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Towards operational crop water productivity monitoring using remote sensing

Xueliang Cai (1), Li Jia (2), Jonna van Opstal (1), Tim Hessels (1), and Wim Bastiaanssen (1)

(1) UNESCO-IHE, Delft, the Netherlands, (2) State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences

Water productivity (WP) is increasingly high on international development agenda. Incorporating water productivity into current reporting system, such as those required by Sustainable Development Goals (SDG), however faces major challenges in the lack of tools, data, and human capacity for timely reporting at different scales. The concept of WP is yet to be familiarized with decision makers, practitioners, and farmers. And particularly, it remains unclear how WP analysis could help planning, design, and operational management of water use systems. This paper describes an effort to address some of these challenges at the global water accounting group of UNESCO-IHE. The Surface Energy Balance Algorithm for Land (SEBAL), originally an ET model, has been further developed to include crop biomass and crop WP (CWP) estimates. The new model, named PySEBAL, is developed based on Python open source platform and it is capable of semi-automatic processing of selected satellite images, benefiting from the improvement to include a function on automatic selection of hot and cold pixels. Biomass accumulation is modelled through light use efficiency which represents the rate of solar energy being used for effective photosynthesis processes by vegetation. The seasonal biomass is thereafter converted into grain yield using harvest index. Two streams of publically available image sources are currently supported natively by PySEBAL model: Landsat 5, 7, and 8 at 30 meter and PROBA-V/VIIRS at 100 meter nominal resolutions. HANTS algorithm is employed to remove clouds and reconstruct daily time step reflectance from PROBA-V and land surface temperature from VIIRS.

CWP analysis is carried out in a number of Asia and Africa countries using the PySEBAL model. A pilot study examined CWP of rice, coffee, and mango in the central highlands and coastal areas of Vietnam. The study found that the model was able to capture fine details for the relative dense yet fragmented cropping systems. While more crops are being assessed, initial results show that the CWP of high value crops are low: 0.3 kg/m3 for mango and 0.6 kg/m3 for coffee. The variability of CWP in one rice system is found to be as high as those reported in literature globally. Moreover, CWP, and yield maps together with time series spatially explicit ET maps help reveal potential for water saving and/or yield improvement, identify hero farmers, and provide guidance on separating infrastructure and management related water problems.