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Reality vs. Management: The Role of Ecological Numerical Models

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Numerical models are increasingly being used to understand and predict the hydrology and ecology of estuarine, coastal and freshwater environments. Generally, hydro-ecological models which adequately represent 'reality' have restricted simulation run times due to requirements of high temporal and spatial resolution. On the other hand, models which are used to simulate processes occurring on annual or interannual time scales, and thus assist management strategies, have generally been subjected to gross temporal and/or spatial approximations, and their representation of reality can be considered questionable. The latter models generally reduce the spatial dimension or decouple hydrodynamics and water quality. There is therefore a necessity to produce long simulation periods using fine temporal and spatial resolution and full representation of the relevant physical , chemical and biological processes. The production of these models is still fundamentally inhibited by computer hardware constraints, although the advent of faster computers with larger memory capabilities has made the models more conducive to process descriptions and management applications. In addition, computer code compilers which perform array processing can dramatically increase the simulation speeds.

The number of state variables represented in the model, the number of grid points used for the selected spatial domain and the time step used to advance the simulation still largely govern the simulation run time. By optimising these factors through array processing techniques, sparse grid notation, a suitable choice of advection scheme and increasing time steps beyond the restriction imposed by the CFL (Courant-Friedrichs-Levy) stability condition, simulation run times can be decreased substantially.
A water quality model ELCO-WQ, is presented which takes full advantage of the strategies outlined above, reducing simulation times by ~50 times over conventional model formulations. The water quality and hydrodynamics can be fully coupled on a fine resolution grid, and simulation lengths of 1 to 5 years are achievable with a desktop workstation computer. The modelling techniques here are highly beneficial when the model is to be used as both a management and scientific tool.

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