

# Dutch Water Intelligence: Adaptation, planning and design against climate change

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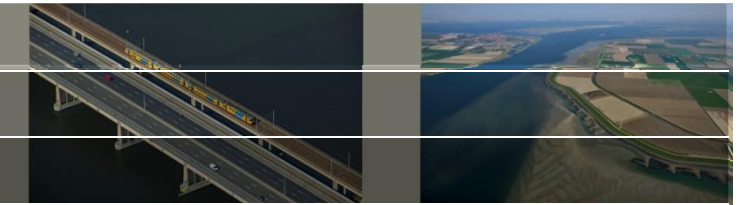
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Strategic advisor



# This presentation

- The Netherlands
- Dutch Water Intelligence
- Applied research Institute Deltares
- Modelling support APD
  - Delft3D (Flexible Mesh)
  - Cascade effects
  - AST





# The Netherlands – the lowlands

Safe delta  
Unique nature



Important  
economy



Beautiful  
landscape



Attractive to live

**Deltares**



# The Netherlands – the lowlands

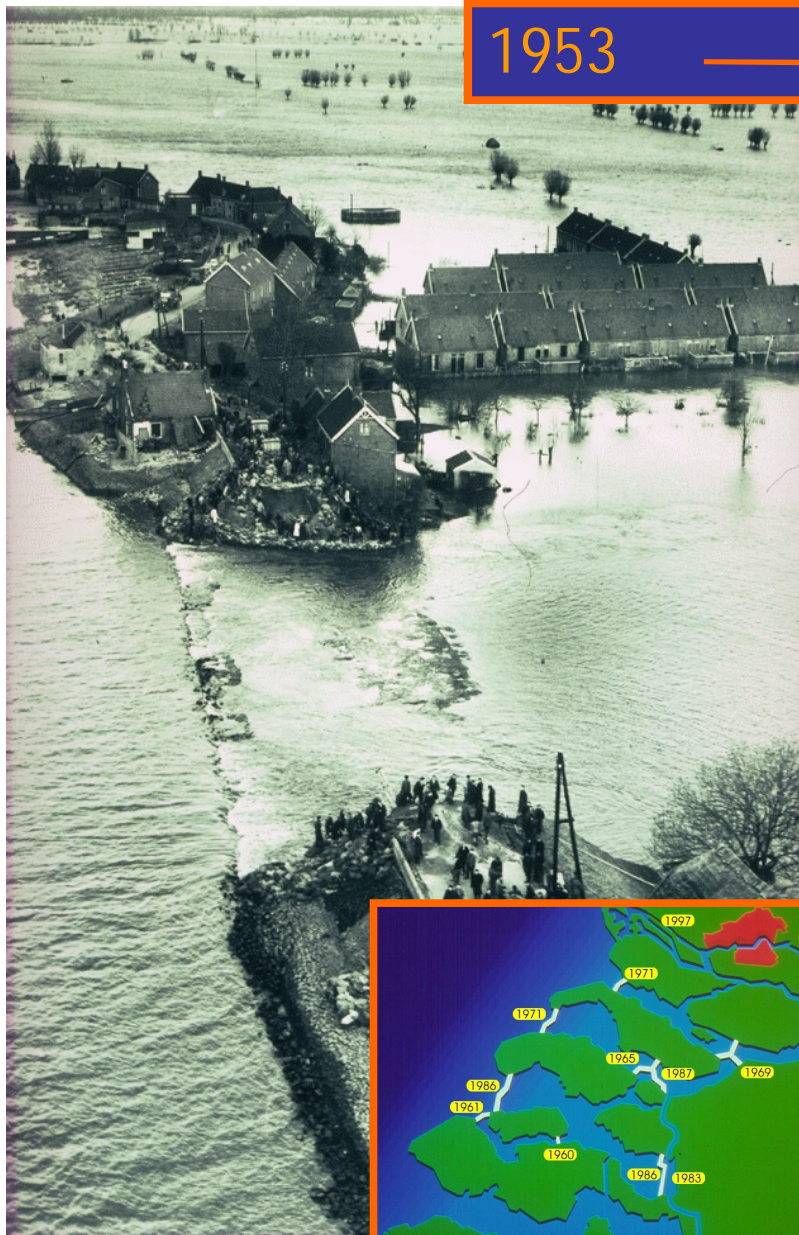




# Dutch response (1st delta commission)

1953

1997



Eastern Scheldt closure (1986)  
2500 M€

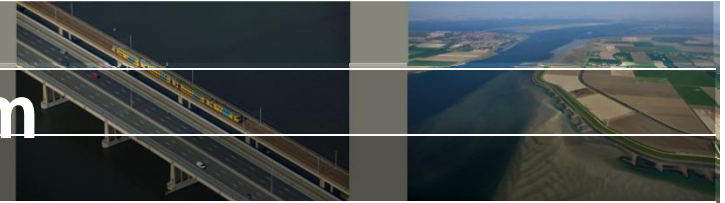


Maeslant closure (1997) 450 M€





# Protection of port of Rotterdam



## Example: “tipping point” Maeslantkering



1/10 per year →

Sea level rise

+ 75 cm: 1 /y

+ 150 cm: 10 /y

+ 300 cm: 100 /y

→ Increasing  
coincidence with  
river floods



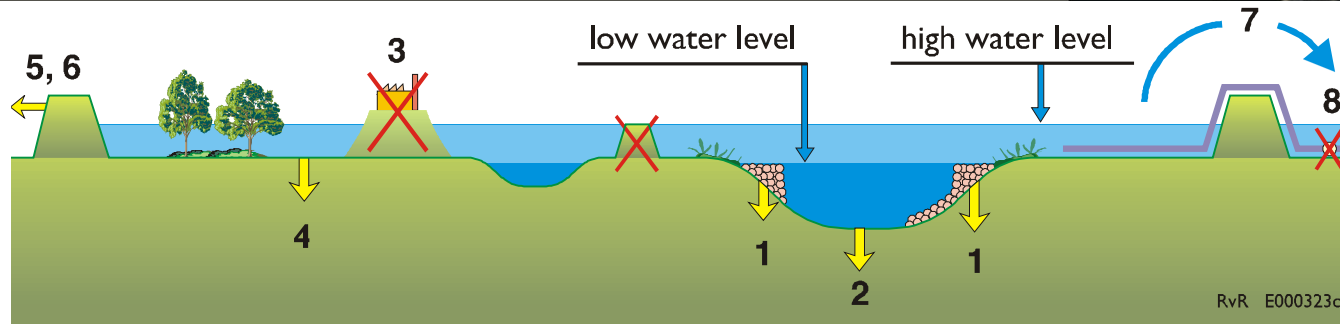
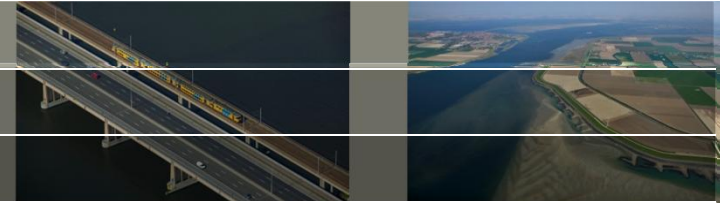
# Rhine flood threat 1995 – wake-up call

- 1/100 year Rhine floods
- True safety much less than 1/1250
- 250,000 persons evacuated
- Potential damage up to Euro 18 billion





# Room for the River

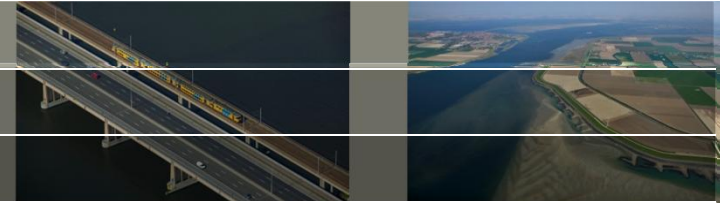


- 1 - lowering of groynes
- 2 - deepening low flow channel
- 3 - removing hydraulic obstacles
- 4 - lowering flood plains
- 5 - locally setting back dikes
- 6 - setting back dikes on a large scale
- 7 - detention reservoir
- 8 - reduction lateral inflow

