif[3], Abdalla Elamin[4], SanLinn Kaka[2], and Abdulaziz al-Shaibani[2]

[1]Department of Geoscience, College of Petroleum Engineering and Geoscience, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia (dipta165@gmail.com)
[2]Department of Geoscience, College of Petroleum Engineering and Geoscience, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia
[3]Department of Civil and Environmental Engineering, College of Engineering, University of Texas at San Antonio, San Antonio, USA
[4]Center of Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Abstract

Saudi Arabia is classified as a country with poor of water resources. Growth of economy and population, ineffective irrigation, and climate change definitely puts strain on water availability. Utilization of Gravity Recovery and Climate Experiment (GRACE) in this region would be helpful to observe the sustainability of water resources since hydrologic data are often unmonitored. This study estimated the sustainability of Saudi's water resources by computing GRACE observation model over 10 years, from January 2007 to December 2016. The result of this study shows that the Kingdom has been experiencing depletion in total water storage of approximately 7.848 ± 0.44 mm/year, equal to 12.49 ± 0.69 km³ of water loss volume. Jouf, Hail, Qassim, Northern Borders and northern part of Riyadh and Eastern Province are regions that have high contribution of Saudi's water deficits due to extensive irrigated agriculture and low annual precipitation. However, since Saudi water demand relies on groundwater, further research is required to observe it by integrating with another NASA satellite and local well observation.

References Cited

FAO, 2009, The State of Food and Agriculture: Food and Agriculture Organization of the United Nations, Rome, Italy, 180 p.

Saudi Arabia's General Authority of Statistic, 2015, https://www.stats.gov.sa/en. Website accessed May 2018.

UNSCWA, 2013, Annual Report 2013, 40 Years with the Arab World, Economic and Social Commission for Western Asia (ESCWA), 65 p.

UN Water, 2015, WWAP (United Nations World Water Assessment Programme), 2015, The United Nations World Water Development Report 2015: Water for a Sustainable World. Paris, UNESCO, 122 p.

جامعة الملك فهد للبترول والمعادن
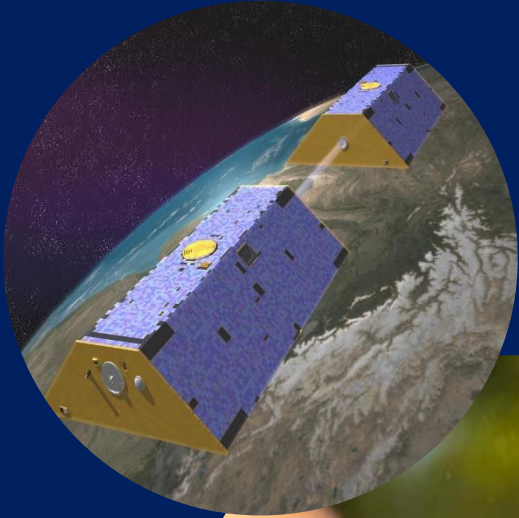King Fahd University of Petroleum & Minerals

The ... y of Saudi Arabia's Water Resources from the Past Decade: A Remote Sensing Approach

