



Climate preparedness and resilience R&D activities, priority gaps and opportunities NL-Deltares perspective

Taking advantage of climate change mitigation options Preparedness and robustness to climate change risks

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Content

- Deltares perspective
- Integrated systems approach
- Hydropower, tidal, wind & thermal R&D
- R&D on protecting critical infrastructures
- Knowledge gaps and opportunities

Deltares mission

 The top-level development and practical application of expertise in the area of water, subsurface and infrastructure for people, environment and society.

Deltares facts and figures



- Legal form: Foundation under Dutch law
- Workforce: 840
- Number of nationalities: 28
- Annual turnover: 113 million euros
- Locations: Delft and Utrecht
- National and international activities
- Unique in-house facilities

Deltares R&D themes and critical infrastructures







Water & energy infrastructures

Flood defense

infrastructures



Transport & building infrastructures





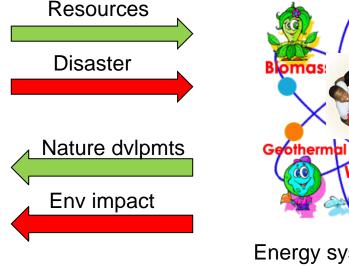
Ecosystem infrastructures



R&D to optimise oppportunities and to reduce risks



Earth systems (natural)



Energy systems (society) and food and water

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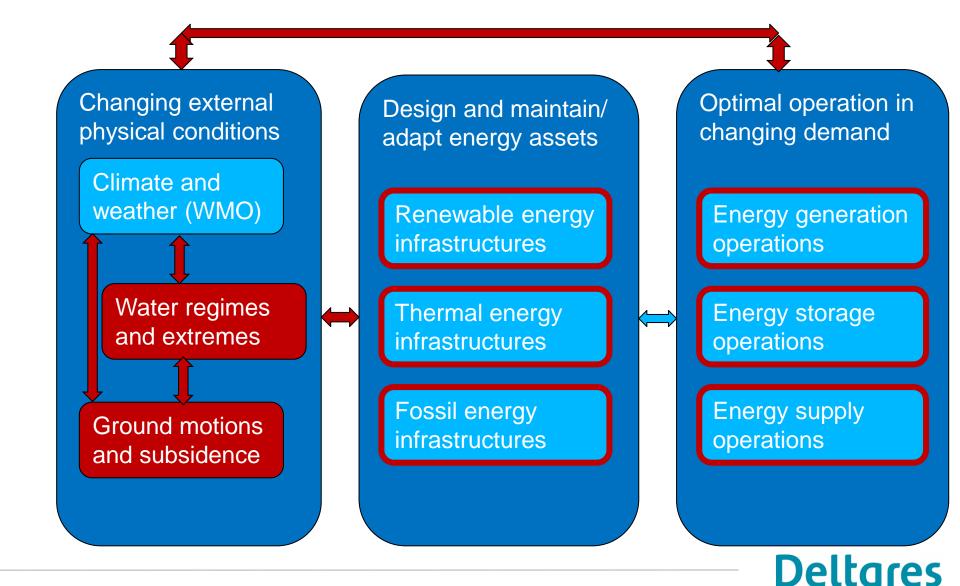
Water

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"We make assumptions about climate risk and resources when we build infrastructure.

- Invalid assumptions lead to high risk of exposure"
- Flexible investment plans can optimize value"

Earth-Energy Systems interaction



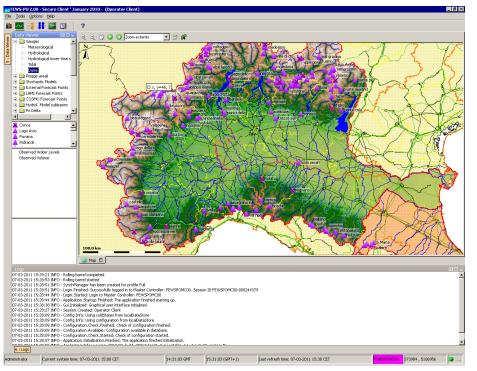
Hydropower dam design and operations

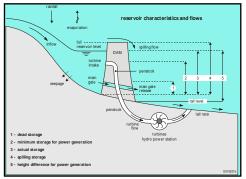
Long Term (LT) Reservoir inflow predictions