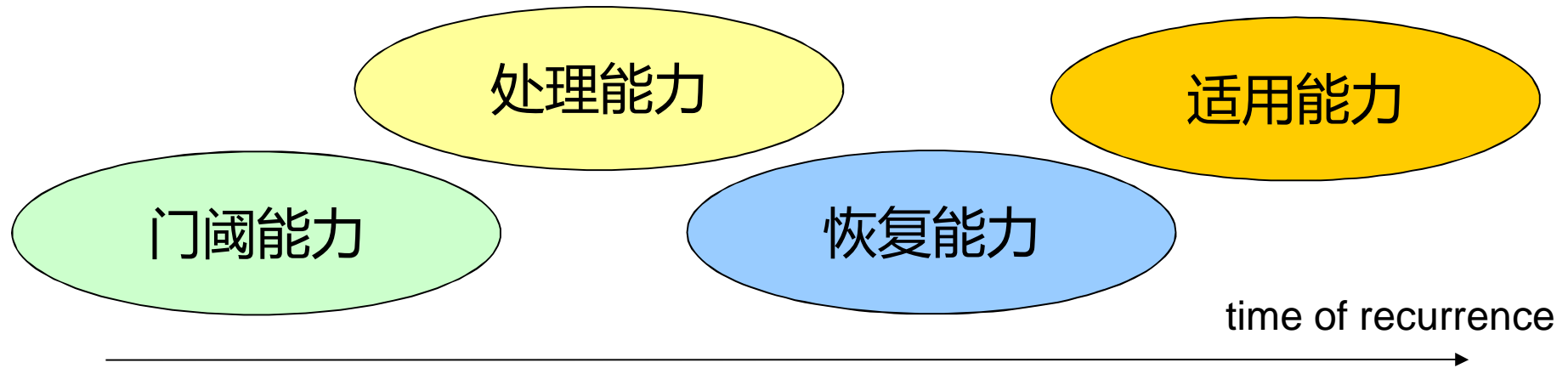




# 降低洪水脆弱度的策略

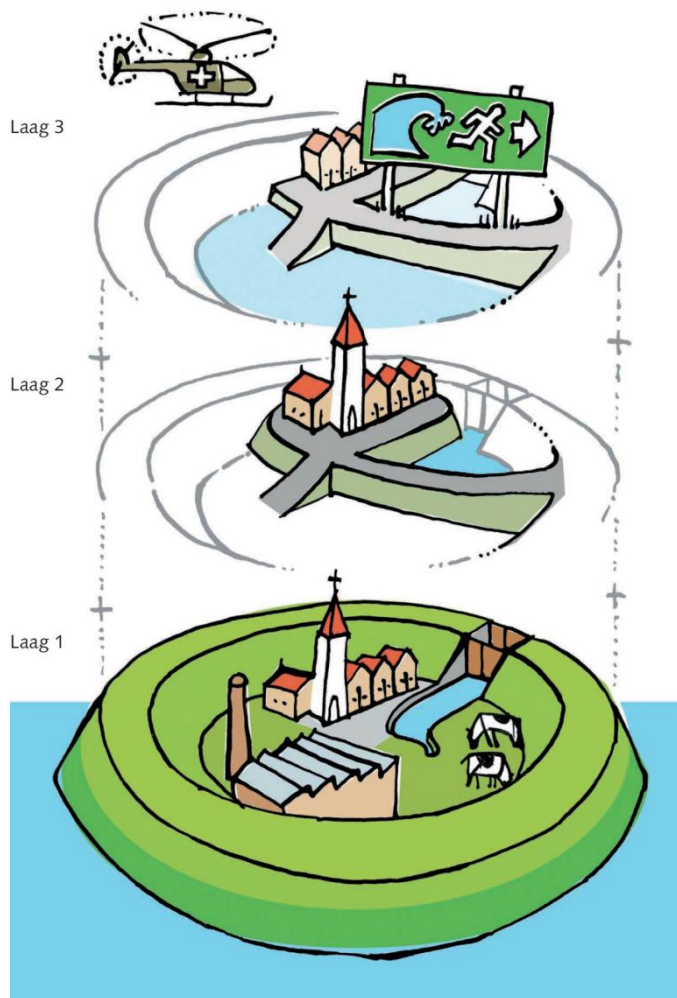
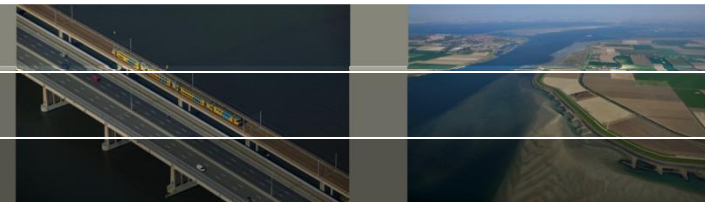


四种减少脆弱度的能力:



\* Graaf, R. de, N. van de Giesen and F. van de Ven, 2007, Alternative water management options to reduce vulnerability for climate change in the Netherlands, Natural Hazards nov.

# 荷兰的多重保护策略



## 多重保护策略:

**阶段三：  
有效洪水预警和应急预案**

**阶段二：  
突发大洪水的空间规划**

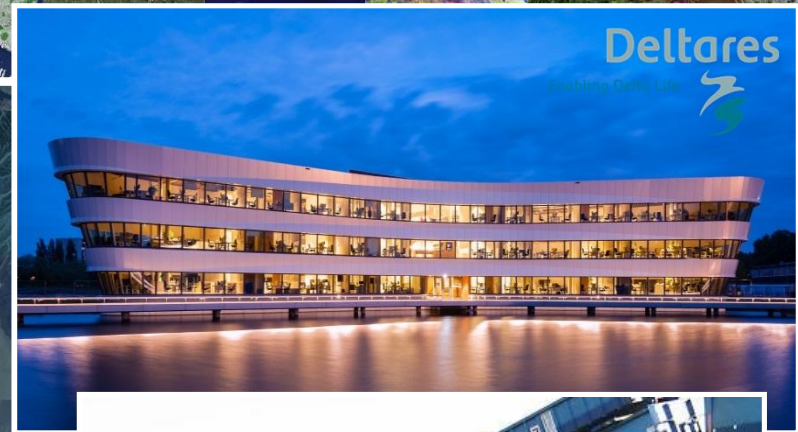
**阶段一：  
防洪**



# Deltares

Deltares is a **not-for-profit, independent and internationally operating research and specialist consultancy institute**, incorporating advanced expertise on water, soil and infrastructure issues.

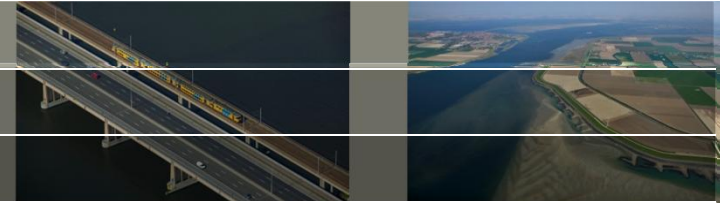
Deltares is at the forefront in the global development, distribution and application of expert knowledge and software (**open source, freeware, open knowledge sources,...**)



