Estimation of actual evapotranspiration to derive irrigation efficiency indicators in the Aral Sea Basin, Central Asia

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Abstract

Detailed knowledge of land surface fluxes, especially latent and sensible heat components, is important for an improved understanding of interactions between the climate and land surface. The determination of these fluxes, in particular actual evapotranspiration (ET) enables a better understanding how artificial ecosystems such as irrigated agricultural landscapes affect the natural water cycle. It also contributes valuable input for agriculture applications such as irrigation water management, because it allows for assessing the performance of irrigation systems as well as sustainability studies. Both directions of information flow are urgently required in the Aral Sea Basin of Central Asia, where the withdrawal of water for agricultural use in the countries of Central Asia is more than 90 %.

The use of remote sensing data to determine actual ET is particularly suitable to provide area based indicators for the evaluation of the efficiency and productivity (crop water consumption) of irrigation systems. This study is aims at both, the quantification of ET and the calculation of indicators for irrigation system management at the example of the Fergana Valley in the Aral Sea Basin. The study belongs to the in context of the CAWa ("Water in Central Asia", www.cawa-project.net) project which aims on building a scientific and technical data basis for a sustainable water management on a cross-national level.

One of the most common models dealing with energy budget residual, the Surface Energy Balance Algorithm for Land (SEBAL) is applied to six Landsat 8 images in 2015. SEBAL requires remote sensing input data like radiation, surface temperature, NDVI, and albedo. Based on a Landsat based crop map, both, crop water demands and crop water consumption (actual ET) are derived. The relation of crop water consumption and crop water demands is then calculated as indicator of water supply. Furthermore, crop yield information is used to calculate an indicator for water productivity with respect to evapotranspiration (WP).

Mean values of daily ET ranged between 0 and 13 mm for agricultural fields. The regions mean WP is 0.48 kg/m³ for winter wheat and 0.23 kg/m³ for cotton. Thus, WP is small compared to other irrigation systems of the world.