WACC
Dynamic Vision for Sustainable Life

Deltares
Enabling Delta Life

ON THE FLOOD AND INUNDATION MANAGEMENT OF HO CHI MINH CITY, VIET NAM

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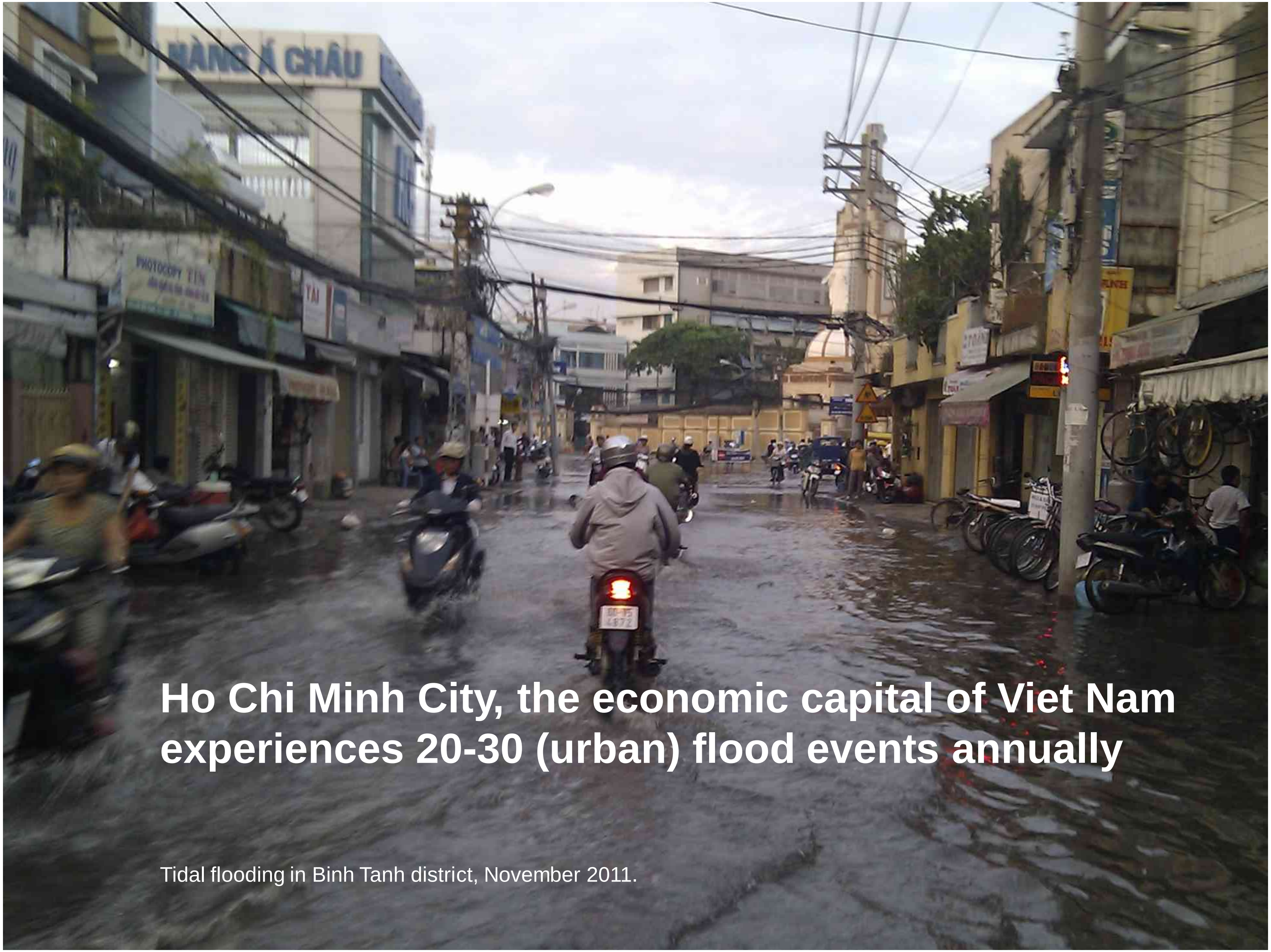
Ho Chi Minh City, the economic capital of Viet Nam experiences 20-30 (urban) flood events annually



Tidal flooding in Binh Tanh district, November 2011.