Arya Pradipta[1], Mohammad H. Makkawi[1], Hatim Sharif[2], Abdalla Elamin[3], SanLinn Kaka[1], and Abdulaziz al-Shaibani[1]
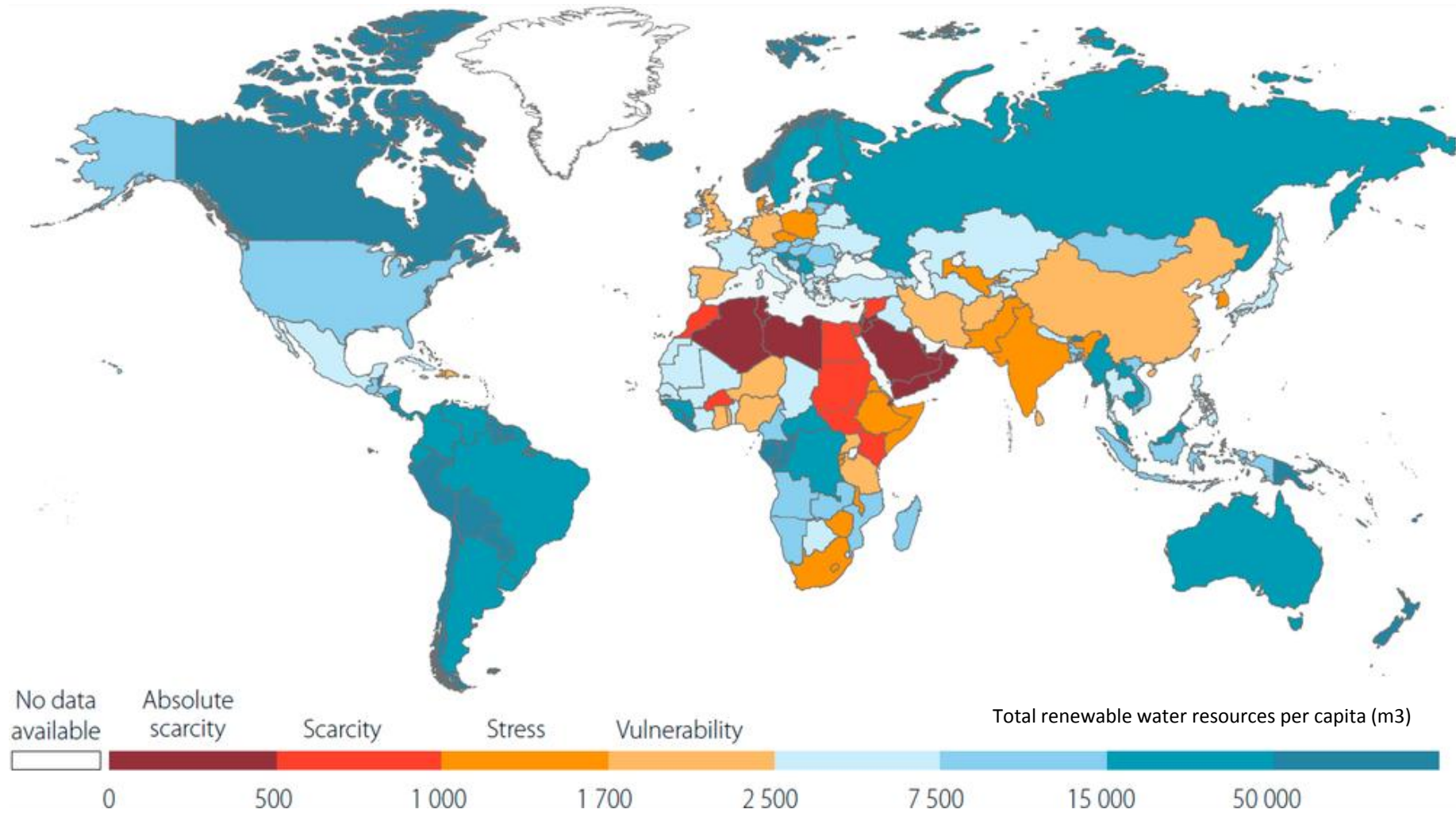
1 Department of Geosciences, College of Petroleum and Geosciences, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia
2 Department of Civil and Environmental Engineering, College of Engineering, University of Texas at San Antonio, USA
3 Center of Environment and Water, Research Institute, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia
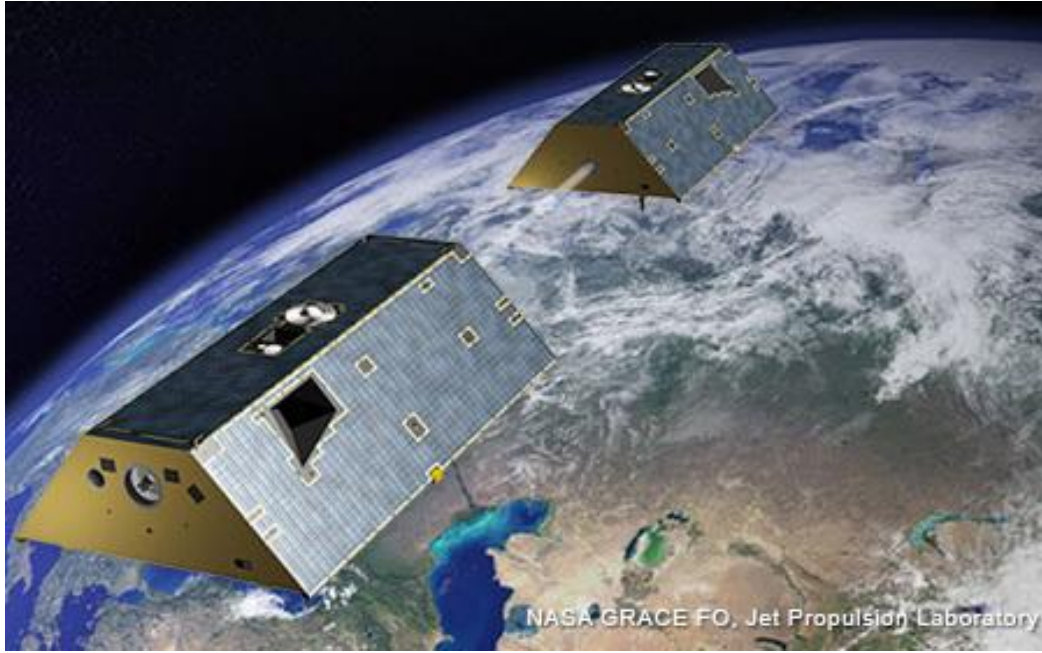
INTRODUCTION

