IAHS2017-367
IAHS Scientific Assembly 2017

Assessment of the time-dependent crop water footprint

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Food security intrinsically depends on a sufficient production of food and on the possibility to make it available to everyone. Water availability is a major constraint to food production. To explore the water-food nexus, we adopted the crop water footprint (CWF) concept. Crop water footprint measures the water amount required by the crop production. It is determined by the evapotranspiration and yield value, which can be highly variable in space and time. Heterogeneous spatial patterns of climatic conditions and agricultural practices imply a highly variable geographic distribution of CWF. Since these patterns may vary substantially over time, due to climate changes and yield variations, also the temporal dynamics of CWF can be significantly variable. A number of studies approached this issue by associating the time variability of crop water footprint only to yield changes, while considering constant evapotranspiration. Validation of such assumption has yet to be provided. As a new contribution, we proved the feasibility of this approach by comparing the CWF estimates with those obtained with a detailed model that accounts for the variations of both yield and evapotranspiration. Overall, the estimates compare well, showing high coefficients of determination, close to 1 for all crops (wheat, rice, maize, and soybean). From this comparison, we derived the model uncertainty, which is around $\pm 10\%$. Such uncertainty is lower than that of the model used to estimate the crop water footprint (i.e. $\pm 30\%$), confirming then the feasibility of the methodology.