The Netherlands - the Lowlands



# Deltares innovative modelling

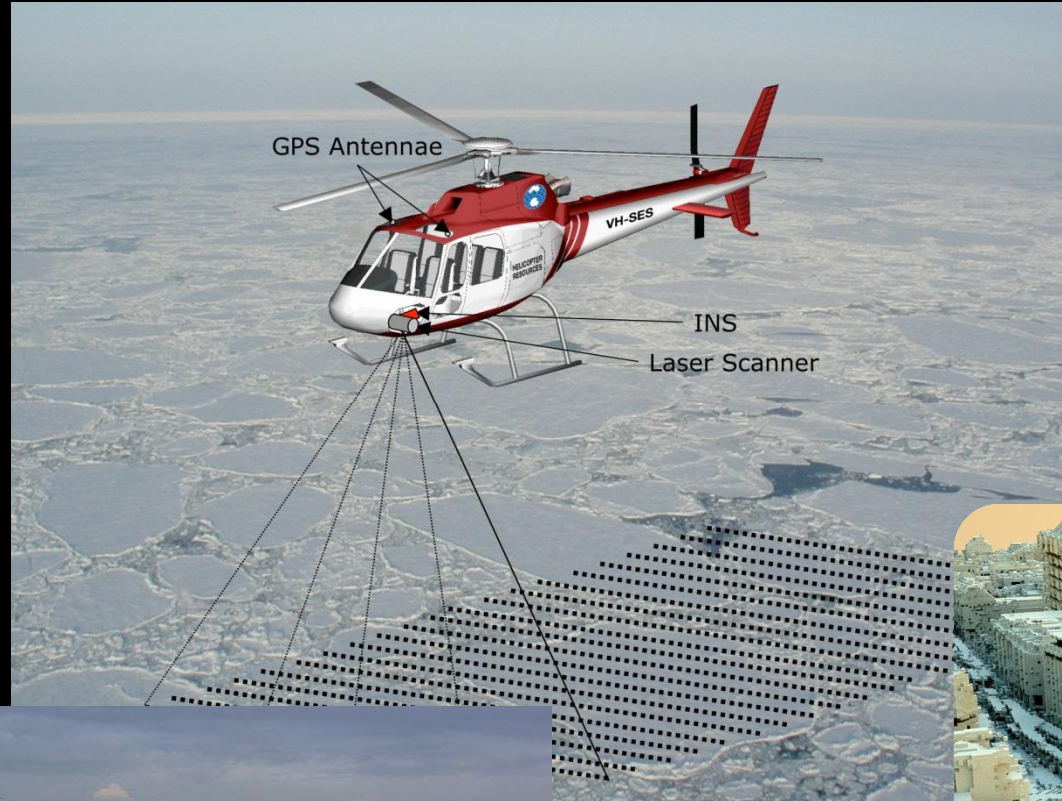
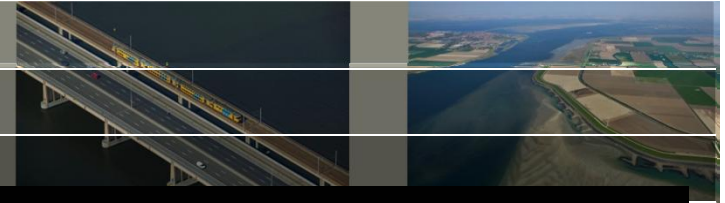


**Comprises a number of innovative, interrelated developments**

- **Interactive calculations**
- **Calculation in the cloud**
- **Accurate and fast (100 – 1000 faster than any commercially available software system)**
- **Realistic visualization**
- **Organization of modeling:**
  - ✓ **Propagation of floods / disaster management**
  - ✓ **Climate adaptation**
  - ✓ **Spatial Planning**



# Innovative software systems



Drive mapping

Deltares



# San Francisco Bay - SLR island gridding





# San Francisco Bay - SLR island gridding

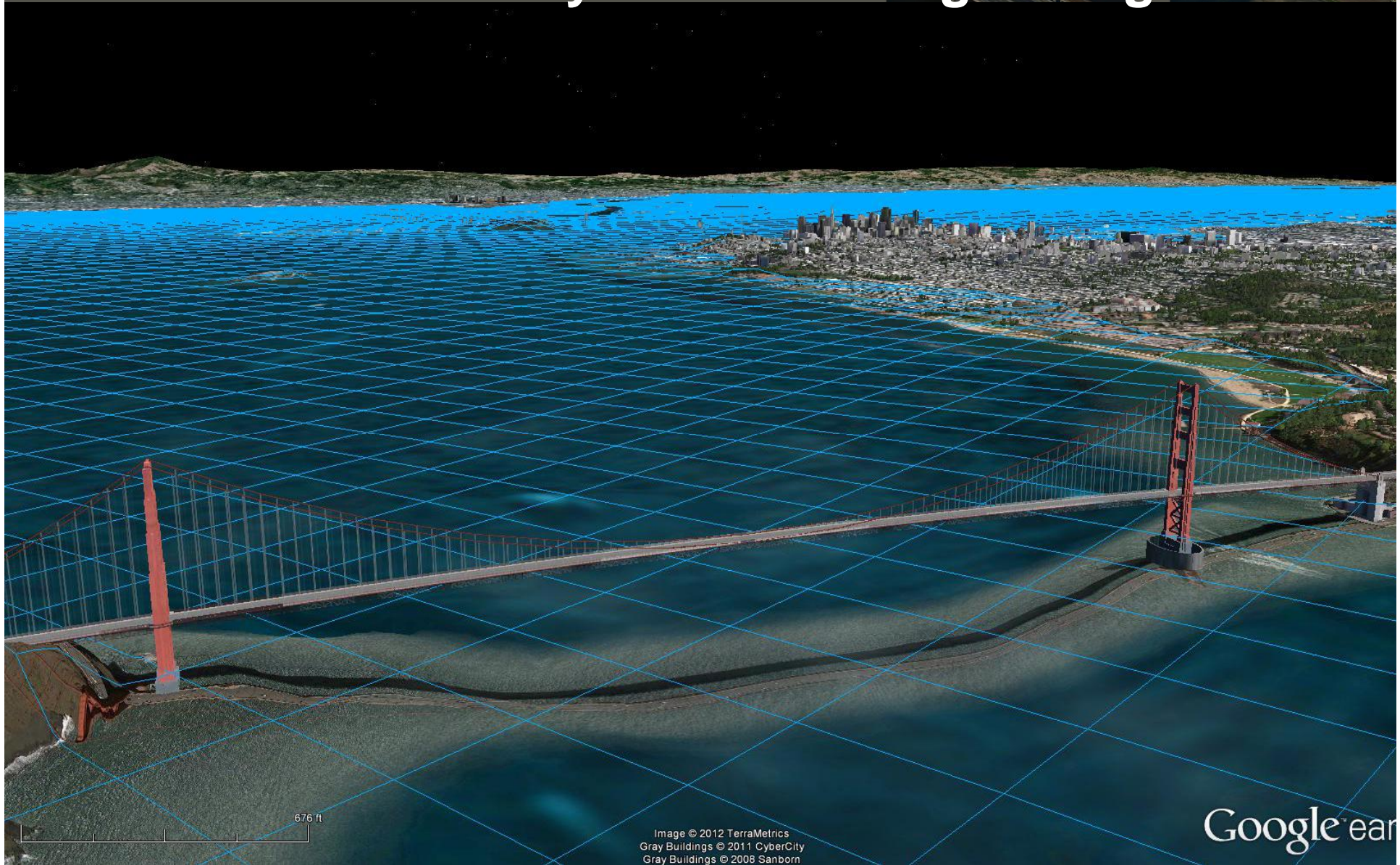


Image © 2012 TerraMetrics  
Gray Buildings © 2011 CyberCity  
Gray Buildings © 2008 Sanborn

Google™ earth

**Deltares**

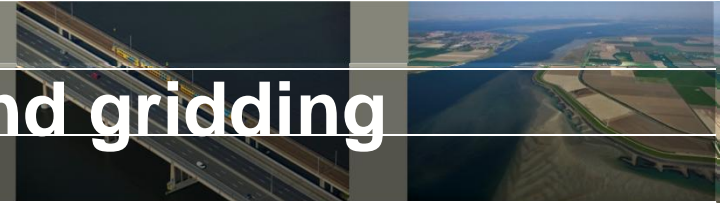


Deltas: numerous curvilinear rivers, triangles for coupling and for lakes.