- Low-flow management and control (Sobek)
- Hydraulic in/outflow design and control (Wanda)

Short Term (ST) Reservoir inflow predictions

Weather forecasting & Hydrology (FEWS)





Key clients

- Power companies (Verbund ag, Endesa, Bonneville, EdF),
- Environmental protection agencies (UK, IT, AT, DE, NL)

Reservoir management reducing environmental risks

Water Quality Studies

- Reservoir stratification
- Algae blooms
- **Reservoir Sedimentation**
 - Volume reduction by sediment inflow

Reservoir optimization

- Operational rules
- Multipurpose reservoirs

Key clients

- Power companies (Verbund Ag),
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- Singapore and Taiwan

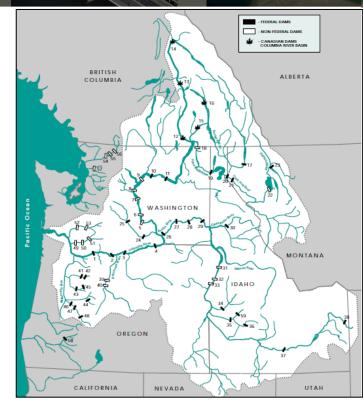






Water prediction for reducing Generation-Marketing Risks

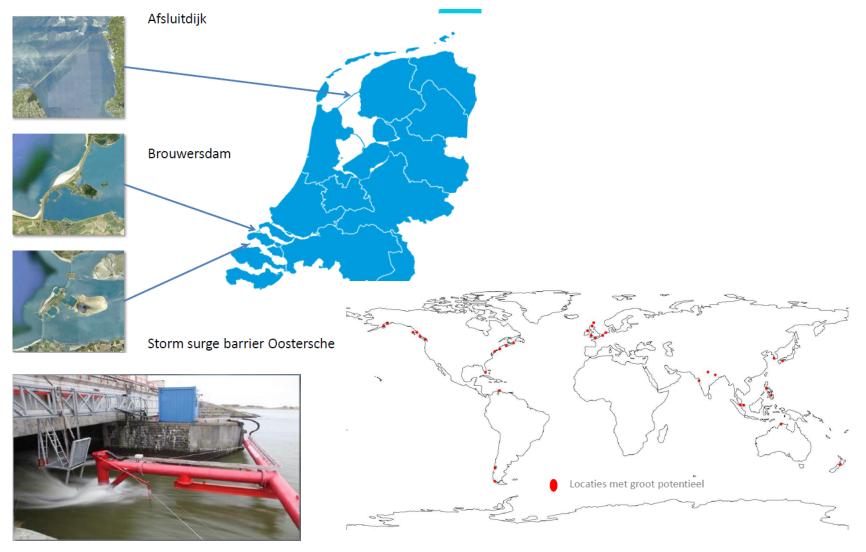
- Goal: a reliable predictive model that:
 - integrates the meteorological uncertainty of wind power, water flow and load demand
 - supports more predictive power on grid imbalance for electricity generation and storage marketing
- Case: Columbia river, >20 dams, 22 Gigawatt



Key clients:

- Bonneville Power Administration (BPA) and Companhia Energética de Minas Gerais S.A. (CEMIG)
- Deltares, Fraunhofer IOSB-AST, LACTEC (Instituto de Tecnologia para o Desenvolvimento)
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Low head tidal power feasibility and robustness in deltas