Increasing Ho Chi Minh City’s flood resilience

Viet Nam: Within the top five of countries potentially most affected by climate change.
(Daspugta *et al.,* 2008)

Ho Chi Minh City: Ranked within the top ten cities world wide in terms of exposed population affected by climate change. (Nicholls et al., 2008)

Ho Chi Minh City: Accounts for 23% of GDP and 20% of foreign direct investments. (ADB, 2010)

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Frequent flooding hampers the fast development of HCMC.

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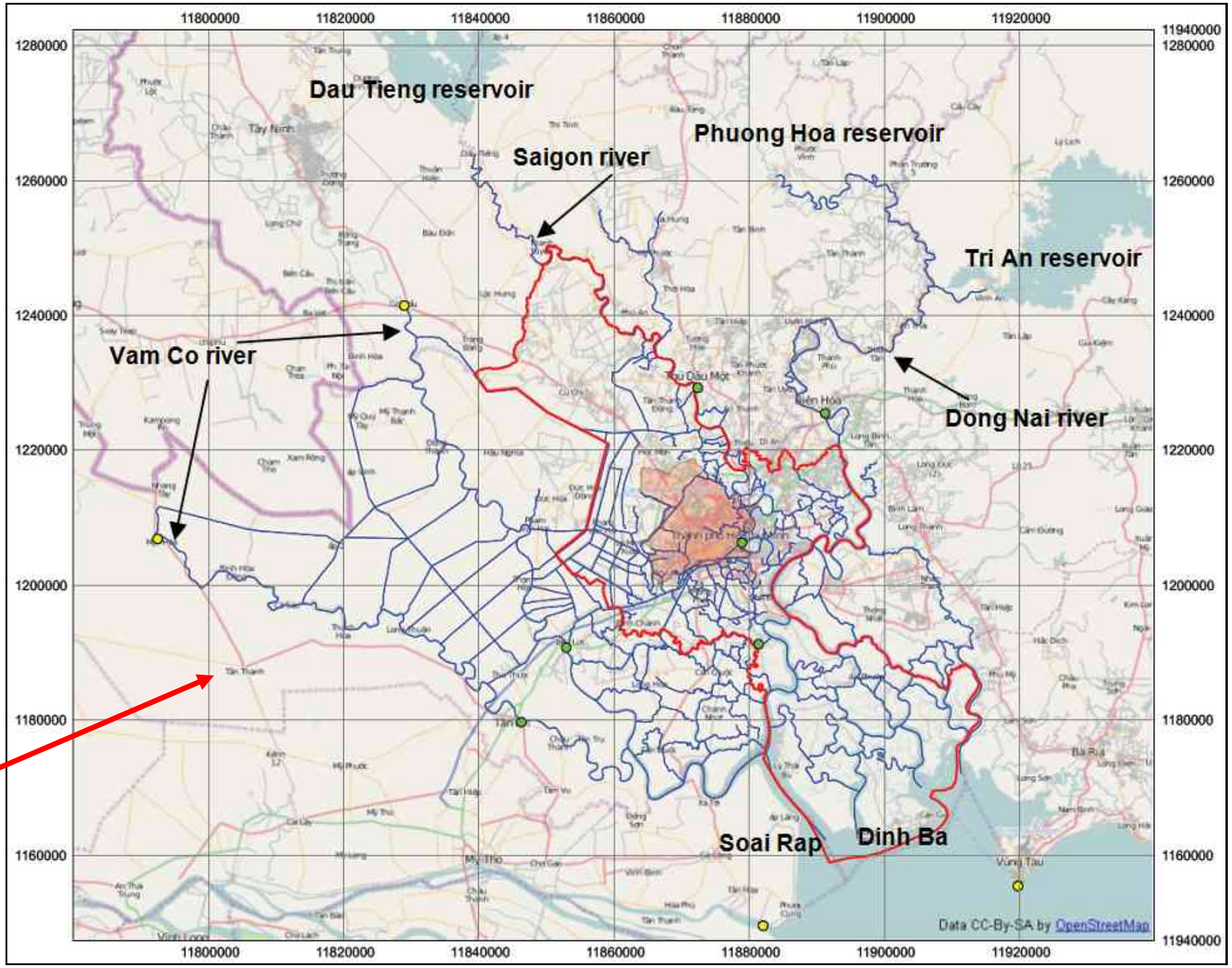
Increasing HCMC’s flood resilience is eminent.

