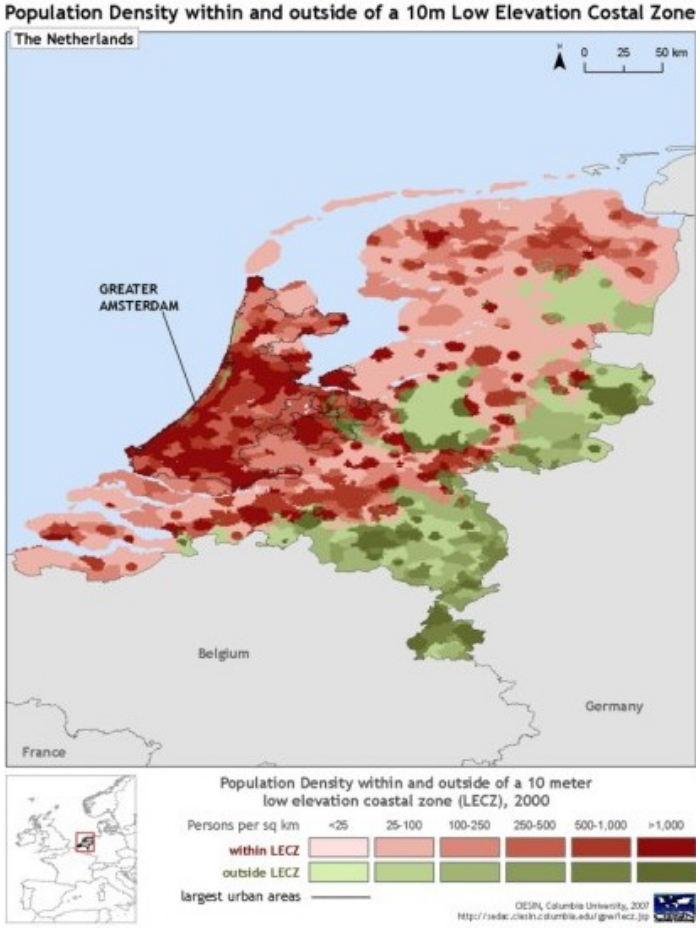
Interactive Simulation and Visualization of Realistic Flooding Scenarios

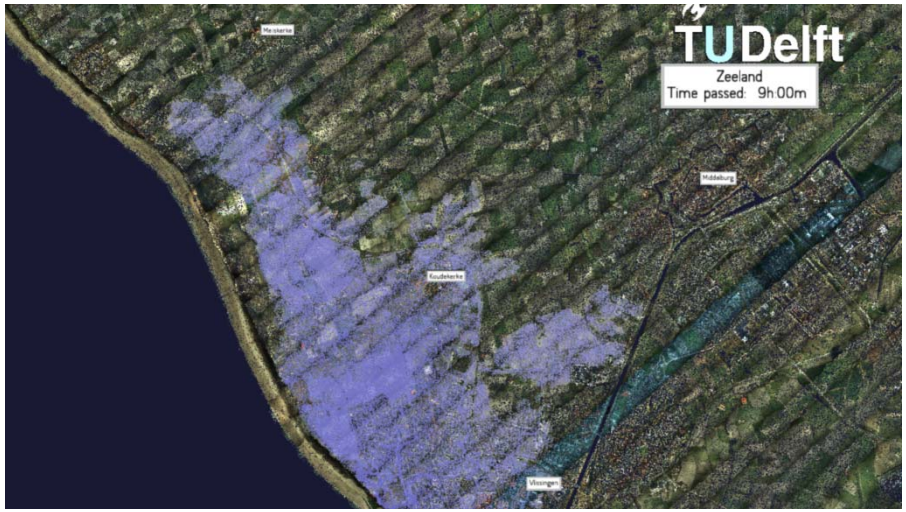
Overview

- Background
- Project Goals
- Large-Scale Point Cloud Rendering
- Interactive and Adaptive Flooding Simulation
- Geo-Information Integration
- Multi-Scenario comparative Simulation Visualisation
- Concept Assessment in Water Protection Policy Domain
- Current Results
- Future Research