Total renewable water resources per capita (m3)

No data available | Absolute scarcity | Scarcity | Stress | Vulnerability

0   500   1 000   1 700   2 500   7 500   15 000   50 000

Low renewable water resources
[*UN Water*, 2015]

Most of Saudi population lives under water scarcity level
[*UNSCWA*, 2013]

INTRODUCTION

- Gravity Recovery & Climate Experiment (GRACE) is joint satellite mission between NASA and the German Aerospace Center

- Measuring changes in total Terrestrial Water Storage (TWS) from space

- Providing time-variable gravity field

- Variations of earth's gravity field largely determined from motion of water
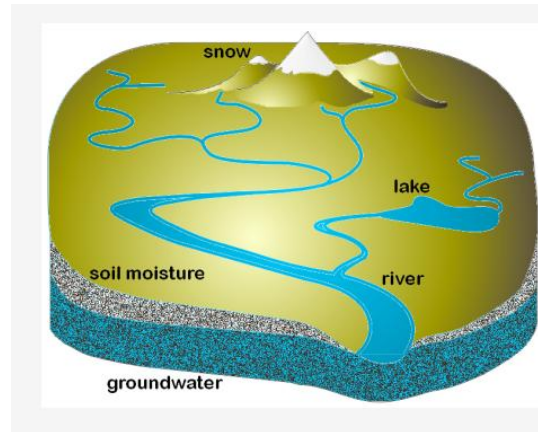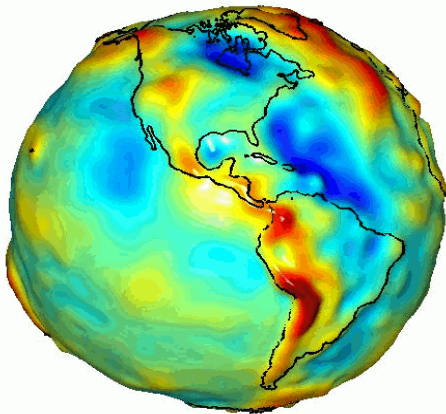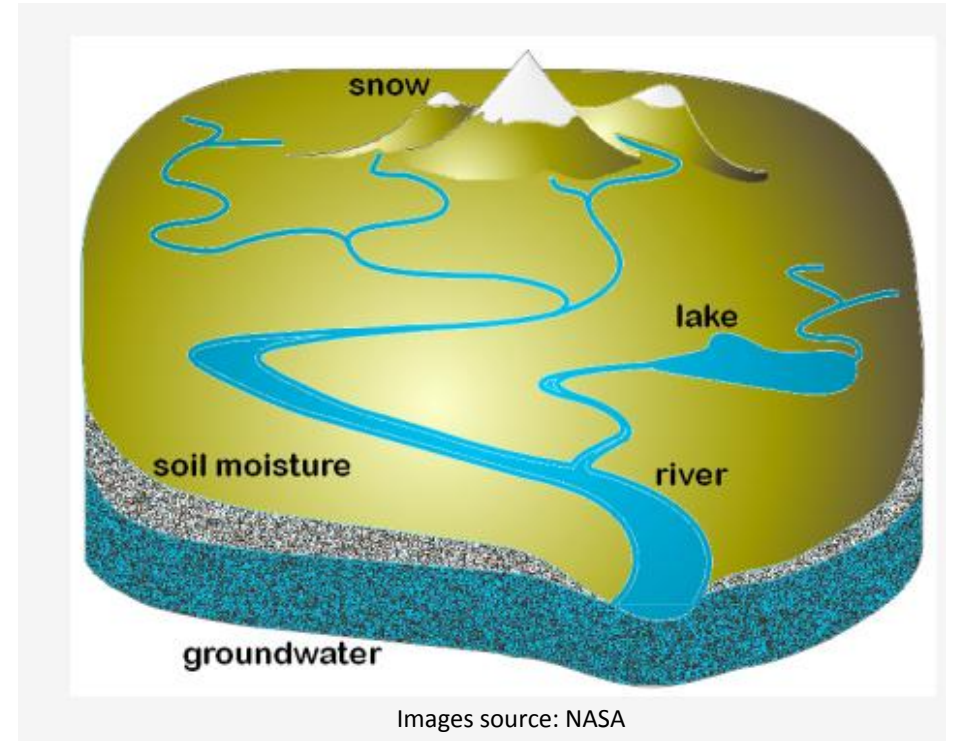
Images source: NASA

