6th IAHR Europe Congress, June 30th – July 2nd, 2020, Warsaw, Poland

Urban flood risk analysis based on digital city models - the FloRiCiMo approach

Torsten HEYER, Rocco ZIMMERMANN, Hellen HAMMOUDI, Lars BACKHAUS, Jürgen STAMM[1],
Arne SCHILLING, Stefan TROMETER[2]

[1] Institute for Hydraulic Engineering and Technical Hydromechanics, Technische Universität Dresden, Germany
email: wasserbau@tu-dresden.de

[2] virtualcitySYSTEMS GmbH, Berlin, Germany
email: info@virtualcitysystems.de

ABSTRACT

Digital city models are created and used increasingly worldwide. If designed properly, such models provide great application potential for simulations of various physical processes. In this regard, the research project "Flood risk analysis using 3D city models (FloRiCiMo)" aimed for enhancing urban flood risk management by coupling 3D digital city models with hydronumeric solvers (2D, 3D). By combining flood simulation results with the specific damage potential of urban components (buildings, infrastructure, inhabitants), flood risk can be analyzed and managed in a more sophisticated way. Furthermore, 3D city models provide an excellent platform for risk communication, as results can be displayed user-specific for experts and citizens (e. g. photorealistic, VR and AR representations). The methods and results of the FloRiCiMo project are explained and demonstrated more detailed on the example of a pilot study that was conducted for the City of Dresden/Germany.

1. Introduction

According to the EU Floods Directive inundation risks of flood prone areas have to be analyzed and risk management plans have to be revised every 6 years. As flood risk assessment incorporates the need for hydronumeric computations, the recurring efforts become obvious. This holds particularly true for flood risk assessment projects in urban areas, where the damage potential is high and flood relevant structures and conditions are very complex. In conclusion, there is a constant need for updating and operating hydronumeric models as well as for flood risk assessments for urban areas in particular. From a broader perspective, possible inundation processes are just one of many aspects that need to be considered in development and management of urban regions. Other issues, such as population and infrastructure development can be equally important. In this regard, semantic 3D city models offer a wide range of functionalities as they contain large volumes of data that might be relevant for the simulation of physical processes (terrain elevation, land use, etc.) and for risk analysis (damage potential evaluation). These city models are based on the international standard CityGML, a database solution that allows for various object queries in opposition to simple 3D visualizations of buildings. The FloRiCiMo-approach follows the idea of interlinking semantic 3D city models with hydronumeric solvers (2D, 3D) for the purpose of enhancing flood risk assessment in urban areas.

2. Methodology

The main objective of the FloRiCiMo-project was to develop a methodological framework and a workflow including required interface tools and transformation techniques allowing semi-automated flood risk assessments for urban areas (see Fig. 1). As a core component, a web portal was established for the purposes of data storage and administration, providing import/export functionalities, selecting and querying regions or objects and many more. In the FloRiCiMo-approach, two types of hydronumeric simulations (2D, 3D) can be conducted for different model extends and purposes. Although both simulation techniques can be performed independently, they can also be linked by using the results of the 2D computations (large scale) as hydraulic boundary conditions for 3D simulations on object scale (e.g. bridges, houses). The whole concept and its components can be user-tailored to the specific demands of the client, e.g. formats of exported data can be adjusted to the requirements of the hydronumerical solvers used by the client.

3. Result processing and visualization

In contrast to classical representations of hydraulic parameters in 2D maps, results in FloRiCiMo are displayed in the 3D environment of the digital city model. As maintaining and raising flood risk awareness of "non-

expert" citizens was one main objective of the project, a photorealistic visualization of the computed flow characteristics was developed (Fig. 2). Successful attempts for virtual reality (VR) and augmented reality (AR) applications were also made.

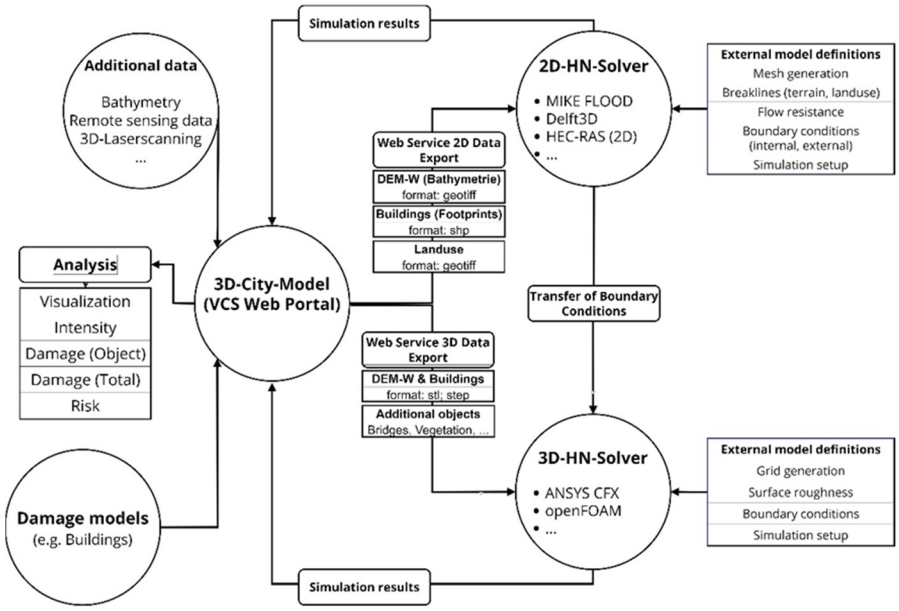

Fig. 1. General scheme and workflow of the FloRiCiMo-approach.

Fig. 2. Example of photorealistic flood scene in web portal (animation based on 2D-simulation results)

By overlaying the 2D simulation results of flood scenarios with the local damage potential characteristics, flood hazards and damages (using depth-damage functions) can be computed and displayed for individual buildings as well as for larger urban districts. The event specific flood risk can then be determined by multiplying the damages with the occurrence probability of the simulated flood event. Beside the calculation of direct damages at buildings, alternative hazards assessments can be incorporated and displayed in the web portal, e.g. stability evaluations of people or cars in floodwaters.

4. Conclusions and perspectives

Within the FloRiCiMo project a new approach of interlinking semantic 3D city models and hydronumeric models was developed. The methodology and tools were tested exemplarily for the City of Dresden, Germany. It could be shown that the FloRiCiMo-approach provides best opportunities for a modern and sophisticated flood risk management and bears potential for further enhancement. By utilizing the potential of semantic 3D city models, more information on the impact (hydraulic data) and on the resistance and damage side can be implemented and interlinked in the future. Perspectively, it is expected that "state-of-the-art" 2D-GIS systems of urban areas will be fully substituted by 3D-solutions with multiple functionalities in the near future.

Acknowledgements

FloRiCiMo was funded by the German Federal Environmental Foundation (DBU). Furthermore, the City of Dresden and the LHW Saxony-Anhalt contributed significantly to the project by sharing data, experiences and ideas, e.g. to identify issues and goals of the FloRiCiMo-approach with special focus on practical relevance and applicability.