Background

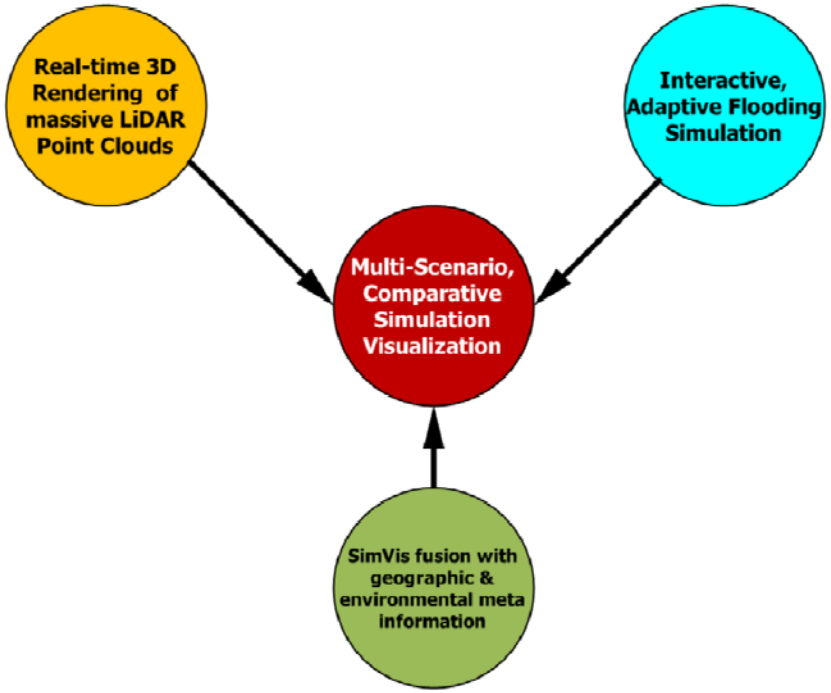


Population density of different elevation levels in the Netherlands [GPWv3/SEDAC]



Background

Which algorithms and data structures promote a multi-source, content-rich, interactive visualisation and simulation for flooding-aware environmental discussion ?



Project Goals

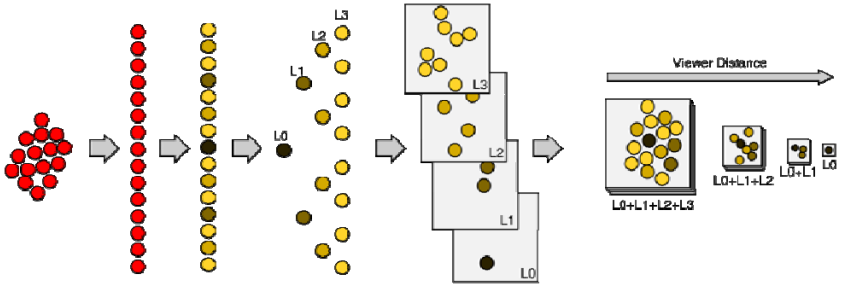
- interactive renderings of 3D geographic scenes
- interactive, steerable, accurate flooding simulations
- Immediate Response System for flooding events
- promotion environmental assessment on very large-scales
- support time-dependent data insight

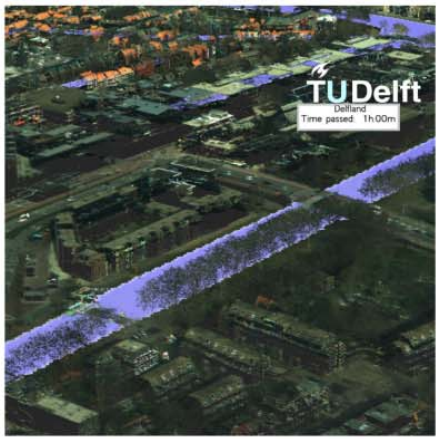
Broader project goals:

- establish 3D visualisation in water protection policy management
- Fused knowledge of GIS, hydrology and 3D visualisation
- enable analysis of historic floods for understanding of flood flow

Large-Scale Point Cloud Rendering

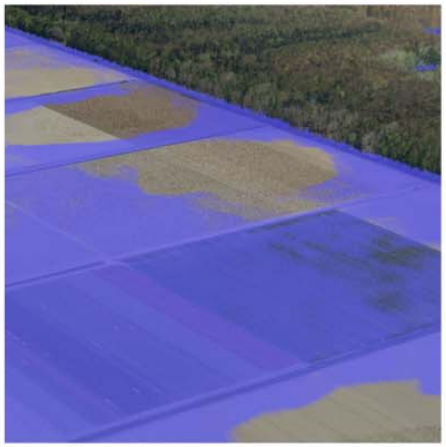
- tiled, hierarchical, paged tree-LoD-structure
- water visualisation as blue-tone transfer function(a), realistic wave animation(b) or mesh(c)





(a)

