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Coupling High-Resolution Flood Modelling and 3D Digital Twins for Climate Change Adaptation

Creating a Decision Support System for Flood Management in the Netherlands

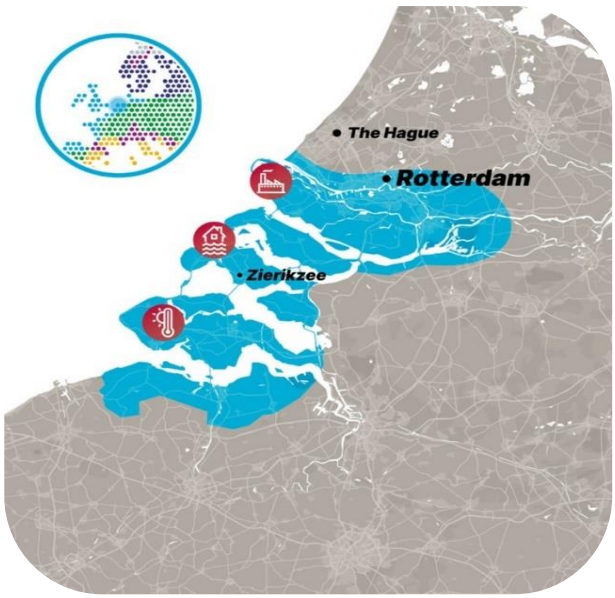
Innovative technological solutions are crucial for adapting to climate threats. In the Netherlands, a Decision Support System integrates hydrodynamic modelling with 3D Digital Twins. This system helps manage flood risks and visualise potential adaptation measures.

Key Learnings

- **Technology for flood risk management:** Rapid technological developments, such as 3D Digital Twins, and increasingly accurate hydrodynamic models play a vital role in future flood risk management. These innovations are valuable tools to mitigate climate threats as they provide detailed risk assessments and bridge the gap between experts and non-experts.
- **Citizen engagement:** Raising public awareness about flood risks begins with understanding the potential impacts. Transparent and accessible information, presented through easy-to-understand visuals, supports local dialogues and ensures that critical information is available for everyone and encourages public participation in flood management.
- **Informed decision-making:** Comprehensive flood risk data supports resilient spatial planning, quantifying potential impacts and testing adaptation strategies. This strengthens informed decision-making in the region. The Decision Support System improves disaster risk management as it provides multi-disciplinary teams with rapid information and sets a Common Operational Picture.

About the region

The western Netherlands is in a delta system at the end of multiple major transboundary rivers, including the Scheldt, Meuse, and Rhine. The region, consisting of islands, peninsulas, and estuaries, holds significant economic value due to its proximity to Rotterdam, Europe's largest port. However, it remains highly vulnerable to flooding as large portions of the land lie below sea level. Rising sea levels and increased precipitation driven by climate change are expected to increase flood risks, putting additional pressure on its flood defence systems.



Climate Hazards

Flooding

Sector

Water management

Key system

Critical infrastructure, Water Management, Health and Wellbeing

Climate Threats

The western part of the Netherlands, located near the North Sea and with large parts of the land below sea level, is vulnerable to flooding. Climate change is driving sea-level rise, increasing the threat of flooding. The Dutch research programme 'Deltaprogramma' has calculated that climate change could cause sea levels near the Netherlands to rise by up to one to two meters by 2100. Similarly, heavy rain events and intensity will drive river discharge. Storms aggravate flood risks, putting flood prevention systems under severe pressure.

The potential of technology in flood risk management

As climate threats intensify, there is a growing need for accessible information to support better decision-making. Currently, non-experts struggle to understand the complexities of climate risks, which hinders effective action.

However, technological innovations are advancing rapidly, including 3D Digital Twins, more accurate and realistic hydrodynamic models, and gamification through virtual reality. Leveraging these technologies can translate flood risk information into clear, practical insights for decision-makers and the public. This provides essential tools for mitigating the impacts of climate threats and advancing adaptation efforts.

"Innovative technologies like 3D Digital Twins can bridge the gap between complex data and clear insights, allowing everyone, regardless of expertise, to make well-informed decisions.",

Joep Grispen, Director of Technology at Nelen & Schuurmans

Coupling hydrodynamic models to 3D Digital Twins

The CLIMATE IMPETUS project team developed a Decision Support System to improve flood risk management. Hydrodynamic software models serve as the baseline system, enabling accurate modelling of flood propagation under various climate conditions. These models perform calculations at a high spatial resolution, down to 0.5 x 0.5 metres. The solution uses hydrodynamic software from 3Di water management due to its strong visuals and solid academic computational methods.

