Automated model-based flood risk mapping for future scenarios of urban growth and climate change

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Abstract

The CORFU approach formalises the dynamic interplay between regional economic and urban growth, climate change and the resilience of an urban system to flooding in a drivers-pressures-state-impacts-responses (DPSIR) framework. We have implemented a chain of computational models that automates the proposed DPSIR framework as part of the open-source Kalypso Planner Client decision support tool.

DPSIR FRAMEWORK

Socio-economic change and regional economic growth *drive* land demand, a competition in space, spatial planning, and, consequently, lead to land use change through urbanisation. These drivers create *pressures* on the urban system (*state*) in the form of increased vulnerability to flooding and surface imperviousness. Likewise, climate change is likely to lead to more frequent and extreme flood events. Flood *impacts* and an overall increase in flood risk change the people's perception of their risk, provoke a *response* and may result in renewed socio-economic change (Fig. 1). We have implemented a chain of computational models in order to automate one cycle in the proposed DPSIR framework.

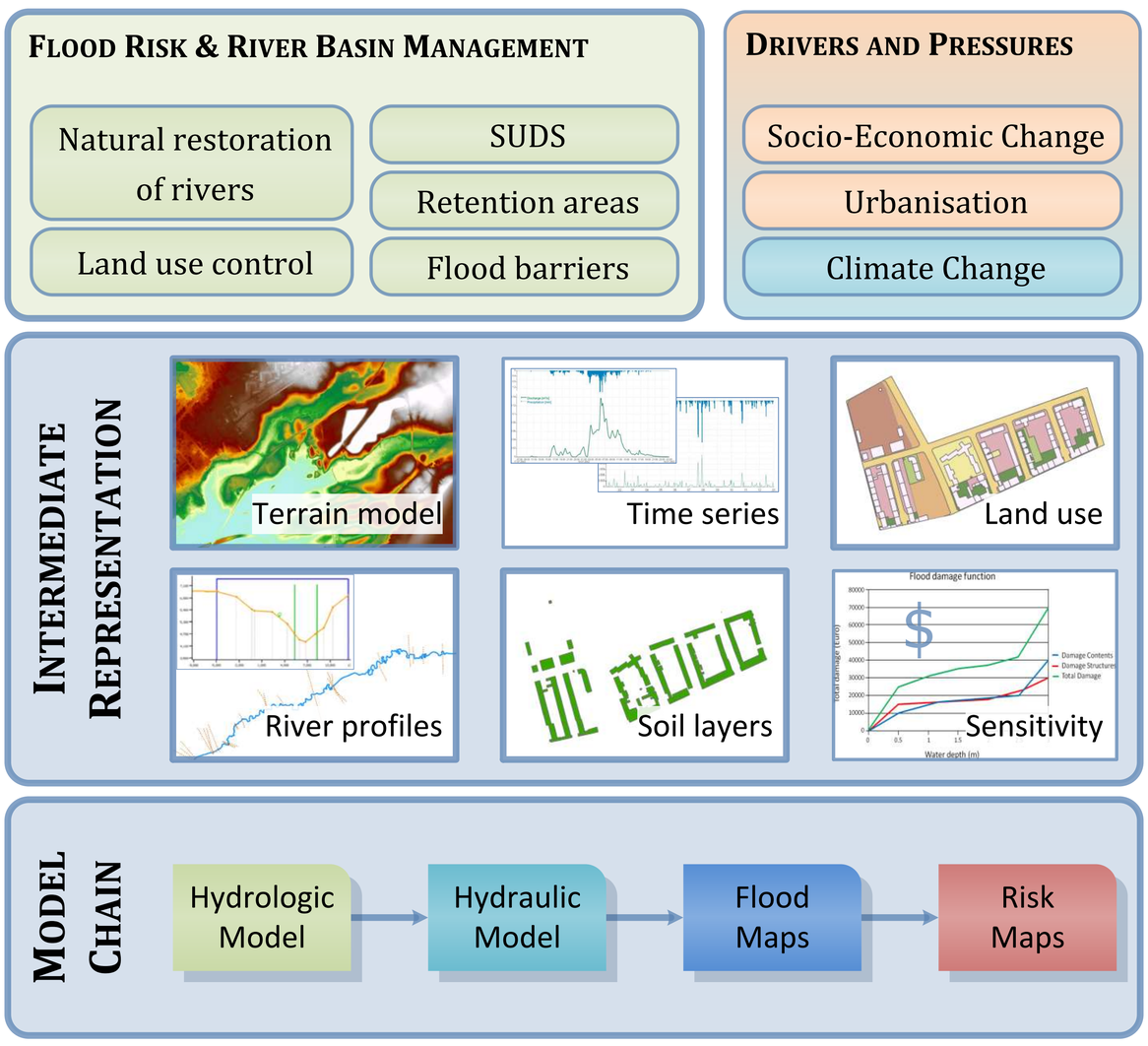

Figure 2. Model-based assessment of elements of flood risk and river basin management under future scenarios of socio-economic and climate change.