OBJECTIVE & DATA

Objective
Observing water storage changes using NASA's Gravity Recovery & Climate Experiment (GRACE) mission

Data
- Monthly gravity field (GRACE)
- Precipitation (Land Surface Model)
- Evapotranspiration (Land Surface Model)
- Surface and subsurface runoff (Land Surface Model)

Images source: NASA

Workflow

Monthly gravity field derived from CSR (Center of Space Research, UT Austin)
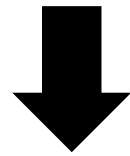
Precipitation, evapotranspiration and runoff simulated from NOAH Land Surface Model (LSM)
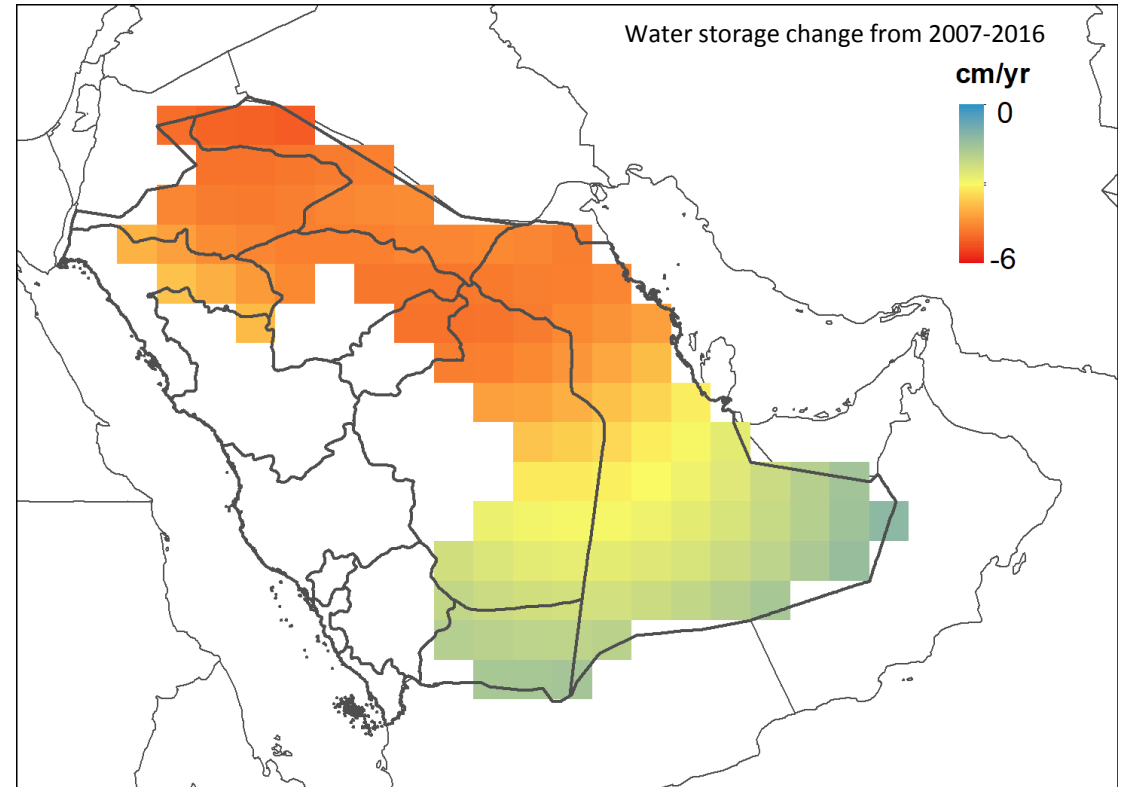
↓

Water Balance Model (P-E-Q)

