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From science to management: the case of the Nam Theun 2 Reservoir model

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Water quality (WQ) issues and large gross greenhouse gas emissions (GHG) are reported in some tropical reservoirs, mainly located in South America. These concerns are gaining more and more attention not only in the scientific community but also among hydropower project developers and financial institutions. Prior to the construction of a dam in tropical or sub-tropical areas, questions are now raised on the impact on WQ, mainly for downstream uses, and on the long term GHG footprint of the project. The hydrodynamic and biogeochemical processes responsible for WQ and GHG issues are complex and interrelated and modelling is often a useful tool to answer these questions. However, so far only one process-based model has been developed for GHG emissions from the Petit Saut Reservoir (French Guyana). Such models are thus far from being routinely used to answer developers or managers questions.

The Nam Theun 2 Reservoir (450km^2, 3500 Mm3), located in Lao PDR, was flooded in April 2008. In order to monitor and predict WQ and GHG emissions, important pre and post impoundment pluriannual programs have been instigated including monitoring, research and modelling tasks. As regard this later aspect, the main objectives were (i) to assess mean and long terms WQ and GHG emissions, (ii) to study exceptional meteorological or hydrological phenomena, (iii) to provide a tool for the management of the reservoir and (iv) to provide significant inputs to the scientific knowledge. To reach these objectives a 3D process-based model has been developed and calibrated. This model includes a hydrodynamic model for the prediction of water flow fields and thermal stratification (as input into a water quality model), based on Delft3D-FLOW (Deltares) and 3D WQ model that also predicts sediment quality and GHG emissions into the atmosphere and via water outflows, based on Delft3D-ECO (Deltares). The WQ model is divided into 5 submodels: water and sediment quality, phytoplankton, light regime, vegetation and sediment.

The calibration of the hydrodynamic and WQ parts was done with 2008-2010 data from the regular monitoring and research programs as well as with data from specific measurement missions. Then the model has been used to answer some specific questions: Will the reservoir be stratified – destratified each year? What would be the consequence on hydrodynamics and WQ of an exceptional wet or dry year or a strong storm? From where originates the released water? What would be the mean and long term trends in WQ? etc.