# San Francisco Bay - SLR island gridding



10095 ft

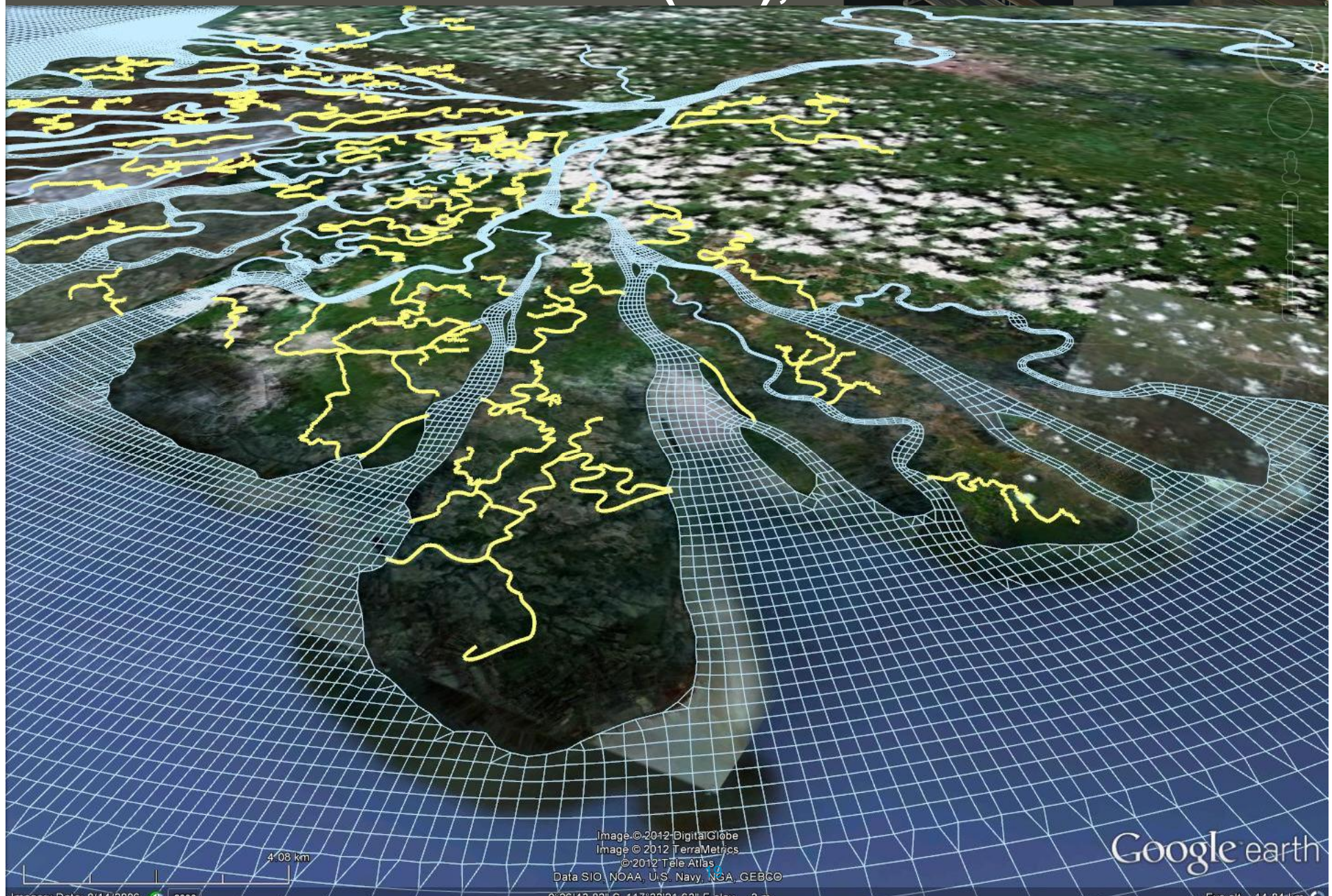


# San Francisco Bay - SLR island gridding





# Mahakam-delta: 1D-2D(-3D), Delft3D -> D-Flow FM



4.08 km

Image © 2012 DigitalGlobe  
Image © 2012 TerraMetrics  
© 2012 Tele Atlas  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