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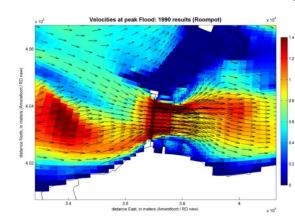
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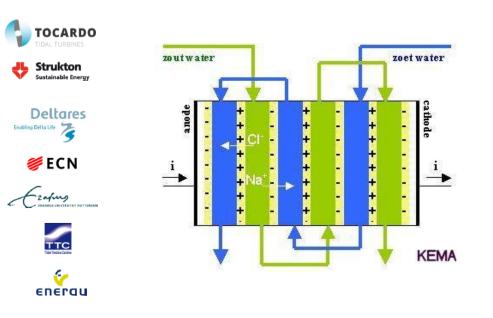
Energizing flood defenses in deltas

Tidal energy in Rhine-Meuse estuaries Performance and environmental impact of free stream turbines (Delft3D)

Blue energy (salt-fresh water mixing) in "Afsluitdijk"

Testing installations at lab and field scale Environmental impact assessment





Energy producing levees and dams



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Wind and hydrocarbon offshore JIP's

- **Oscar** (completed): offshore scour and remedial measures for grounded structures (hydrocarbon, wind)
- **Windjack** (in progress): interaction of the platform jackup legs with the seabed to enlarge installation time window
- Safetrench (in preparation): burial depth and protection of subsea cables and pipelines against ships' anchors
- Arctic (in preparation): Preventing ice gouging and iceberg collisions to wind platforms

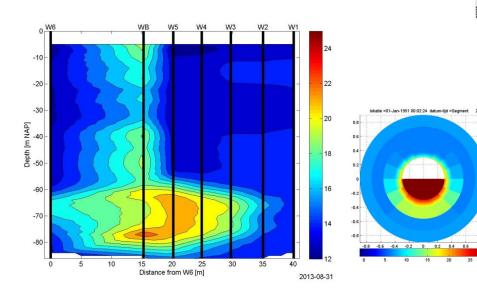




RD&D Thermal energy underground storage

Monitoring ATES Tetra

- Underground DTS
- Tracer experiments
- Building H/C system
- Optimisation rules

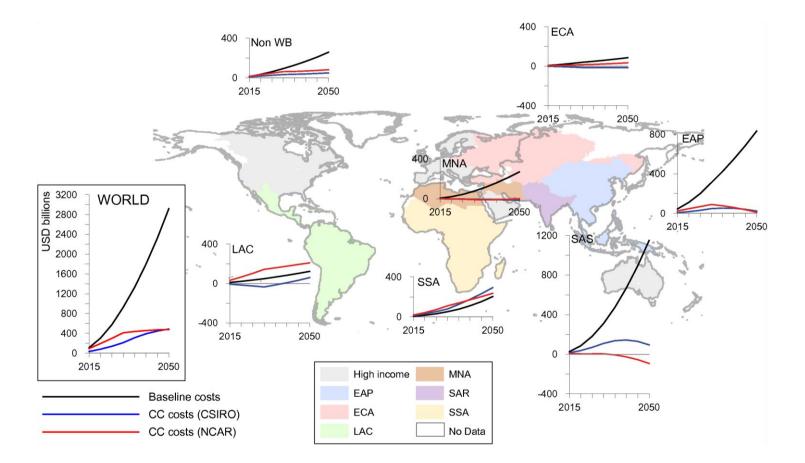




Impact climate change on critical infrastructure



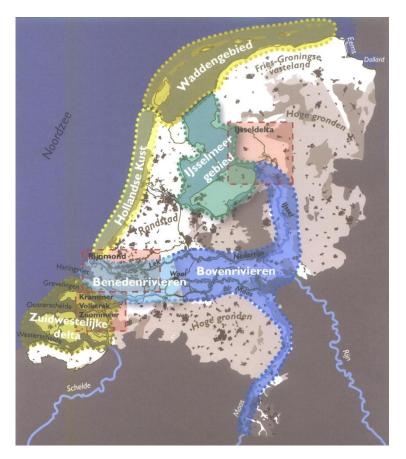
Building up resilience of critical infrastructures