Study area of the FIM-project



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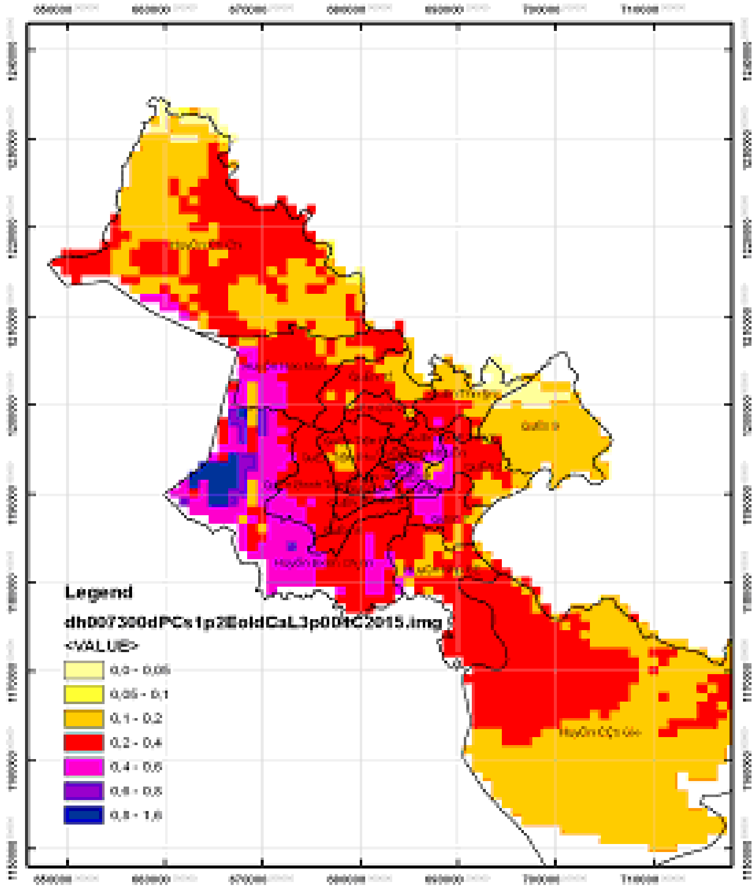
Flood risk reduction with measures

4 Strategies
- Reference
- MARD-plan (12 gates, 172 km embankment)
- MARD-variant
- Soai Rap barrier

4 Scenario's
- Urban Planning (2025)
- Land subsidence (forecast 2025, 2050)
- Climate Change (SLR, rain)
- Control level gates

4 reference years: 2010, 2025, 2050, 2100



Land subsidence 2025 forecast

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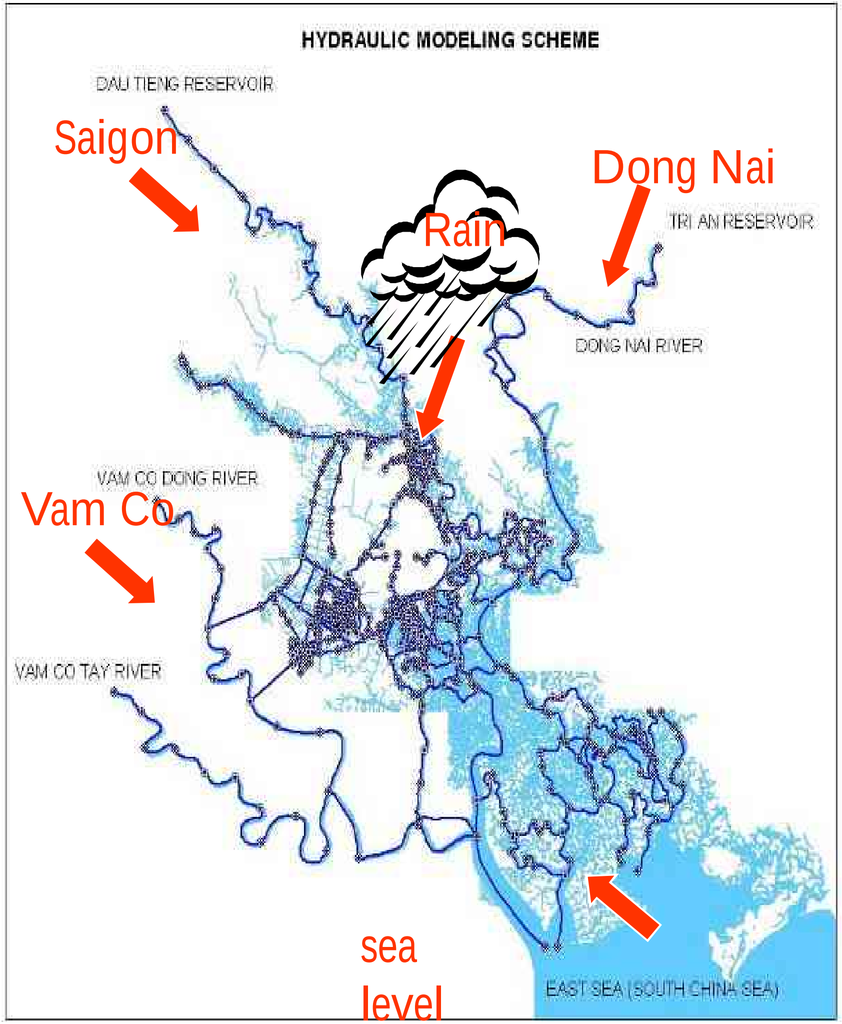
Threats / forcing factors

