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Modeling of over Lake Wind Profile for Estimating Water Surface Evaporation Using Land-based meteorological Data

Ali Abbasi and Nick van de Giesen
Technische Universiteit Delft, Water Resources Management, Delft, Netherlands (a.abbasi@tudelft.nl)

Evaporation from reservoirs and small lakes plays an important role in water management. Estimating the evaporation from surface water resources such as small lakes and reservoirs requires extensive data. Evaporation is difficult and expensive to measure experimentally over the water surface. For operational purposes it would be attractive if evaporation from a lake could be estimated with acceptable accuracy from standard meteorological data taken at nearby land-based stations.
Several techniques and models have been suggested and used to estimate evaporation from open water bodies. One of the most commonly used methods is the aerodynamic mass transfer method which gives reliable results for water bodies if suitable data are available. With the aerodynamic approach, evaporation rate is modeled as the product of a vapor pressure deficit between the water surface and upwind air and a wind function that depends on the wind profile over the water surface. As measuring wind speed, and other meteorological data, over a water surface is not easy, most literature uses land-based meteorological measurements. Using land-based meteorological stations data in estimating evaporation introduces significant errors in estimated values of evaporation. On the other hand, the aerodynamic method should account for the size or fetch of a desired water body as evaporation rate decreases with distance downwind from the land-water edge due to increased entrainment of water vapor. Neglecting the fetch effects in this method introduce errors in estimated evaporation values.
In this paper, we use a CFD model (RANS Model) to simulate the wind profile over the water surface that utilizes land-based measurements. The modeled wind profile is used to estimate evaporation from water surface using the aerodynamic approach. This proposed model is tested for small lakes and reservoirs in arid and semi-arid regions. Results show a good agreement with the experimental measurements and can be used in water management plans to estimate evaporation from reservoirs and small water bodies.