Geophysical Research Abstracts, Vol. 9, 05317, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-05317

Framework for integrating numerical hydro-ecological simulation output into a linguistic decision making domain

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Riverine ecosystems are critical habitats for a variety of threatened species. They are under continuous threat of destruction and are bedevilled with complex hydro-environmental problems. Mathematical models can serve as powerful tools in solving water resources problems. Most of the models available for water management are crisp, deterministic and precise in character. However, most water related problems are neither crisp nor deterministic. Solutions to such problems require a cocktail of models along with expert knowledge, which is formulated with words. This work herein presented is expected to help bridge the gap between numerical simulation output and policy formulation by proposing a framework for the integration of linguistic guidelines and indicators, developed a priori, into a purely numerical hydro-ecological system. The impact of a proposed hydropower plant in a protected park is used a case study.

A series of biophysical modelling exercises are being undertaken to firstly access the status quo and subsequently model the impact of the plant at the study location. The exercises include assessment of habitat requirements for an endangered species of hippopotamus and development of a model to characterise mesoscale hydrological processes in the watershed. The impact the impoundment is expected to have on the riverine habitat and an endangered species of hippopotamus upstream of the dam is evaluated. The ensemble hydro-ecological simulation serves as input into the Linguistic Numerical Transition Know-how algorithm, in short LiNK. LiNK is based on fuzzy

rule formulation and computing with words techniques.

The LiNK algorithm and its framework are both applied to the case study involving the impact of a proposed hydropower project on the protected Bui nature reserve in Ghana. Construction for the 400 MW plant, is expected to commence in the fourth quarter of 2007. The resulting lake is expected to inundate slightly more than a third of the park. The algorithm and its framework are utilized to model the competing interest of stakeholders including the BOOT (build own operate and transfer) operators of the dam, biologists and local government authorities. Both the complex biophysical and decision making processes are modelled. The approach, it is believed, can help optimize management strategies (best management practices) for the watershed within which the dam is located while serving as a powerful tool for wider environmental management policy analysis and formulation. The work also discusses limitations in the use of traditional numerical models to aid decision support and initiate policy.