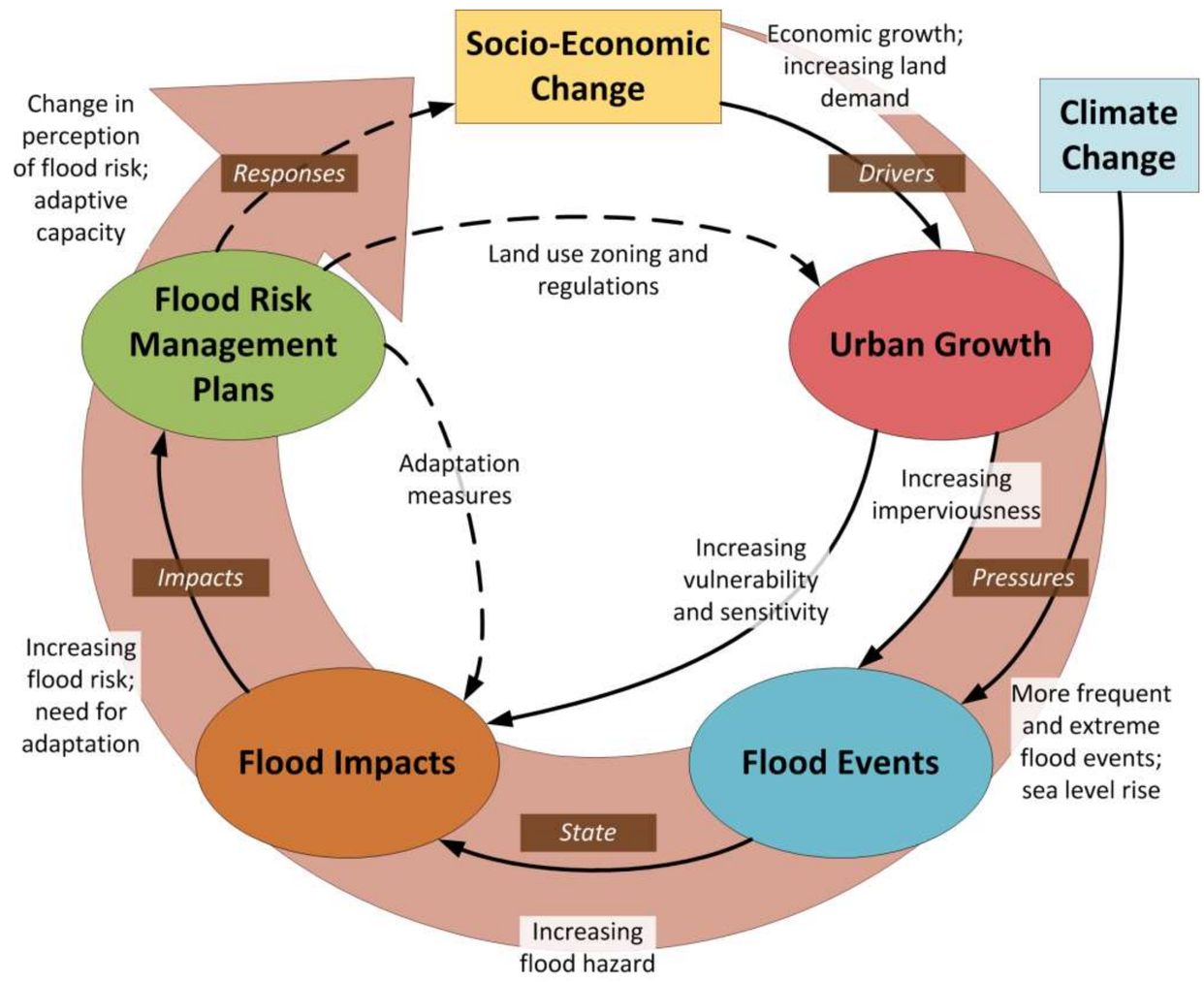

Figure 1. The CORFU **D**rivers-**P**ressures-**S**tate-**I**mpacts-**R**esponses framework

FLOOD RISK MANAGEMENT AND URBAN CHANGE

The Floods Directive (2007/60/EC) requires flood risk management plans to be implemented for rivers and coastal areas with a substantial flood risk based on flood hazard and risk maps. The directive calls for a revision and update of these maps and plans every six years taking into account the possible impacts of climate change. Likewise, socio-economic change and its manifestation in the form of urban development was found to be another significant driving force of flood risk, especially in areas featuring unconstrained urban growth. An additional challenge arises if elements of flood risk management are to be harmonized with river basin management actions. Kalypso Planner Client (Shaikh et al., 2013) uses a sequence of Kalypso simulation models for mapping expected future annual flood damages (EAD) for pluvial-fluvial-type flooding processes. This model chain is based on the standard Web Processing Service (WPS) interface issued by the Open Geospatial Consortium (OGC). Model inputs and outputs are exchanged in the widely accepted OGC Geography Markup Language (GML) according to an intermediate data model (GML schema) that is independent of any concrete computational model (Fig. 2). Kalypso applies scenarios to the intermediate data model prior to running the model chain (Fig. 3).