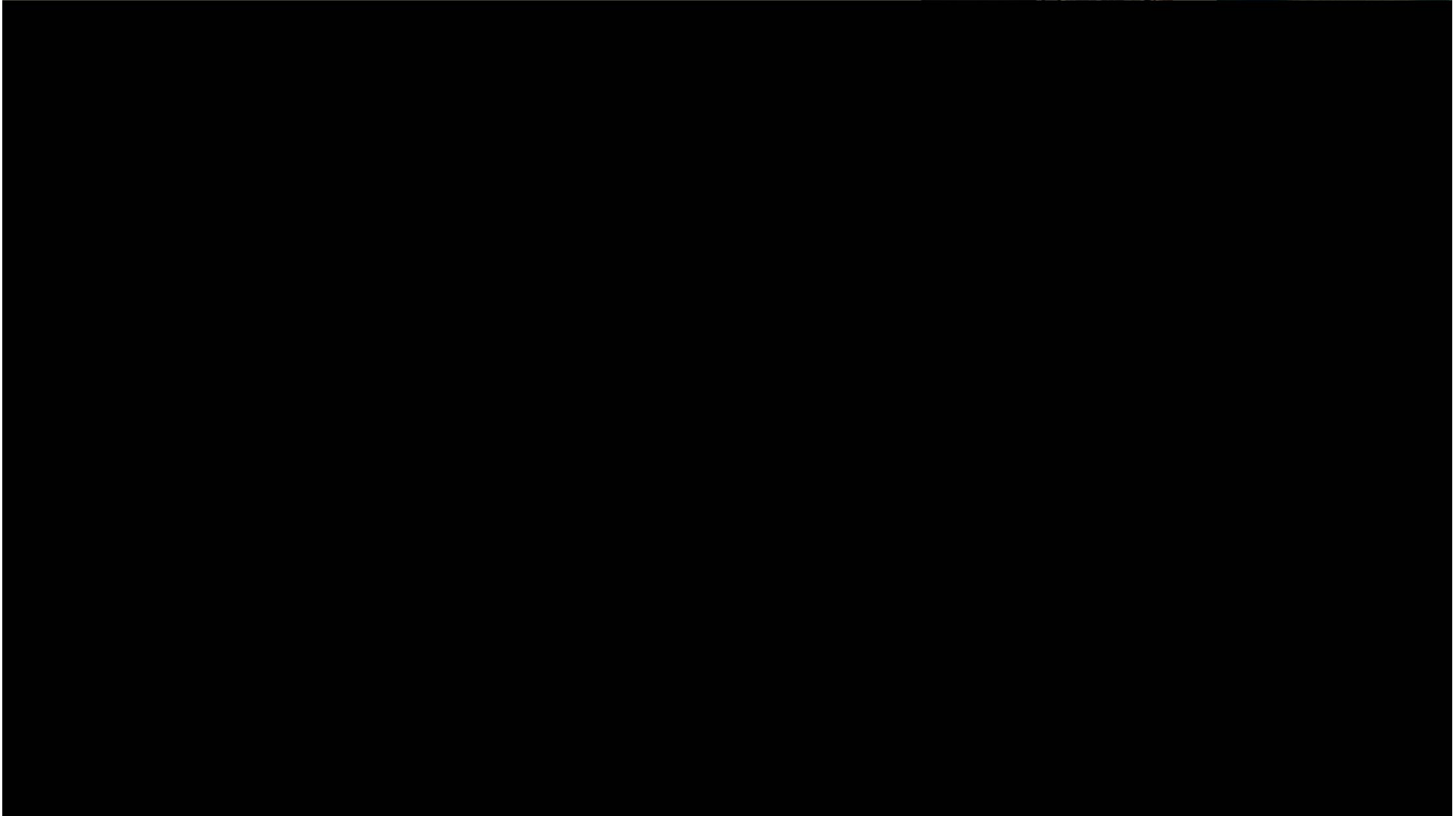
Google earth

Imagery Date: 8/14/2006

0°26'12.89" S, 117°21'31.62" E, Elev: 2 m

Eye alt: 11.64 km





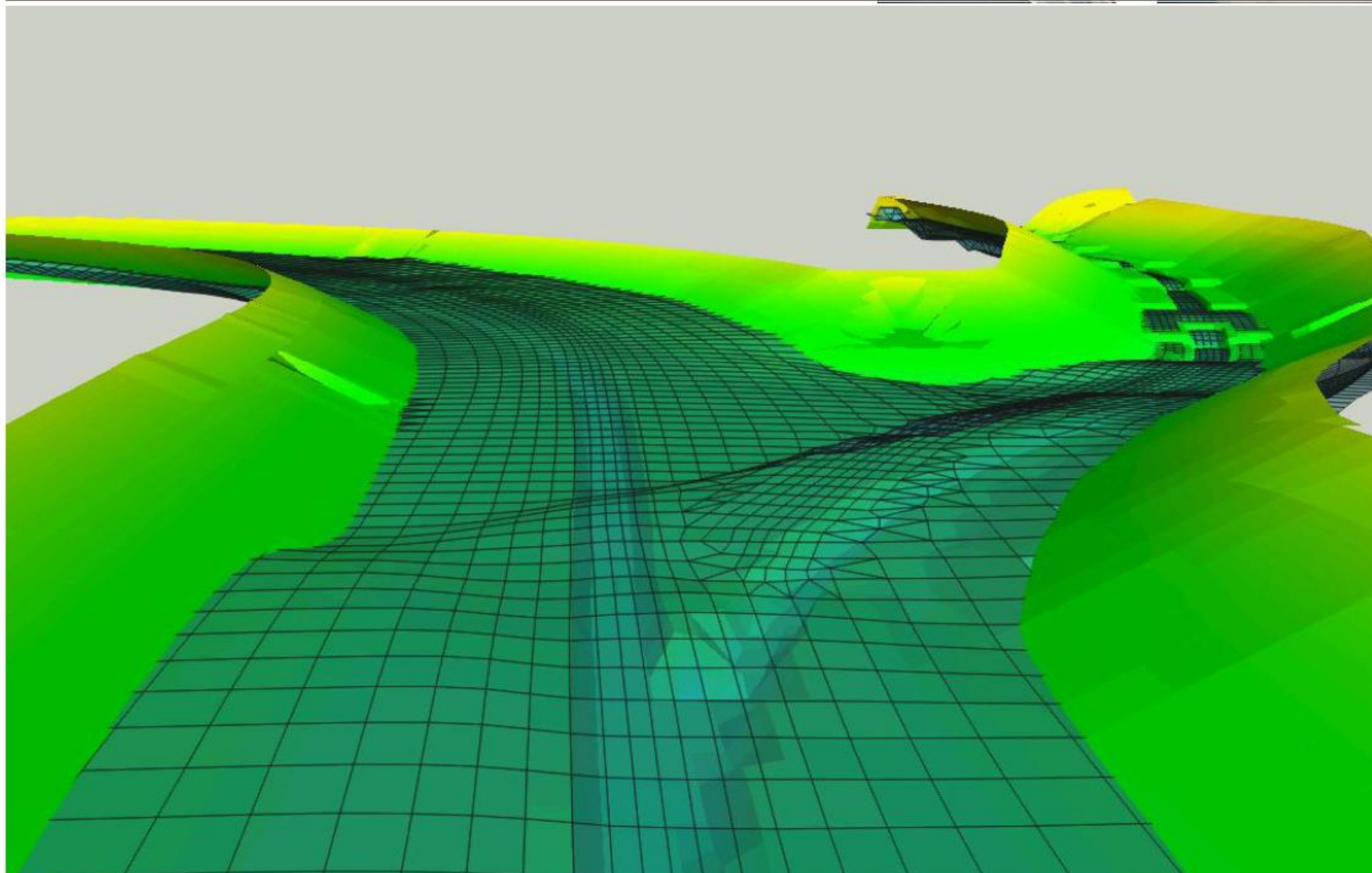
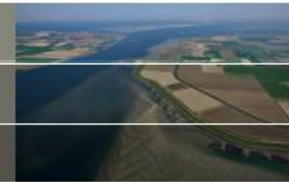


peak flows ~ 6 m/s



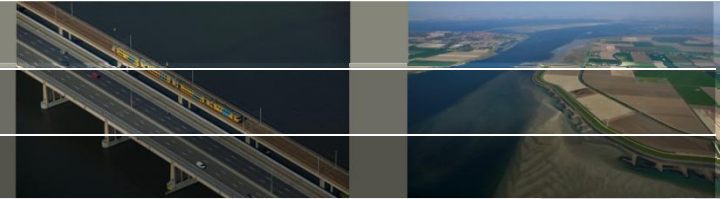


# 3D visualization of D-Flow FM results





# 3Di - Stamford catchment



- Stamford catchment is sub-catchment of Marina Reservoir catchment
- Total area of 6 km<sup>2</sup>
- Situated in main shopping district of Singapore

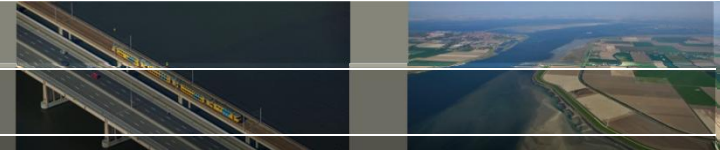


# Stamford catchment





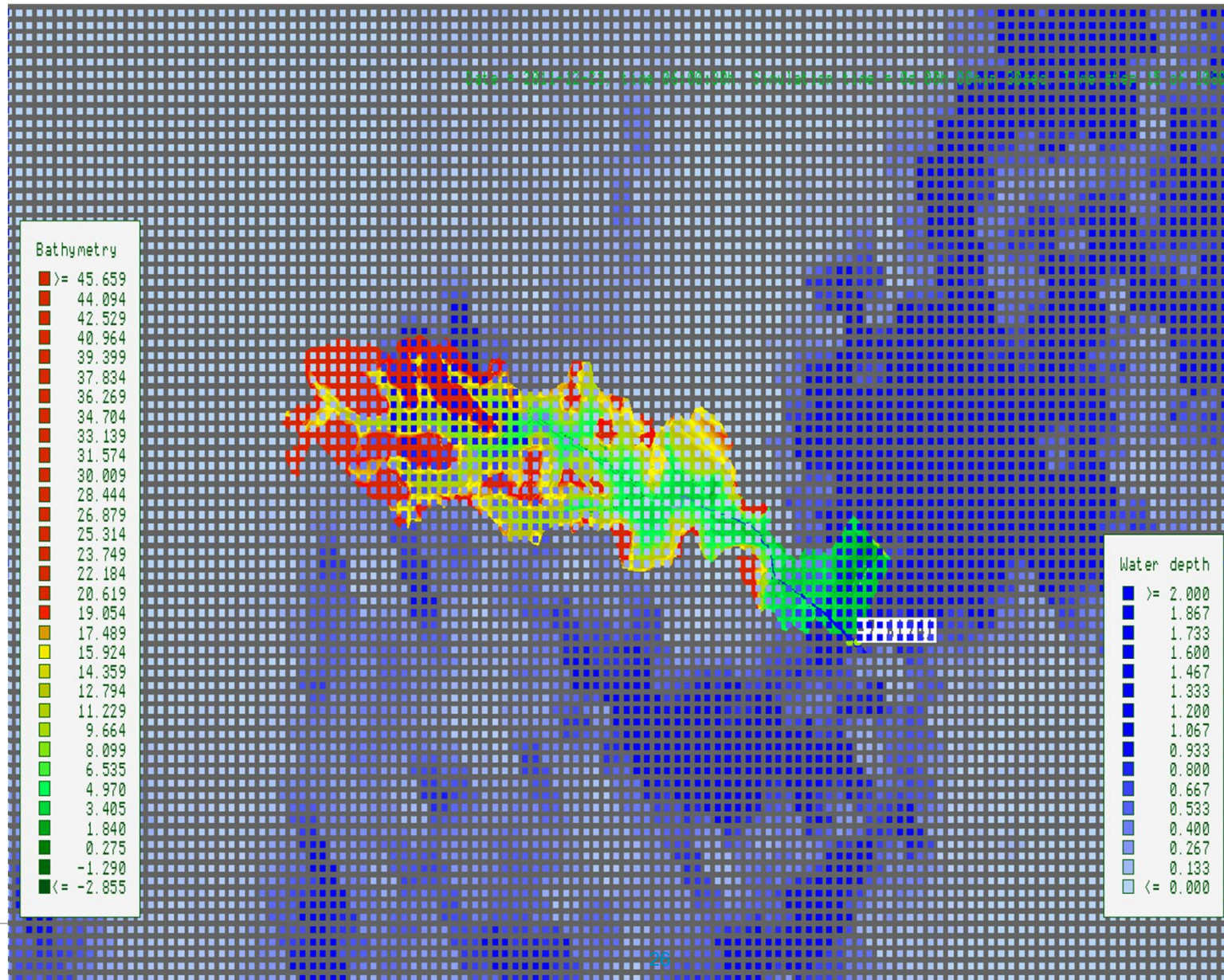
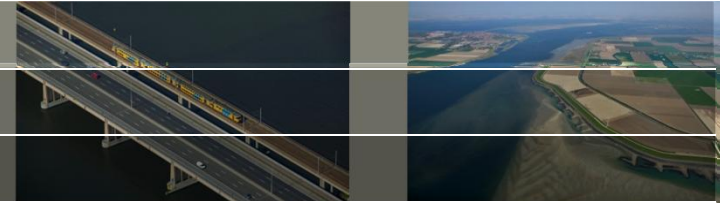
# Stamford catchment



