Geophysical Research Abstracts
Vol. 16, EGU2014-6520, 2014
EGU General Assembly 2014


# Improving the performance of lysimeters with thermal imaging

Bernard Voortman (1), Ruud Bartholomeus (1), Jan-Philip Witte (1,2)

(1) KWR Watercycle Research Institute, Nieuwegein, The Netherlands (bernard.voortman@kwrwater.nl), (2) VU University, Institute of Ecological Science, Department of Systems Ecology, Amsterdam, The Netherlands

Precision weighing lysimeters generate data of evapotranspiration (ET) at a high resolution in the order of 0.01 to 0.05 mm. Though this resolution is often reported as the accuracy of the lysimeter, it is in fact the precision of the weighing device. The accuracy of a lysimeter is heavily dependent on its ability to duplicate environmental conditions of its surroundings. In general, measurement errors will decrease with increasing lysimeter dimension, primarily because a larger part of the lysimeter is unaffected by its boundaries and because heterogeneities in soil hydraulic properties and micro-climate are more averaged out. However, the cost of large lysimeters make them unattractive and scientists often choose for more economical solutions, optimizing between lysimeter dimensions and costs.

Instead of investing in large lysimeters or putting effort in duplicating environmental conditions, we invested in monitoring the surface temperature of zero tension lysimeters with a thermal infrared camera to detect deviations in ET. In such a system, measurement errors caused by deviations in moisture content can be compensated, without the struggle of controlling the lysimeter moisture content with pressure plates and vacuum pumps or preventing wall flow. Other advantages of using thermal imaging are that (i) measurements of ET can be extrapolated to much larger areas than the surface area of most conventional lysimeters, and (ii) ET can be split into soil evaporation and transpiration, which allows us to study the effects of the vegetation structure on the water balance.

Several experiments were performed to estimate differences in ET between lysimeters based on the radiometric surface temperature. Two simple methods, 1) linear scaling and 2) a comparison of the surface energy balance were applied to translate differences in surface temperature to differences in ET. We examined the application of both methods on bare sand, moss and grass. We show that the performance of lysimeters can be monitored and improved with the aid of thermal imaging. For example, estimated ET based on thermal images of moss lysimeters showed a model efficiency (Nash Sutcliffe) of 0.94 and 0.93 and a RMSE of 0.02 and 0.03 mm for method 1 and 2 respectively. However, for bare sand the model efficiency was much lower: 0.54 and 0.59 with a RMSE of 0.53 and 0.60 mm for method 1 and 2 respectively. This poor performance is caused by the large variation in albedo of bare sand under moist and dry conditions, affecting the available energy for evaporation.