

A methodology for Near-Real Time Spatial Estimation of Evaporation

Location	KwaZulu-Natal and Eastern Cape, South Africa
Contractor	WorldBank
Partner	CSIR
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Scope of the project

In a water scarce country like South Africa with a number of large consumers of water, it is important to estimate evaporation with a high degree of accuracy. Many of the conventional methods used locally and internationally can only be applied at field scale and provides point based estimates of evaporation. Evaporation estimates are often also required at scales larger than field scale e.g. at catchment scale. Remote sensing data to estimate evaporation holds great potential for improved water resources management. This project aimed at determining the best methodology to estimate evaporation using remote sensing images.

Study approach

Although a number of remote sensing based models varying in complexity are available to estimate evaporation spatially, only four internationally applied models were selected and evaluated for different land covers and geographical regions within South Africa. The four models evaluated using Landsat imagery included the Surface Energy Balance Algorithm for Land (SEBAL) model, the Surface Energy Balance System (SEBS) model, the Mapping EvapoTranspiration with high Resolution and Internalised Calibration (METRICtm) model and the Vegetation index / Temperature trapezoid (VITT) model. Four different research sites for which energy balance and evaporation data are available, were selected for this study. The sites were situated in KwaZulu-Natal and the Eastern Cape provinces, representing different climatic regions. The instantaneous energy flux estimates, i.e. the energy flux estimates from each of the different models at the time of the satellite overpass, or a comparable time, were compared to that measured.

Results

The accuracy of the components of the energy balance as well as evaporation, estimated with the SEBAL, METRIC, SEBS and VITT models were evaluated for different land surfaces, ranging from a water body, plantation forestry, wetlands and native vegetation under semiarid environments varying in vegetative cover. It was shown that although most models (SEBAL, METRIC, and SEBS) quite easily simulate net radiation accurately, the estimation of soil heat flux and heat storage of a water body is more complex and variable. Similarly, the estimation of sensible heat flux density at the time of satellite image overpass for various land uses and with different models remains a complex process, and accurate estimates of H, when compared to that measured, is not always achieved. The evaporative fraction estimated however, in many instances can be simulated accurately when compared to measurements, and where this is the case, the daily evaporation rates measured compared favourably to that simulated. It was further shown that the accuracy of evaporation estimates is occasionally improved over longer simulation periods.

Conclusions

Although remote sensing based evaporation estimation techniques hold great potential, locally and internationally, there are still some shortcomings that will need to be addressed in future. First of all, the most general short coming of remote sensing based evaporation models at this moment is the limited availability of high resolution thermal infra-red (TIR) images. A second major challenge is the scattering and absorption of radiation by clouds. Thirdly, evaporative processes in mountainous areas are very complex due to the presence of strong lateral movements of heat and the three dimensional flow of air. Lastly, the evaporative fluxes over water bodies are difficult to estimate because of a large component of the energy balance that is related to heat storage and release through the water.