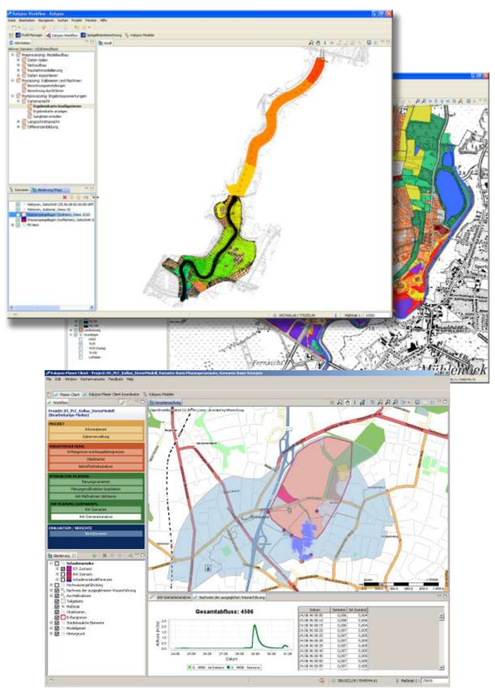

Figure 3. The Kalypso simulation models and the Kalypso Planner Client decision support tool

CONCLUSION

Automated flood risk mapping with Kalypso Planner Client is a powerful tool for flood risk and river basin management planning. In addition to analysing the potential future changes in flood risk due to socio-economic and climate change, as required by 2007/60/EC, the tool enables stakeholders to evaluate the effectiveness of adaptation measures under current and future conditions (Hellmers et al., 2013).

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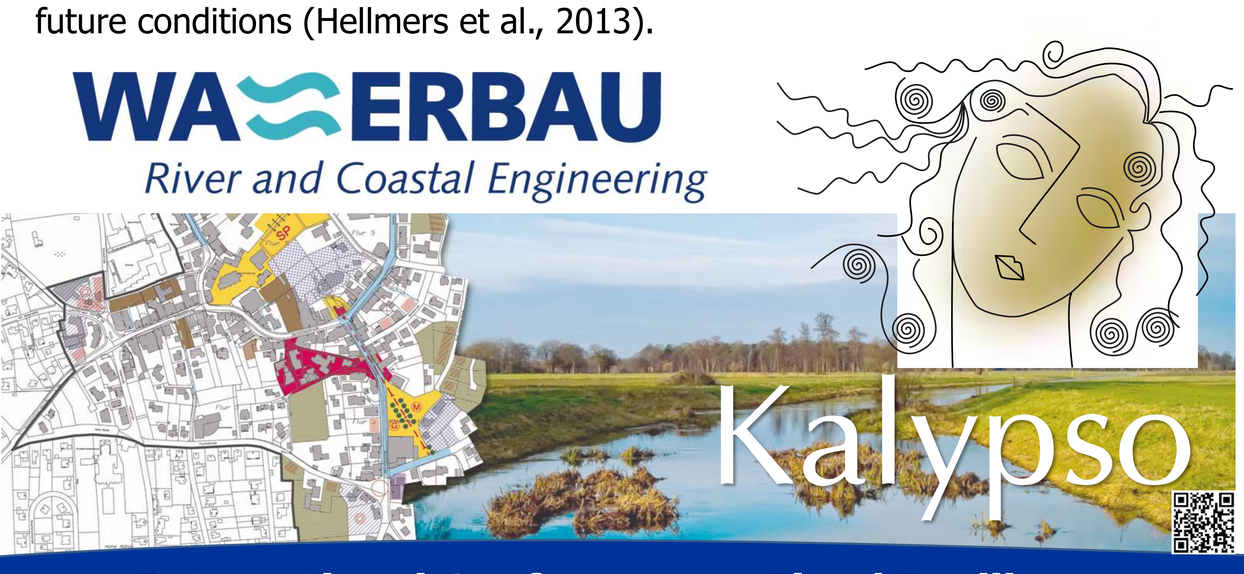

Kalypso (http://kalypso.sourceforge.net) is an extensible, standards-based, open-source product with support for the KalypsoHydrology rainfall-runoff model, the KalypsoWSPM, Open Telemac-2D and RMA·Kalypso hydraulic models and additional modules for direct damage assessment and the creation of flood and risk maps.

References

- Hellmers S, Kurzbach S, Manojlović N, Palmaricciotti G (2013) Multiple linked SUDS in hydrological modelling for urban drainage and flood management. ICFR 2013, Exeter, UK.
- Shaikh S, Kurzbach S, Manojlović N (2013) Towards a decision support tool for adaptive flood risk management in an urban catchment. ICFR 2013, Exeter, UK.