- Three large rivers
- Intense rainfall on the city
- High tides



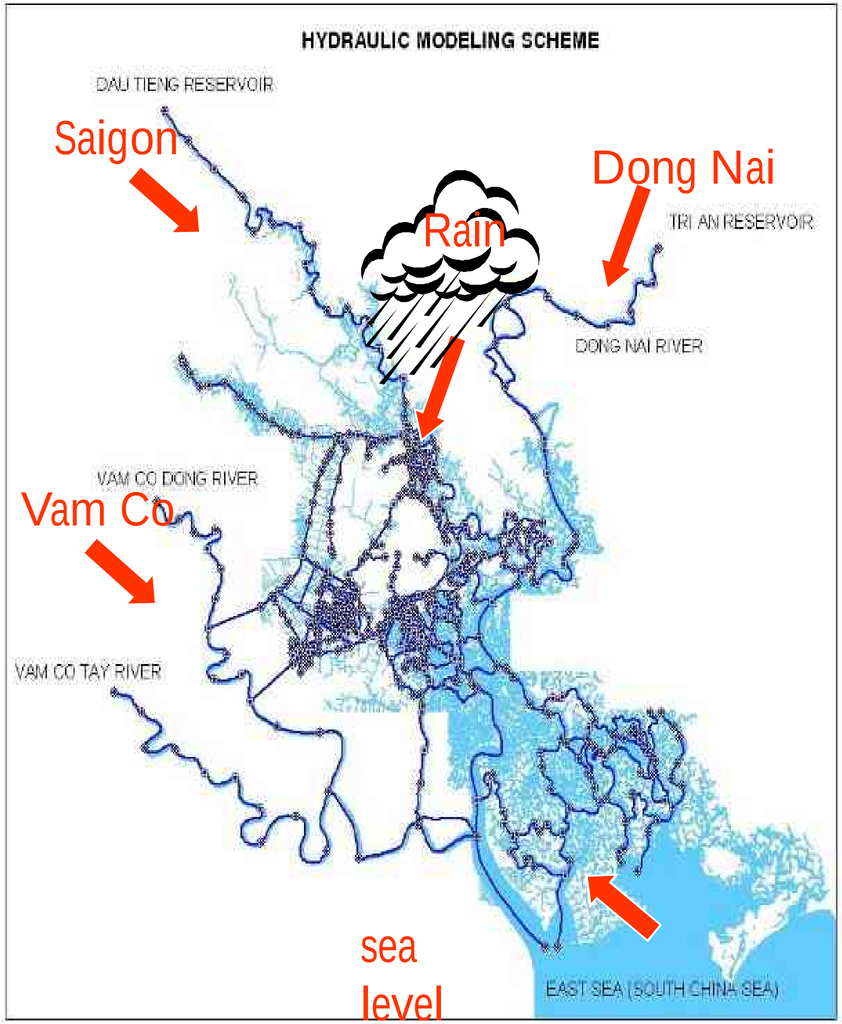
Need for probabilistic risk analysis

265 communities

Set of measures (ADB, 2009)

241 communities

We developed a framework for probabilistic analysis to assess flood hazards of all combinations, i.e. strategies, scenarios, reference years.