*Runoff generated by an ordinary rainstorm in Singapore*

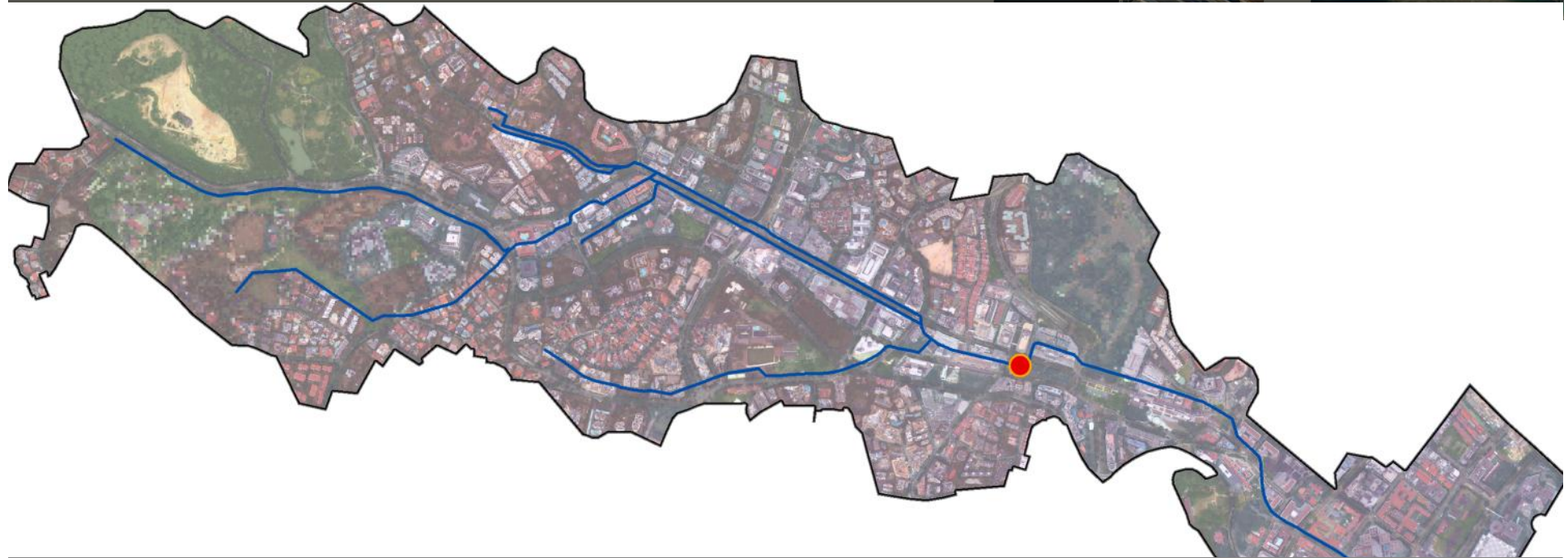
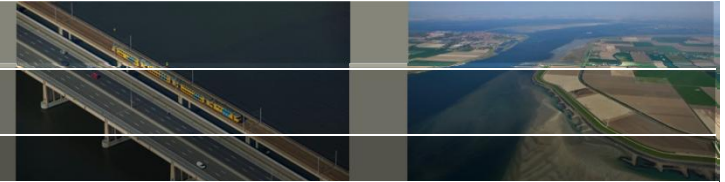