↓

GRACE TWS ←→ NOAH TWS

Comparing to assess the contribution of anthropogenic effect

RESULT

Water storage change from 2007-2016

cm/yr

- Study area: Arabian Basin (The aquifer map is derived by Worldwide Hydrogeological Mapping and Assessment Program)
- Jouf, Hail, Qassim, Northern Borders and northern part of Riyadh and Eastern Province are regions that have high contribution of Saudi's water deficits

RESULT
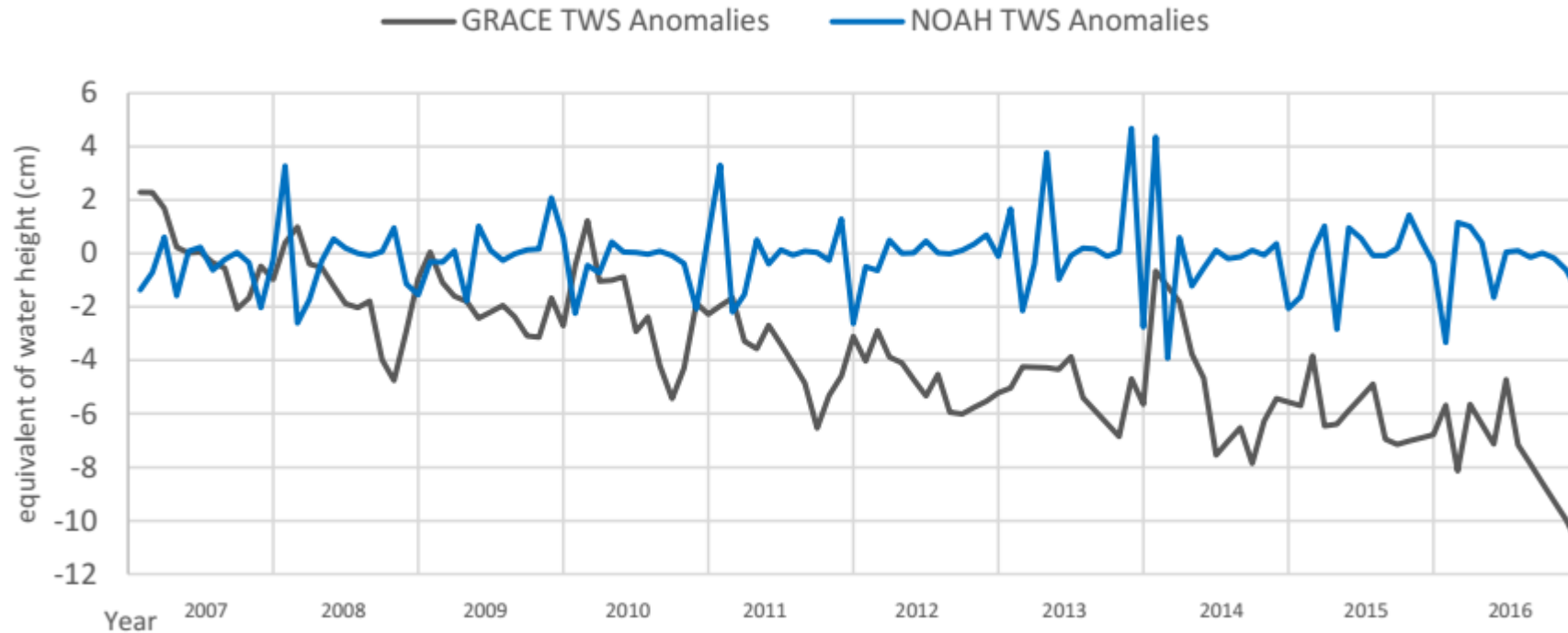
- Arabian Basin has been experiencing water deficit during the study period
- Approximately the basin lost around 7.848 mm/year of terrestrial water storage
- Water balance derived by NOAH LSM deviate significantly from GRACE. Representing domination of human contribution on TWS.

SUMMARY

- A remote sensing-based could provide valuable insight in regional water management

- Previous researches showed that GRACE TWS agreed well with NOAH LSM TWS. In region with high contribution of anthropogenic influence (ex: groundwater abstraction for irrigation purpose), GRACE TWS will significantly deviate from NOAH TWS.

- Jouf, Hail, Qassim, Northern part of Riyadh and Eastern Province are classified as the largest agriculture area than other provinces (Saudi Arabia's General Authority of Statistic, 2015). The significant water deficit might caused by agriculture activities since 88% of total water uses in Saudi Arabia were consumed for agriculture sector (FAO, 2009)

THANK YOU