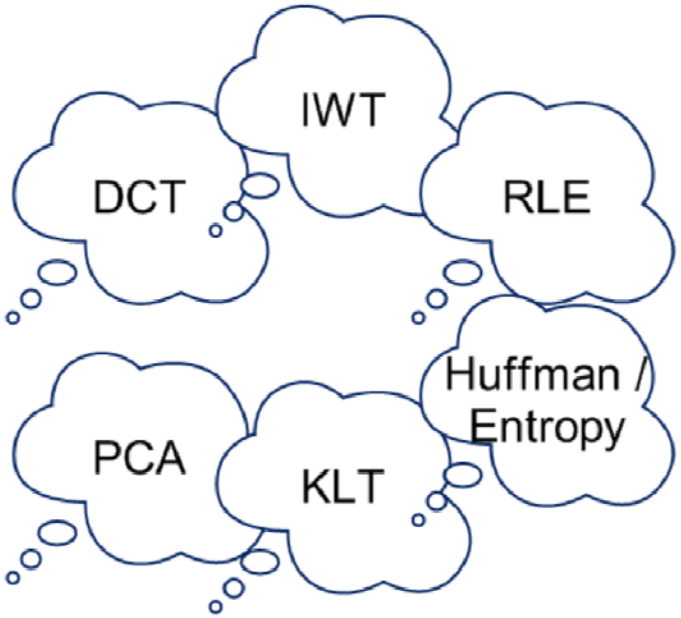
(b)

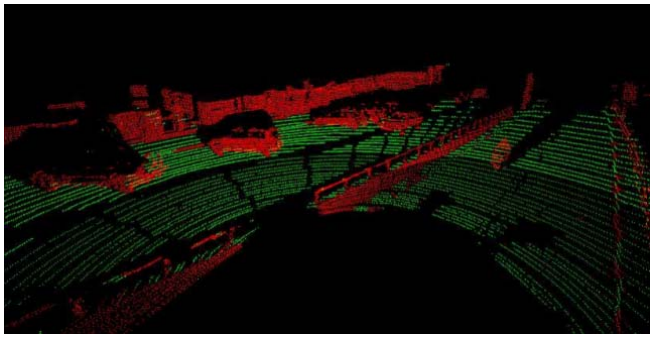


(c)

Large-Scale Point Cloud Rendering

- future work to overcome drawbacks
- Point Cloud compression
- feature adaptive sampling
- from uniform tree structure to Labelling and adaptive trees





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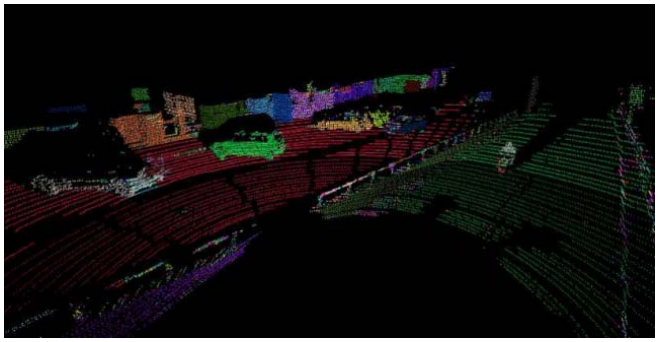
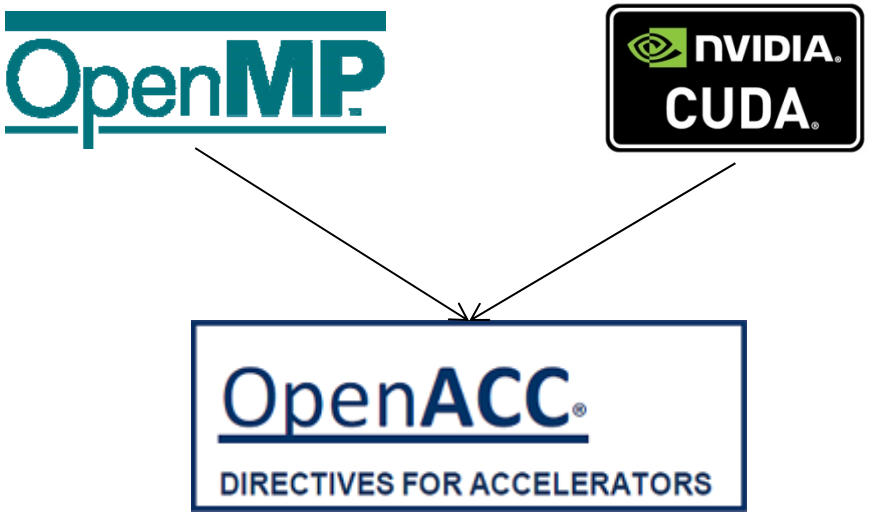