The Decision Support System integrates dynamic flood models in a 3D Digital Twin environment. Digital Twins provide a virtual 3D representation of the physical environment, created using real-world data and advanced visualisation techniques. The project team developed new software, employing open-source coding standards from the Open Geospatial Consortium to visualise water levels in three dimensions. The Decision Support System combines realistic water dynamics with high-resolution flood simulations, seamlessly integrating them into the 3D Digital Twin environment, whilst enabling exchange with other systems.

Impacts in the region

The Decision Support System incorporates gamification principles as interactivity and navigable 3D environments, to present realistic flood data in an easy-to-understand format. It enables dynamic comparisons of local flood risks and impacts across different scenarios.

As a digital replica of reality, the tool helps non-experts understand flood impacts by visualising flood events on familiar landscapes, making complex data accessible. For local experts, the system offers a reliable way to simulate, quantify and evaluate the effectiveness of adaptation measures such as floodproof infrastructures or barriers, helping shape resilient community-level actions. The results support informed decision-making in spatial planning and disaster risk management while also raising public awareness about flood risks and adaptation strategies.

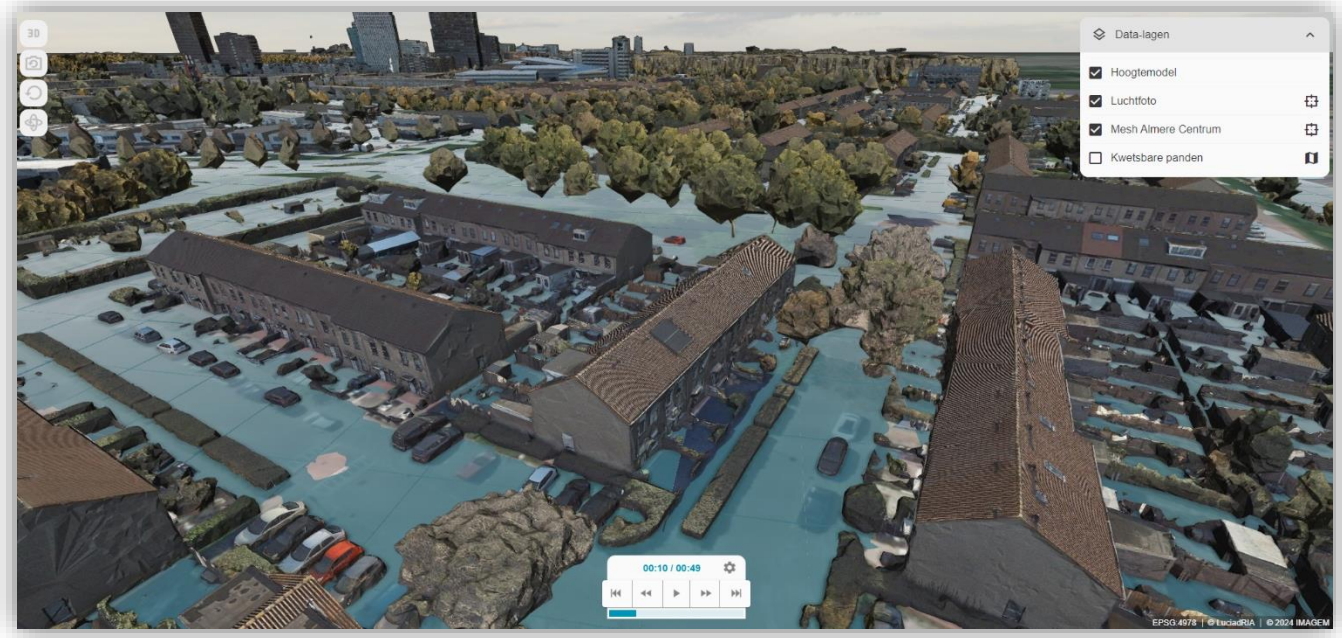


Figure 1: Visual representation of the Decision Support System, showing a realistic modelled flood event within a 3D digital twin environment. Image Credit: Nelen & Schuurmans.

Summary

Combining high-resolution hydrodynamic models with 3D Digital Twin environments enhances the ability to assess adaptive flood risk strategies in the Netherlands. Providing transparent and accessible climate risk information improves understanding for both experts and non-experts. The project team integrated multiple applications, offering a comprehensive approach to climate adaptation in Europe, leveraging the power of technology to drive progress.

Further information

The work presented in this adaptation story is part of the CLIMATE IMPETUS Mission project.

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The technology within IMPETUS builds upon the existing software part of Nelen & Schuurmans Technology.

- https://3diwatermanagement.com/

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