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Satellite-derived Actual Evapotranspiration Mapping for Basin Water Budget Assessment and Drought Monitoring Applications

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Actual evapotranspiration (ETa) is an important component of the water budget, but arguably, the most difficult to estimate. Being invisible in gaseous state, only indirect methods are used for large-scale ETa estimation. However, ETa can be estimated at a finer spatial scale than remotely sensed precipitation or runoff due to its dependence on land cover and soil moisture in addition to weather parameters. Remote sensing-based ETa can be derived using various methods, from soil moisture accounting to vegetation-index based approaches to simple and complex surface energy balance techniques. Different models tend to diverge in their estimations because of the complexity in fully representing and parameterizing ETa sub-processes. However, most models appear to provide reasonable estimations that can meet users' requirements when applied using localized data inputs. The Operational Simplified Surface Energy Balance (SSEBop) model has been in use by the U.S. Geological Survey's Water Census program and the Famine Early Warning System Network (FEWS NET) to estimate and map seasonal ETa and its anomalies over diverse ecosystems. Successful application of the model includes operational drought monitoring products for the U.S. and the globe at 1-km resolution based on the MODerate Resolution Imaging Spectroradiometer (MODIS). Furthermore, a root-zone soil-water-balance model (VegET) using satellite derived rainfall and land surface phenology (LSP) produces key water budget components such as daily soil moisture, ETa, and runoff. We present application examples as part of aquifer recharge studies in the Middle East and North Africa (MENA) regions, in cooperation with the U.S. Agency for International Development. Runoff depth derived from the VegET model was used to estimate volumetric runoff over watersheds in Jordan, Lebanon, and the West Bank. Drought monitoring products from the SSEBop ET model revealed the severity and spatial distribution of drought in the MENA region. Advantages and limitations of using diagnostic (SSEBop) versus prognostic (VegET) models in drought monitoring and water budget studies are discussed. Although challenges remain in - absolute accuracy of remote sensing estimates, a one-time calibration using in situ data and other independent data sources is a promising solution for obtaining a globally consistent and locally relevant ETa, soil moisture, and runoff for water use and availability studies.