# Spatially distributed rainfall

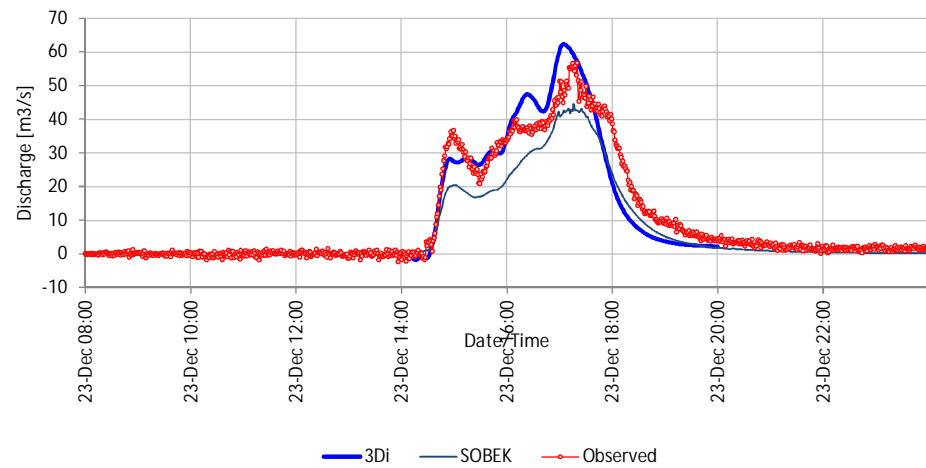




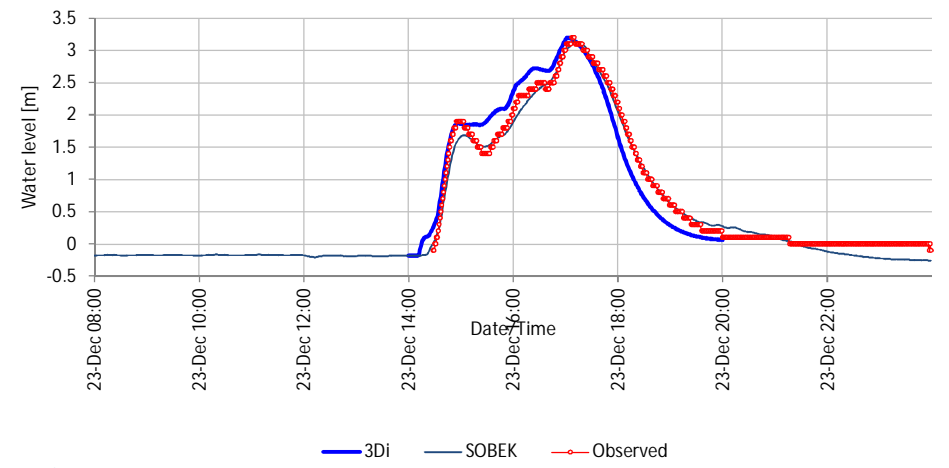
# Calibration results



HMC209 Killiney Rd

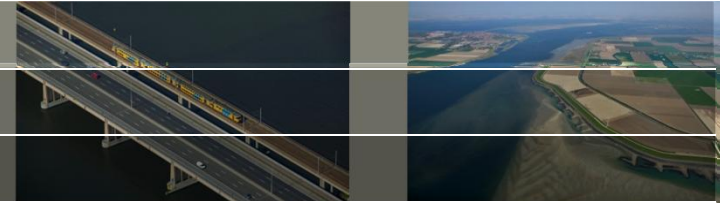



HMC209 Killiney Rd

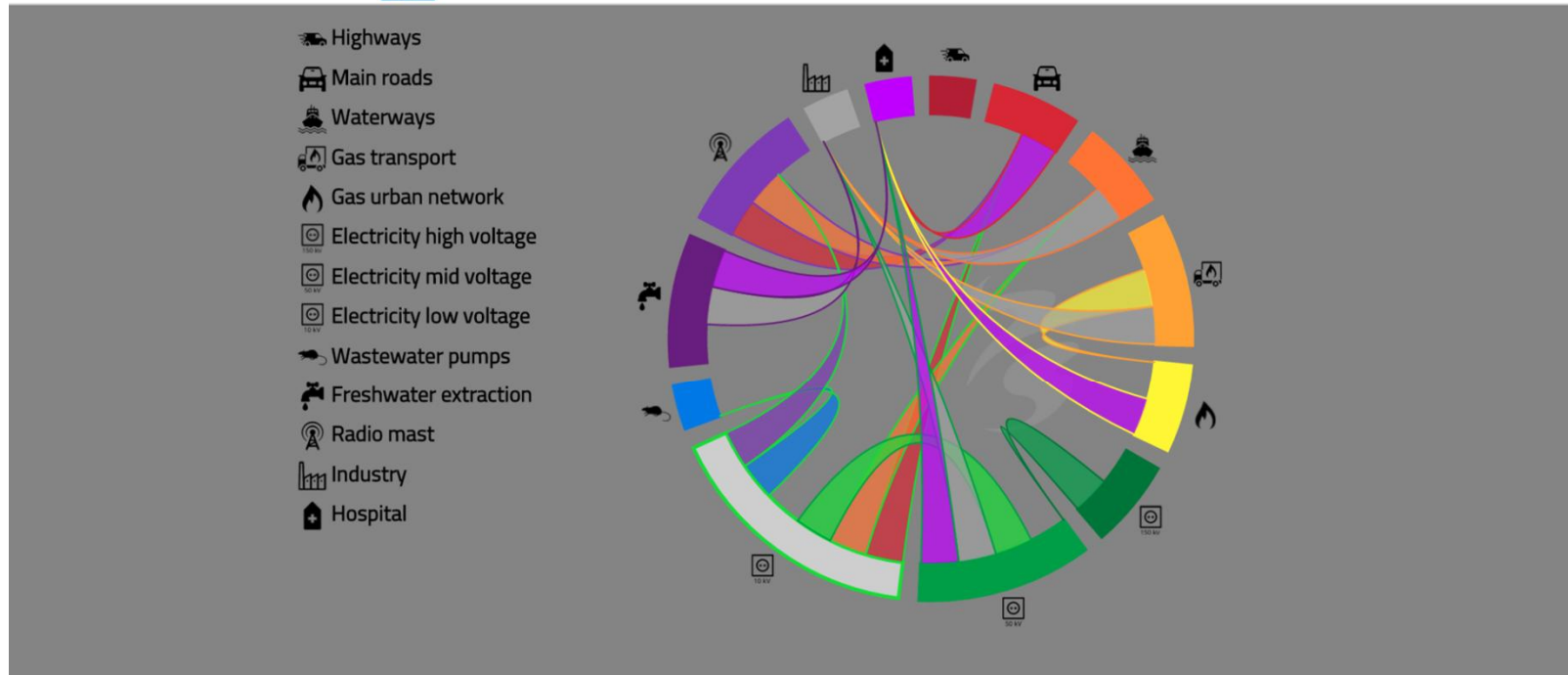




# Circle diagram



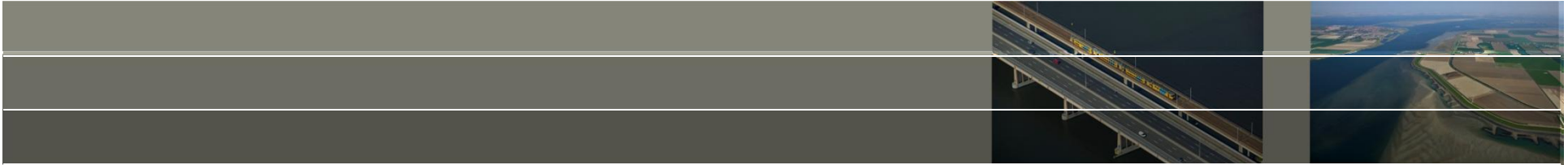
 **Circle** - Critical Infrastructure: Relations and Consequences for Life and Environment



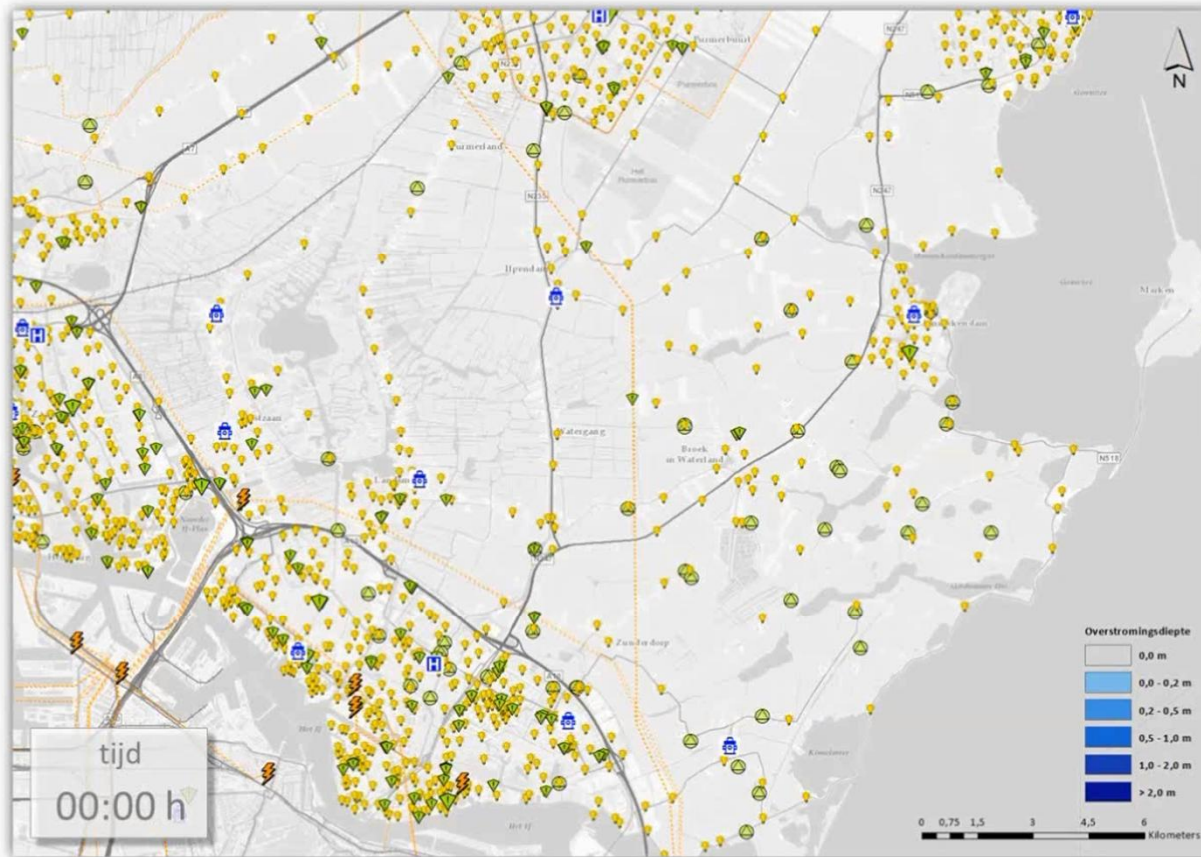
[YouTube video Rotterdam](#)

[YouTube video Cork](#)



