Effect of irrigation water withdrawals on water and energy balance in the Mekong River Basin using an improved VIC land surface model

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We present a detailed analysis of the effect of agricultural irrigation water abstraction on surface water, energy state and flux, using a model simulation to predict changes in Bowen Ratio, surface temperature and water resources within the Mekong River Basin. Using the Variable Infiltration Capacity (VIC) macroscale hydrological model including the infiltration, surface runoff, subsurface runoff, drainage from the soil layer, and irrigation scheme, together with the most recently available and accurate geophysical, geological and meteorological forcing datasets, we carried out the hydrological simulation on three calibration parameters. The multi-objective complex evolution (MOCOM-UA) optimizer was used to calibrate the model, which revealed a significant decrease in Bowen Ratio due to irrigation water withdrawal: this in turn affected surface temperature. We conclude that (1) the performance of the improved
model was generally good, with an overall Nash–Sutcliffe Efficiency of 0.86 for the validation period 1986–1993; (2) the volume-based total Net Irrigation Water Requirement was about 24×109m3/year for the period 1979–2000; (3) including the irrigation water withdrawals from runoff, river channels and dams decreases the total monthly runoff by 32% compared to the “no irrigation” baseline; (4) the period-averaged Bowen Ratio decreased by 6.8% in the dry season as a result of irrigation effects; (5) this significant decrease in Bowen Ratio resulted in a decrease in average surface temperature of 9.3×10−2% and a maximum of 4.8% over irrigated areas during the dry season.

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