EGU21-13724, updated on 28 Oct 2021
https://doi.org/10.5194/egusphere-egu21-13724
EGU General Assembly 2021

How Severe is Water Stress in the Middle East and North Africa Region?

Ashraf Rateb[1], Bridget R. Scanlon[2], Hannes Müller Schmied[3], and Emad Hasan[4]
[1]The University of Texas at Austin, Bureau of Economic Geology, Austin, United States of America (ashraf.rateb@beg.utexas.edu)
[2]The University of Texas at Austin, Bureau of Economic Geology, Austin, United States of America (bridget.scanlon@beg.utexas.edu)
[3]Goethe University Frankfurt, Institute of Physical Geography, Germany (hannes.mueller.schmied@em.uni-frankfurt.de)
[4]State University of New York at Binghamton, Department of Geological Sciences and Environmental Studies,United States of America (eabdou@binghamton.edu)

Assessing freshwater availability in the Middle East (ME) and North Africa (MENA) is crucial to sustaining the life of about ~0.5 billion people who live in this region. Rapid population growth along with climate change imposes additional stresses and limiting the reserve of freshwater resources. The Gravity Recovery and Climate Experiment (GRACE) mission its Follow On (FO) provide an essential tool for studying terrestrial total water storages (TWS) that can be linked to different key drivers. One approach to assessing water depletion is estimating the trend in TWS. Nevertheless, the reliability in the trend is compromised by natural variability (e.g., interannual variations). In this study, we evaluated decadal trends of the GRACE TWS for the period (2002-2020) in the MENA region, including 26 countries. We also analyzed the historical variability of climate-driven TWS (excluding human intervention) for 116 years (yr) (1901-2016) based on the WaterGAP global hydrology model (WGHM) using the cyclostationary empirical orthogonal function approach. Natural variability in TWS includes the modulated seasonal cycle, interannual, decadal, and interdecadal variation. We compared the historical variability of TWS based on the WGHM model with the decadal trends in GRACE and GRACE-FO satellites (18.4 yr) based on two mascons (CSR and JPL) GRACE solutions.

Results show that the variability (e.g., standard deviation) in the climate-driven TWS from WGHM is ≤ 10 mm (1901 – 2016) throughout most of the region. Variability is higher in northern Iran, southern Turkey, western coast of the Persian Gulf, Nile River, northwestern Africa (coastal), and south of Sahara (e.g., Chad, Mali, and Sudan). Such regions with higher variability receive substantial annual precipitation or include a major surface water body (e.g., Nile river).

Decadal TWS trends are more highly negative throughout most ME, particularly most of Iran and Saudi Arabia, than in N Africa, except for Tunisia. Less severe or stable GRACE TWS trends are found in parts of the ME (Iraq, west Iran, southern Saudi Arabia, Yemen, Oman) and most of N Africa. In contrast, increasing GRACE TWS trends are dominant south of the Sahara (Chad, Sudan, Niger, and Mali) and in parts of the ME (Kuwait, W Yemen). The declining GRACE trends throughout

much of the ME (Iran, Iraq, Syria, Arabian Peninsula) and parts of N Africa (Egypt, Libya, Tunisia, and Algeria) are considered reliable because they highly exceed the historical simulated variability of climate-driven TWS (1901 – 2016). Trends in some other localized regions are insignificant relative to historical variability (ratio < 2) in west Iran, Nile river, northwest Egypt, Morocco, and Mauritania. The total loss of water in MENA based on the GRACE period (2002-2020) is about 760 Gt, with an annual trend of -41 Gt/year and R^2 0.72. MENA's total loss represent~3.5% of the annual rate of global sea-level rise with a total of ~2 mm between 2002 and 2020. Combining GRACE data with long-term simulations of TWS helps interpret recent GRACE data within the context of long-term variability and allows us to isolate the human drive contribution to TWS trends.