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Feedback Loop of Data Infilling Using Model Result of Actual Evapotranspiration from Satellites and Hydrological Model

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Using satellite data in a hydrological model has long been occurring in modelling of hydrological processes, as a source of low cost regular data. The methods range from using satellite products as direct input, model validation, and data assimilation. However, the satellite data frequently face the missing value problem, whether due to the cloud cover or the limited temporal coverage. The problem could seriously affect its usefulness in hydrological model, especially if the model uses it as direct input, so data infilling becomes one of the important parts in the whole modelling exercise.
In this research, actual evapotranspiration product from satellite is directly used as input into a spatially distributed hydrological model, and validated by comparing the catchment's end discharge with measured data.
The instantaneous actual evapotranspiration is estimated from MODIS satellite images using a variation of the energy balance model for land (SEBAL). The eight-day cumulative actual evapotranspiration is then obtained by a temporal integration that uses the reference evapotranspiration calculated from meteorological data [1].
However, the above method cannot fill in a cell if the cell is constantly having no-data value during the eight-day periods. The hydrological model requires full set of data without no-data cells, hence, the no-data cells in the satellite's evapotranspiration map need to be filled in. In order to fills the no-data cells, an output of hydrological model is used. The hydrological model is firstly run with reference evapotranspiration as input to calculate discharge and actual evapotranspiration. The no-data cells in the eight-day cumulative map from the satellite are then filled in with the output of the first run of hydrological model. The final data is then used as input in a hydrological model to calculate discharge, thus creating a loop.
The method is applied in the case study of Rijnland, the Netherlands where in the winter, cloud cover is persistent and leads to many no-data cells in the satellite products. The Rijnland area is a low-lying area with tight water system control. The satellite data is used as input in a SIMGRO model, a spatially distributed hydrological model that is able to handle the controlled water system and that is suitable for the low-lying areas in the Netherlands.
The application in the Rijnland area gives overall a good result of total discharge. By using the method, the hydrological model is improved in term of spatial hydrological state, where the original model is only calibrated to discharge in one location.

[1] Alexandridis, T.K., Cherif, I., Chemin, Y., Silleos, G.N., Stavrinos, E. & Zalidis, G.C. (2009). Integrated Methodology for Estimating Water Use in Mediterranean Agricultural Areas. Remote Sensing. 1