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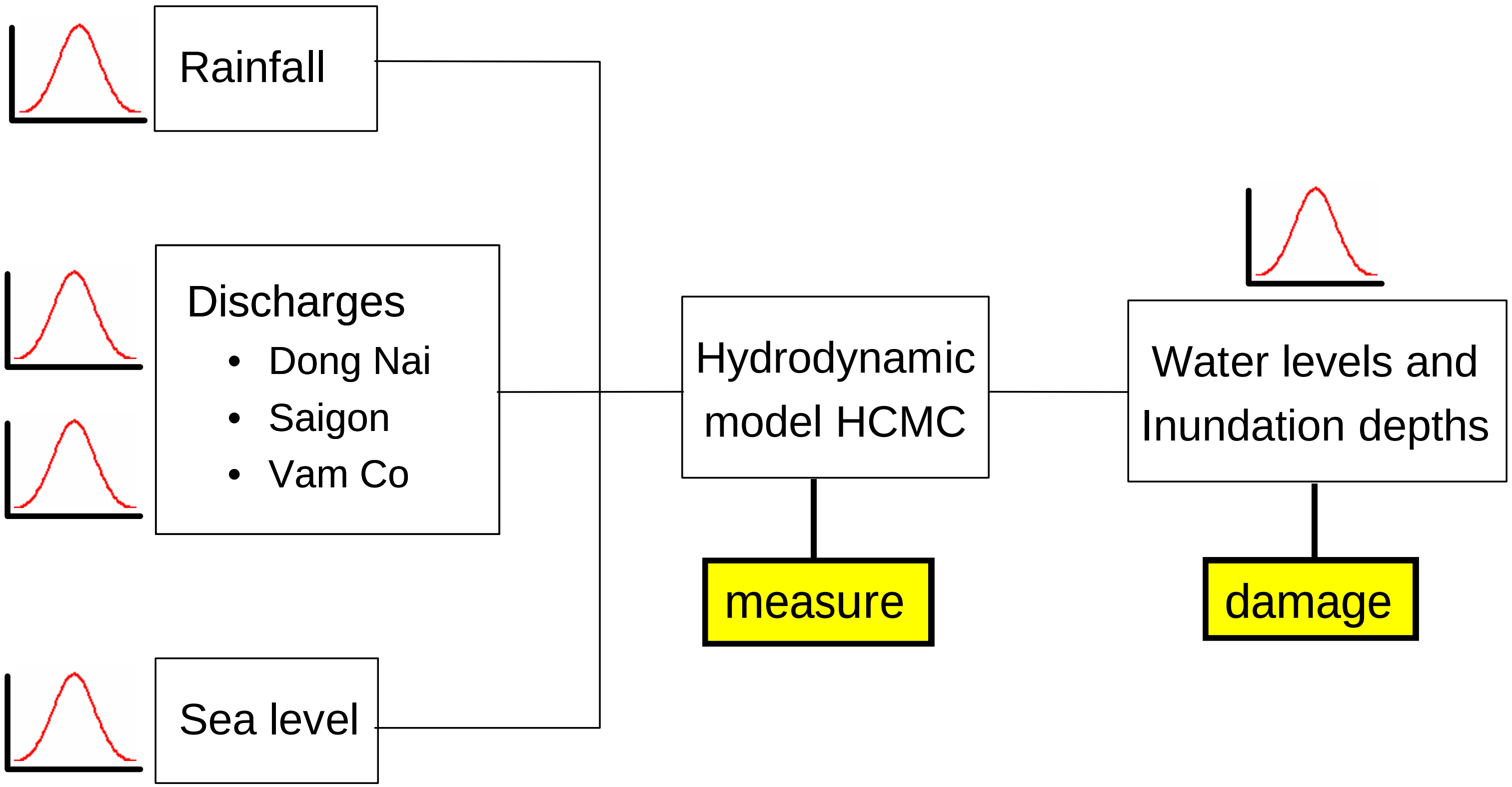
Probabilistic model setup



