

Title: Work done at KIT for the period July – November 2015

by Prof Dr.-Ing. Joseph Awange

Summary

Africa, Asian and Australian continents are experiencing impacts of climate change that is affecting their water potential, thereby worsening the situation for its inhabitants who rely heavily on rain-fed agriculture particularly in Africa and Asia. Monitoring changes in stored water as a result of climate change in these continents is however compounded by sparse monitoring networks, insufficient large scale in-situ hydro-meteorological data, lack of systematic approach to monitoring, impacts of climate variability and human-induced factors such as water withdrawals, hydro-power, etc. My research stay at Karlsruhe Institute of Technology (KIT; July-September 2015) focused on monitoring not only changes in stored water (surface, groundwater, ice/snow, and biomass), but also global warming and its impacts in these continents. In essence, the work motivates geodesists to “think out of the box” and face the emerging challenges of the 21st century exemplified by the increase in severity and frequency of droughts in the Greater Horn of Africa (GHA) and the challenges posed by the changing monsoon characteristics in Asia, among others. Besides the work above, my period at Karlsruhe was also used complete three Springer-Verlag **books** [1,2,3] and other Mathematical-related publications [10,11]:

Specifically;

1. My research explored the impacts of global warming and the influence of global teleconnection such as El’Nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) in Australia and the Asian Brahmaputra basin, regions that are experiencing varied impacts of monsoon. The connection of these teleconnections to the total water storage over Africa was also carried out. The outcomes of this study have been reported in the references [4, 5, 6].
2. Hydrometeorological drought in the GHA was explored by investigating the potential of the new kid in the block, Gravity Recovery and Climate Experiment (GRACE) to provide hydrological drought indices. The outcome is expected to be published in [7].
3. Changes in Terrestrial Water Storage over West Africa between 2002 and 2014 and in the Asian Brahmaputra basin were investigated and the results submitted to [8] and [9].
4. Impacts of global warming on Australia are still ongoing. So far the analyses of GPS signals that pass through the atmosphere and received by low earth orbiting satellites have been undertaken. Furthermore data from NCEP (National Centers for Environmental Prediction NCEP) has been processed. The next step will be comparison of the satellite and the model results. The outcome will be reported in future publications.
5. On 14/09/2015, I gave a presentation to the Physical Geodesy staff and students entitled “**Environmental Geodesy: Probing the stored water and tropopause over Africa, Asia, and Australia**”.

References

Books:

1. Othieno H, Awange J (2016) Energy Resources in Africa. Distribution, Opportunities and Challenges. Springer-Verlag. Berlin, Heidelberg. ISBN 978-3-319-25185-1; DOI: 10.1007/978-3-319-25187-5 (<http://www.springer.com/us/book/9783319251851>).
2. Awange J, Palancz B (2016) Geospatial Algebraic Computations. Theory and applications. Springer-Verlag. Berlin, Heidelberg. ISBN 978-3-319-25463-0; DOI: 10.1007/978-3-319-25465-4 (<http://www.springer.com/us/book/9783319254630>).
3. Sholarin E, Awange J (2016) Environmental Project Management. Springer-Verlag. Berlin, Heidelberg ISBN 978-3-319-27649-6; DOI: 10.1007/978-3-319-27651-9 (<http://www.springer.com/us/book/9783319276496>).

Referred Journals:

4. Forootan E, Khandu, Awange JL, Schumacher M, Anyah R, van Dijk AM, Kusche J (2016) Quantifying the impacts of ENSO and IOD on rain gauge and remotely sensed precipitation products over Australia. Remote sensing of Environment 76: 50-66, [doi: 10.1016/j.rse.2015.10.027](https://doi.org/10.1016/j.rse.2015.10.027).
5. Khandu, Awange JL, Forootan E (2016) Interannual variability of upper tropospheric and lower stratospheric (UTLS) region over Ganges-Brahmaputra-Meghna basin based on COSMIC GNSS RO data. Atmos. Meas. Tech. Discuss., 8, 9399-9453, [doi:10.5194/amtd-8-9399-2015](https://doi.org/10.5194/amtd-8-9399-2015).
6. Ndehedehe C, Awange J, Agutu N, Kuhn M, and Heck B (2016) Understanding changes in terrestrial water storage over West Africa between 2002 and 2014. Advances in Water Resources 88: 211-230. doi: [10.1016/j.advwatres.2015.12.009](https://doi.org/10.1016/j.advwatres.2015.12.009).
7. Awange J.L., Khandu, Schumacher M., Forootan E., Heck B (2016) Exploring hydro-meteorological drought patterns over the Greater Horn of Africa (1979-2014) using remote sensing and reanalysis products. Advances in Water Resources (revised).
8. Khandu, Forootan E, Schumacher M, Awange J.L., and Muller-Schmied H (2016) Exploring the influence of precipitation extremes and human water use on total water storage (TWS) changes in Brahmaputra-Ganges-Meghna Basin. Water Resource Research (Final revision).
9. Ndehedehe C, Awange J, Kuhn M, Agutu N, and Fukuda Y (2016) Spatial variability of terrestrial water storage (TWS) over West Africa and the influence of climate tele-connections. International Journal of Climatology (Submitted).
10. Awange JL, Palancz B, Lovas T, Heck B, and Fukuda Y (2016) An algebraic solution of maximum likelihood function in case of Gaussian mixture distribution. Australian Journal of Earth Sciences (In Press).
11. Palancz B, Awange J.L , Lovas T, Lewis R, Molnar B, Heck B, and Fukuda Y (2016) Algebraic method to speed-up robust algorithms: example of laser scanned point clouds. International Journal of Geomathematics (Submitted).