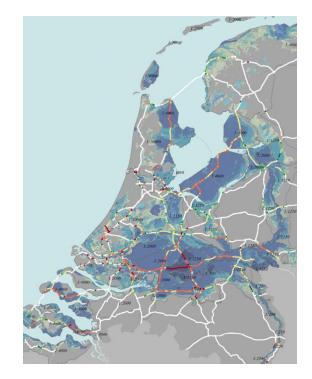
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From Ward et al. 2010, Env. Res. Lett. 5, 044011:

Impact flooding on Dutch infrastructure (Delta plan)

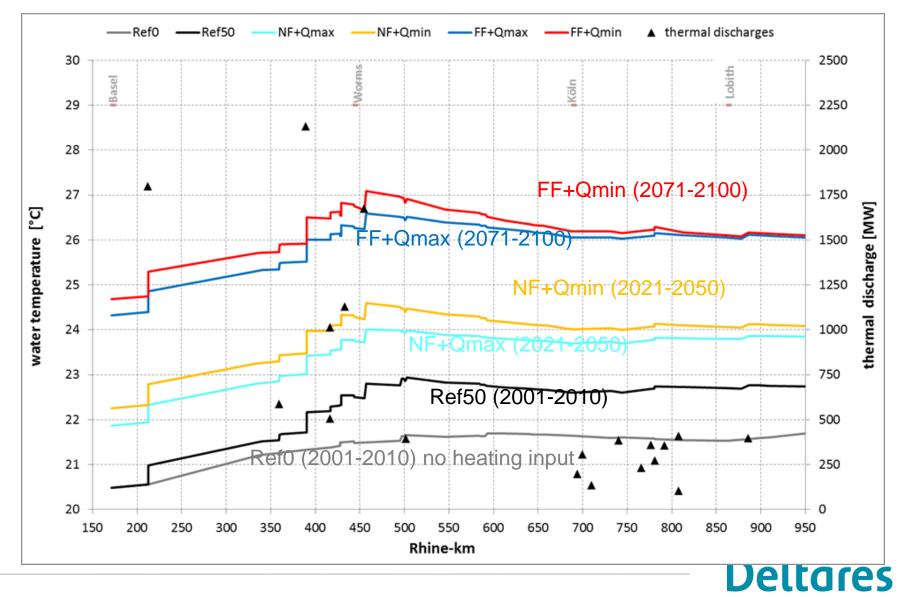


Flood defense and water retention



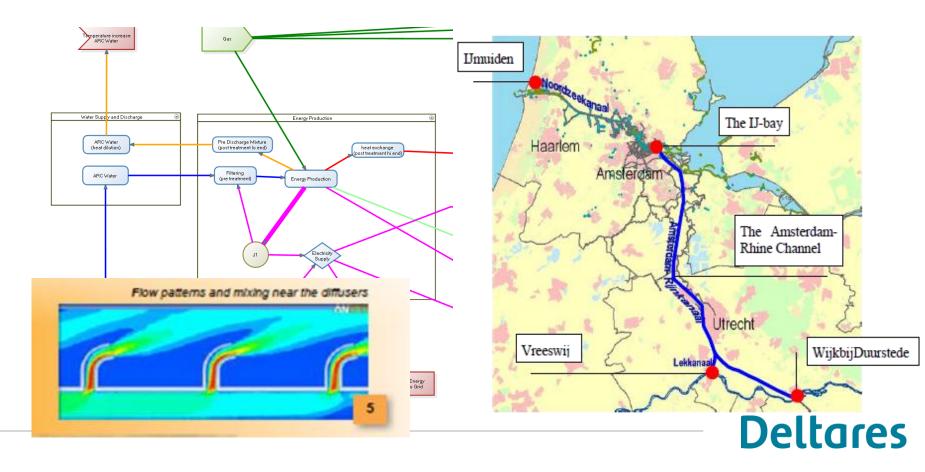


Water temperature scenarios Rhine river depending on electricity production and climate change