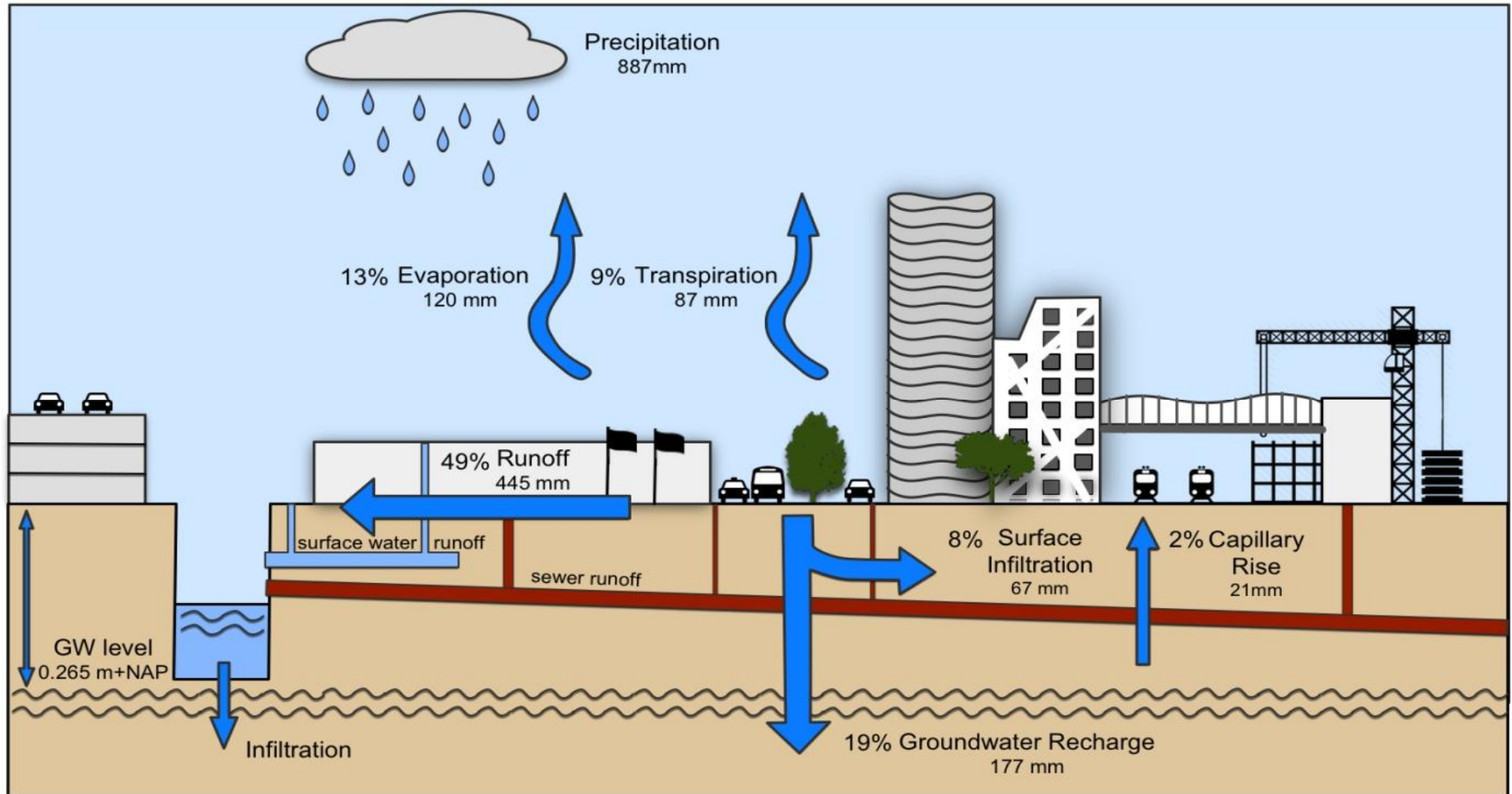


## Circle case study - Cascading-effects in Waterland 1916 – 2016



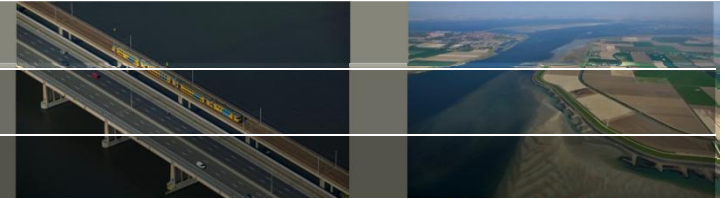


# Utrecht water system & water balance model





# Adaptation Support Tool



Ranked list of measures

Map window

Total score of measures

**Blue Green Dream**

Measures

Search measure

- 1 Helophyte filter 40.0
- 2 Increase height difference between street level and ground floor level 37.5
- 3 Private green garden 37.5
- 4 Cooling with water elements 37.0
- 5 Floating pui-plants (floatlands) 34.0
- 6 Cooling with water elements: ponds 34.0
- 7 Green shores and riverbanks 33.5
- 8 Rainwater retention pond 33.5
- 9 Green roofs with drainage delay 30.0
- 10 Extra intensive green roof 30.0
- 11 Cool paving and building materials 30.0
- 12 Wetting surfaces of

**Contribution**

Climate

- Storage cap.: 60.65%
- Reduct.: 30%
- Normative runoff: 100%
- Brought red.: 0%
- Groundwater recharge: 0%

Water quality

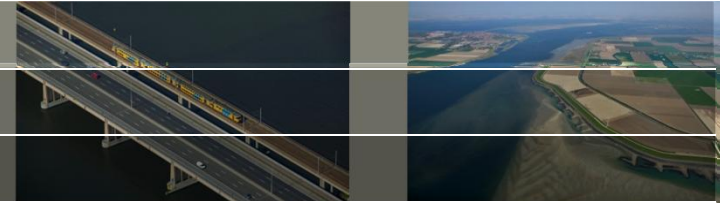
- Nutrient red.: 0.5%
- Pollutants: 9.2%
- Hydrogens red.: 9%

**Legend of implemented measures**

- Project Area
- Green roofs with drainage
- Green shores and riverbanks
- Park or urban forest
- Increase area of surfaces
- Adding trees in streetcaj
- Extra intensive green roof
- Water squares
- Porous pavement
- Urban agriculture
- Extensive green roof
- Rainwater tank



# Adaptation alternatives



- Project Area
- Green roofs with drainage
- Green shores and riverbanks
- Park or urban forest
- Increase area of surface water
- Adding trees in streetscape
- Extra intensive green roof
- Water squares
- Porous pavement

Green development

Storage capacity:  
15,600m<sup>3</sup>



- Project Area
- Green roofs with drainage
- Green shores and riverbanks
- Park or urban forest
- Increase area of surface water
- Adding trees in streetscape
- Extra intensive green roof
- Water squares
- Rainwater tank
- Porous pavement

High urban density

Storage capacity:  
12,194m<sup>3</sup>



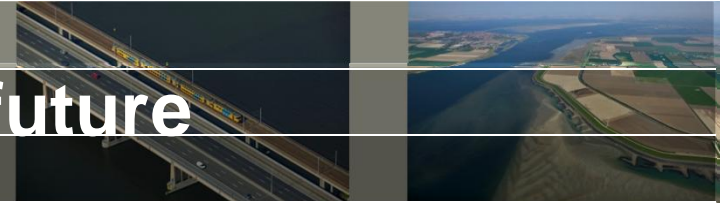
- Project Area
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- Urban agriculture
- Extensive green roof
- Rainwater tank

Maximizing benefits

Storage capacity:  
19,528m<sup>3</sup>



# Preparing Rotterdam for the future



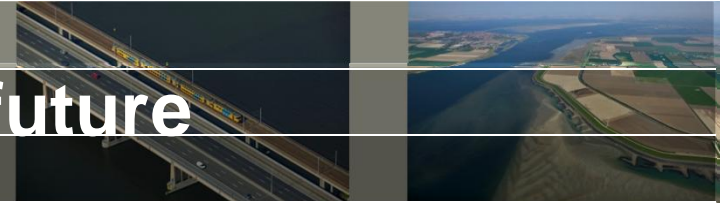
## BLUE SOLUTIONS: multifunctional



**Water Storage** and  
Residential areas  
Blue connections: ecology  
Recreation/Sports  
Underground Parking Garage



# Preparing Rotterdam for the future

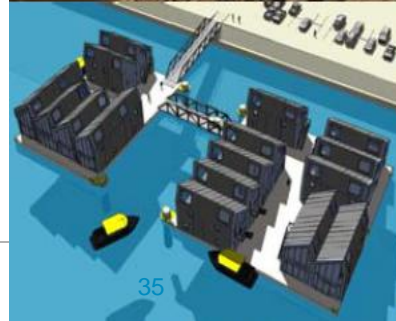




# Preparing Rotterdam for the future



Water square - Benthemplein



**ADAPTIVE BUILDING**







Thank you for your attention!