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Land-based infrared thermography in combination with water temperature as a validation-tool for hydrodynamic modelling of small constructed wetlands

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Modelling water fluxes inside a small constructed wetland using a hydrodynamic model in high spatial resolution may give insights into the distribution of flow velocities, water levels and resulting preferential flow paths. Usually validation of these results is done by hydrometric data like measurements of flow velocities or runoff at certain points in the system. This requires extensive measurement campaigns inside the system. Another way to get spatial distributed information of real flow conditions inside a water body can be the use of hydrological tracers in combination with remote sensing. Existing tracers are e.g. fluorescent dyes which can be observed in the visible spectrum. However, in the case of wetlands with dense vegetation covers tracers must be observable through dense vegetation. A possible solution is offered by warm water in combination with land-based infrared thermography. Using an infrared camera the injection of warm water as a Dirac impulse into the inflowing stream and its convective and dispersive transport was observed in a high temporal and spatial resolution. To account for density differences between waters of different temperatures sodium chloride was added as a mass correspondence The study area is a small constructed wetland (65 m^2, ˜ 6 m^3) in an agricultural catchment near Eichstetten in south western Germany. The wetland is instrumented with a hydrometric station at the inlet and a small weir at the outlet. It is optically divided by ropes into a mesh of grid cells. A meteorological tower at the side of the wetland gives the possibility of landbased remote sensing (observation height: 5.5 m). For tracer experiments we used a handheld FLIR ThermaCam E320 (320*240 pixels) with a thermal sensitivity of 0.1 °C and 50 liters of 30 °C warm water. A time series of thermal pictures was recorded showing the convective transport and the expansion of the warm water cloud in the sense of mixed temperature zones in high spatial resolution. To simulate water fluxes inside the wetland we are using a 2 dimensional hydrodynamic model. This discontinuous finite-element approach calculates flow on the basis of the Runge-Kutta-Discontinous-Galerkin method. The wetland model is represented by a virtual triangular mesh, which is intersected with GIS-based spatial discretized information of ground elevation and Manning's n. For a spatial distributed validation of model runs with dynamic inflow we use the time series of infrared pictures. The georeferencing is realized by using the mesh of grid cells, which is visible on the infrared pictures. The method is promising, and we are planning a series of experiments at different vegetation stages.