Interactive and Adaptive Flooding Simulation

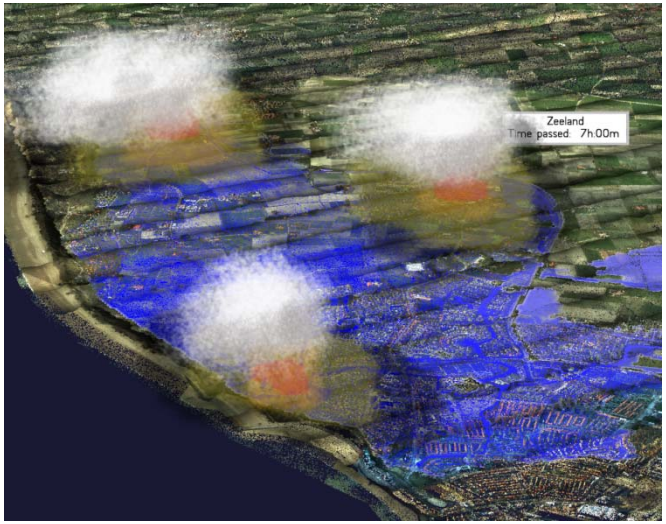
- our reference: 3Di 1D/2D finite volume shallow waters solver
- introduction of GPU acceleration → interactive simulation speed
- data reduction for simulation data
- in-situ adaptation of flooding parameters → large-scale computational steering



Geo-Information Integration

Challenges:

1. GIS operations on point clouds
2. integration of flood-related environmental phenomena (heterogeneous data)

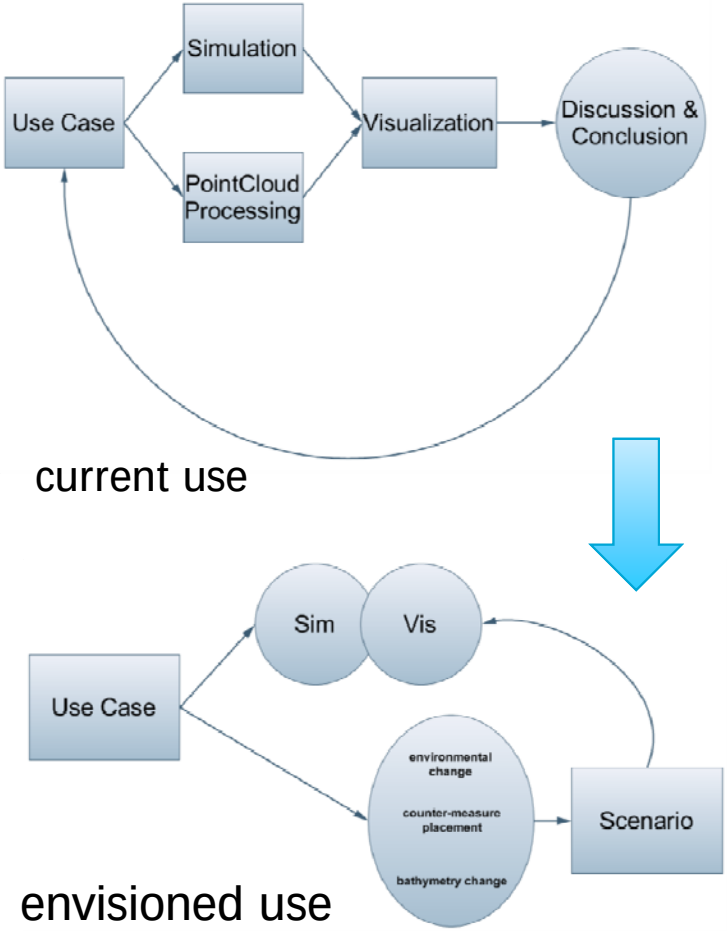


Multi-Scenario comparative Simulation Visualisation

- currently common: discussion fully prepared; no modification of use cases during discussion
- our goal: modification of diverse use cases in runtime

→Computational Steering of flooding simulation

- Advantage: direct comparison of different scenarios



Multi-Scenario comparative Simulation Visualisation

- Challenge: time-dependent simulation modification
- adaptation possibilities of simulation visualisation:
  - water levels
  - terrain heights
  - object placements (i.e. counter-measures)
  - simulation parameters (i.e. advection, infiltration rate)
- restoration & comparison of historic floods

Concept Assessment in Water Protection Policy Domain

- application of our system at domain-specific workshops
- public feedback from museum installations with area-specific use cases
- future: Immediate Response system with hands-on user feedback

Current Results

- Delfland: 67.26 km², 8.2GB
- bird's-eye perspective: ~90 fps
- performance drops when approaching ground
- interactive behaviour stops at wide-angle view (~11 fps)
- wide-angle view important in urban environments

→improved rendering needed, in particular for big scenes

city of Delft, part of "Delfland"

Future Research

- interactive, realistic, large-scale flooding simulations
- fast large-scale LiDAR rendering
- point-based GIS operations
- time-dependent simulation adaptation
- computational steering of large-scale flow simulations
- integration of environmental phenomena in visualisation and simulation