CERIS : Civil Engineering Research and Innovation for Sustainability

Data assimilation for fluvial hydrodynamic and morphodynamic modelling

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PhD program
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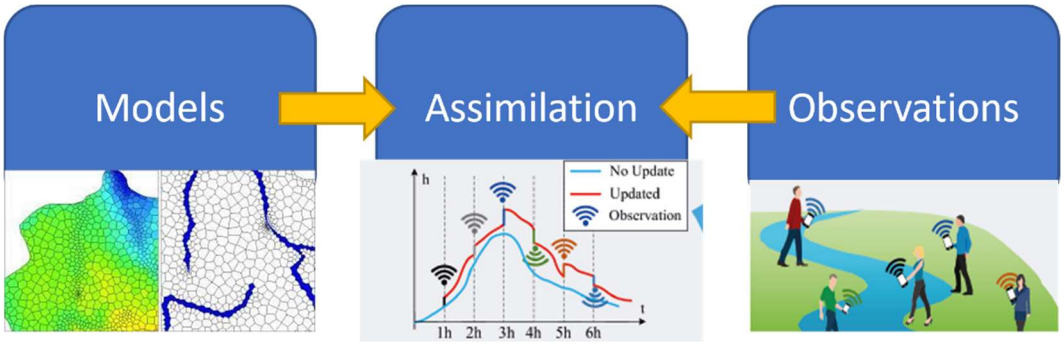
Summary

Mathematical modelling of river systems contributes to cost-effective water management, reliable flood risk management and, overall, sustainability and resilience of human settlements. Low-cost but scientific and technologically challenging improvements come from combining models with data from remote sensing and citizen science. The goals of this doctoral work are: development of methods of data assimilation for hydrodynamic and morphodynamic models, their implementation on efficient computational tools, validation and application. Data assimilation is a discipline aimed on combining observations of Earth System variables/states and models, filling the spatial and temporal gaps in the observations and constraining the models with them. This leverages the strengths in these sources of information objectively, through maximization (or minimization) of a mathematical function. The combination product is called the analysis. This thesis program is in line with the research project PTDC/CTA-OHR/29360/2017, RiverCure. CERIS-IST provides the necessary equipment, facilities at the Laboratório de Hidráulica e Ambiente (LHA) and a mathematical model applicable to geomorphic flows, STAV-2D. Data sources include that resulting from mobile and fixed bed lab experiments, a field observatory in Portugal and authoritative databases for alluvial rivers from the Portuguese state agency for water resources, APA – Agência Portuguesa do Ambiente.

The structural objectives of this doctoral work are: i) the development of methods of data assimilation for hydrodynamic and morphodynamic models, ii) their implementation on efficient computational tools, iii) its validation and application to real test cases. The key methodological steps are listed below. 1- Development of methods of data assimilation for the estimate of effective river properties, streamflow and morphodynamic modelling, using in-situ and remote sensing data, embedded or external to the algorithms of STAV-2D and HEC-RAS 2D/1D hydrodynamic models. 2- Coding the sequential data assimilation methods into STAV-2D within the HPC paradigm. 3- Production of laboratory and field datasets that allow the evaluation and validation of hydrodynamic models. 4- Model validation 5- Application to case studies on Brazilian and American alluvial rivers and river engineering structures. Comparison of morphodynamic models. Potential innovations are: data assimilation methods adapted to fluvial modelling; computational tools that take advantage of HPC (High Performance Computing) parallelization; datasets on ungaged sites; phenomenological understanding of fluvial processes and interactions with structures. The resulting methodology will allow for inferring information for ungauged sites, assessment of the interactions between infrastructure and fluvial flows. It can be exploited by consulting companies, state agencies for monitoring and licensing of water bodies and civil protection authorities.

Keywords

Data assimilation, sediment transport, hydrometry, citizen science.



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