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Developments of IT and SE in Comparison with Developments of Aquatic Modelling

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Rapid advancements in the development of fast computing systems as well as computational techniques are expected to deliver enormous successes in the fields of aquatic ecology, environmental and/or water engineering. Through advancement of software technology, development of utility tools to create visualization of several ecological/environmental/hydraulic processes has become comparatively easy. Through charismatic colour schemes, this visualization often produces significant impressions to the end-users and/or audience. People tend to forget the accuracies of these visualization clips/videos, often not demonstrated along with sufficiently acceptable scientific supporting accuracy protocol/measurements. In many cases overwhelming demonstration of attractive visualization supersedes the necessity of having/presenting proper accuracy testing. This article presents achievements of accuracies in the fields of ecological, environmental and hydraulic simulations compared to the developments of information technology (IT) and Software Engineering (SE).

In regards to surface wager hydrology, computational methods and processes are fairly simple and well-established. There is not much left to achieve in regards to accuracy. Further developments of IT and SE will have insignificant impact in relations to achieving higher accuracy. Integration of water quality components also simple and do not warrant the need for super-computing and further development of IT/SE. Similar is the case of lake hydrology and hydraulics; sufficient accuracy has been achieved. Further development of IT will have insignificant effect in terms of gaining more accuracy. However, it is possible to reduce the computational time for some long-period simulations. Accuracy can be much more improved through having good quality data, which often missing in many cases.

In regards to groundwater hydraulics, computations are bit more complex compared to surface water hydrology. However, sufficient accuracy has been achieved in terms of calculations related to an ideal flow scenario. As off contribution of SE, nothing much to be achieved through advancement of SE, apart from reducing computational time. The greatest challenge remains establishing homogeneity/non-homogeneity of an aquifer. In reality, aquifers are quiet non-homogeneous in nature. However, this is a rigorous, cost-intensive exercise to assess aquifer non-homogeneity to a level of satisfactory accuracy. Due to this major limitation, software visualizations demonstrate an ideal condition only; an accurate estimation is far away to achieve.

In regards to river hydraulics, computational processes are fairly complex and require high level of numerical techniques to be applied as the current knowledge of applied mathematics still unable to solve complex partial differential equations (PDE). Rather it requires some suitable transformations of differential equations into solvable finite difference equations using different numerical schemes. Over the years, numerous researchers have contributed developments of several successful numerical techniques. To date evolved numerical techniques are able to achieve sufficient accuracy in relations to hydraulic computations. The greatest challenge of these computations is numerical instability, for which IT/SE has got nothing to do. Applied mathematics needs to be developed more to overcome this issue or to be able to solve complex PDEs without the use of numerical representations. Nonetheless, development of IT will be able to contribute to reduce computational time.

Another emerging technology named Computational Fluid Dynamics (CFD) is often used in solving several water and environmental problems. Sufficient simulation accuracy can be achieved using CFD. However, CFD is so far feasible for small scale and single-phase fluid. For large scale, multi-phase fluids and for solid-fluid interactions CFD requires enormous computer memory and time. Developments of IT will be able contribute a lot in this regard.

Recent need is to incorporate modelling water quality (WQ) parameters in all the above-mentioned modelling tasks. Often, WQ parameters are closely related with aquatic micro-organisms and usually dealt under the umbrella of ecological modelling. Calculations of common WQ parameters such as BOD & DO can be accomplished with good accuracy. However, accurate calculations of some other WQ parameters such as carbonate/bi-carbonate and pH still requires lots of improvements and in some cases yet to be established through physical laws. Calculations of micro-organisms and nutrients are generally performed through simple equations using conceptual models. The prime drawback of these models is that they require calibration of numerous parameters. The reality is that one is able to achieve a good calibration through manipulations of even some wrong parameter values. Significant advancements are required in this field.

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