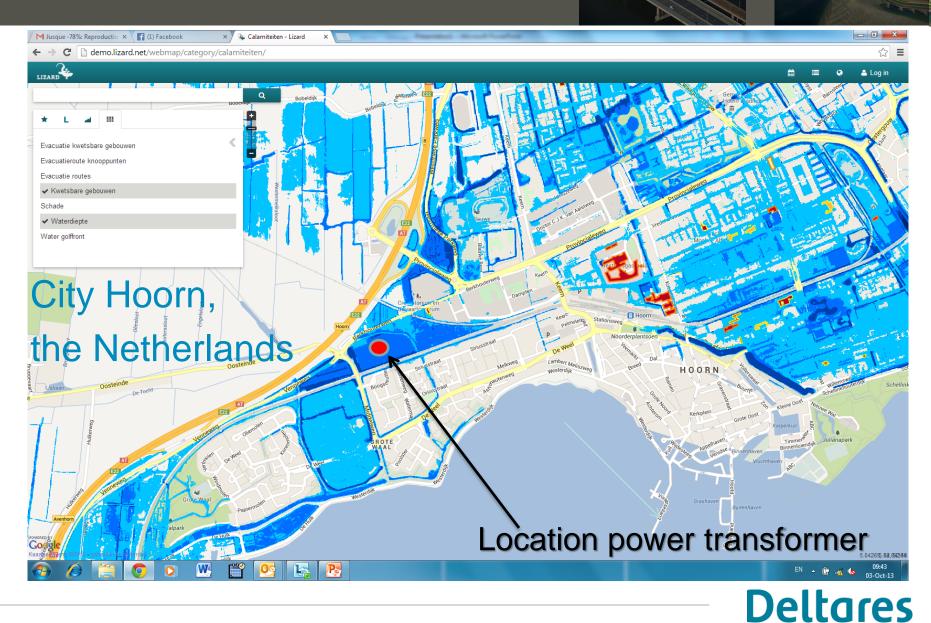


Thermal energy emission interference in Amsterdan Rhine canal

Systematic Environmental Assessment Tool (SEAT) Economic Value Added Toolbox (EVAT) Applied to cooling water case in Amsterdam-Rhine Channel



Impact flooding on electricity distribution



Shared models on physical conditions

- Understanding long term physical conditions for infra design
 - 1. From global climate models to regional and local models
 - 2. From all climate/subsurface models to water models
 - 3. Quantify land and water development/usage scenario's

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4. Sharing scenarios of and data of physical conditions?

Do not forget

- Water + groundwater
- Land motion and flooding
- Water quality issues

Climate mitigation = renewables: knowledge gaps, R&D opportunities

- Renewable energy system design constraints
 - 1. Multi functional spatial planning for renewables
 - 2. Improving renewable efficiencies
 - 3. Interference between energy systems
 - 4. Hydropower and thermal storage capacity in water bodies
- Using short term physical conditions for renewable operations
 - 1. Using RT weather/water data for energy system operations
 - 2. Integrating hydrocarbon, wind, solar and hydropower control
 - 3. Optimisation of generation/storage operations

Climate adaptation = resilient infrastructure knowledge gaps, R&D opportunities

- Design new and adapt infrastructures increasing resilience
 - 1. Fragility curves for new LT climate/water scenarios and risks
 - 2. Climate/water robust investments in new energy assets
 - 3. Timing of adaptation measures for existing assets
 - 4. Interference between energy systems

• Enlarging flexibility in existing assets coping with extremes

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- 1. Easy adaptation, growth adaptability
- 2. Using real time data of the environment
- 3. Contingency measures for extremes

Common delta or industry alone solutions

- 1. Roles of government and private sector
- 2. Insurance statistics and options

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