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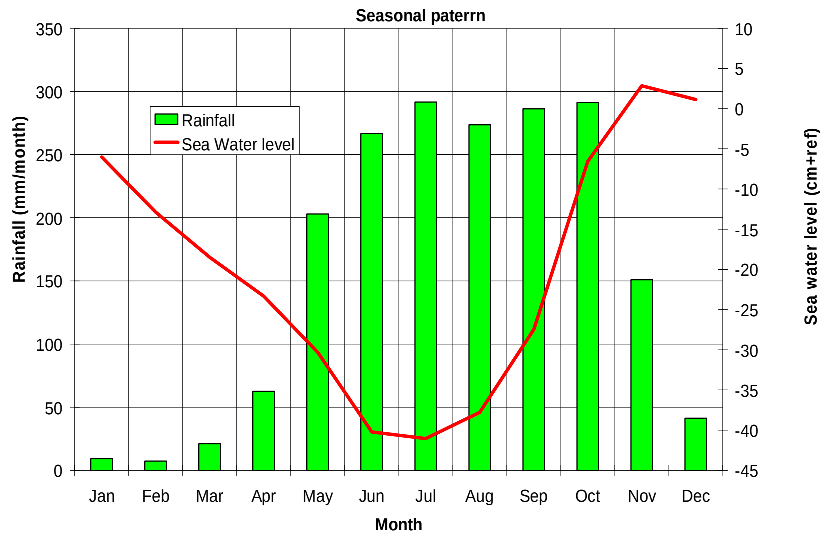
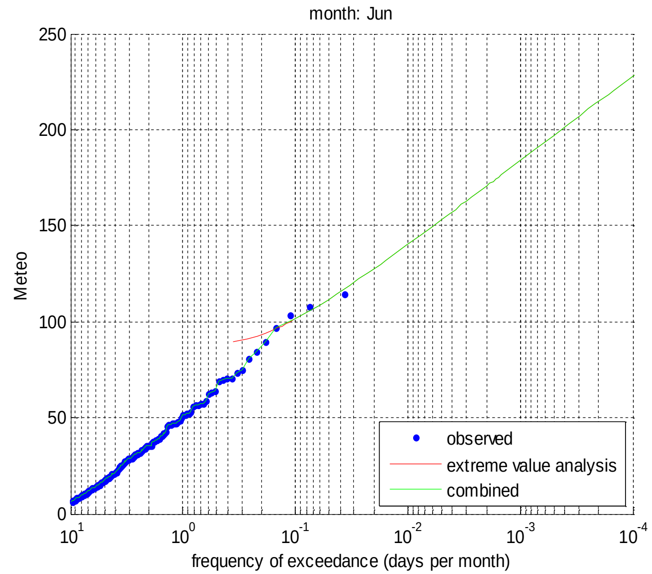
Some challenges in the risk modelling

- Large number of threats
- Seasonal variation of risk
- Statistics for extremes and regular events
- Correlation between river discharges
- Different time scales (river vs sea)
- Non-stationary input series (sea level)





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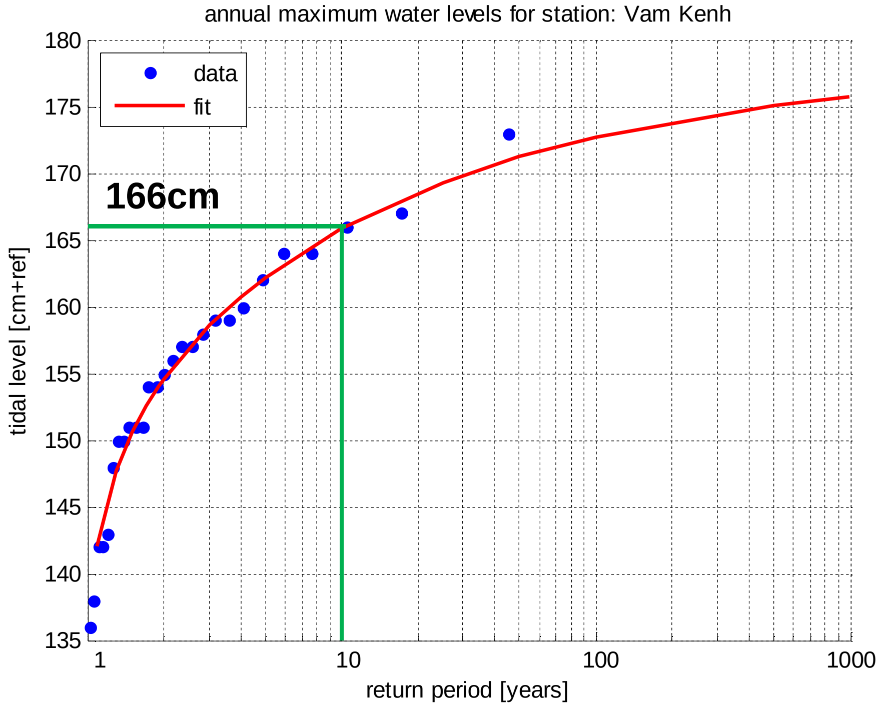
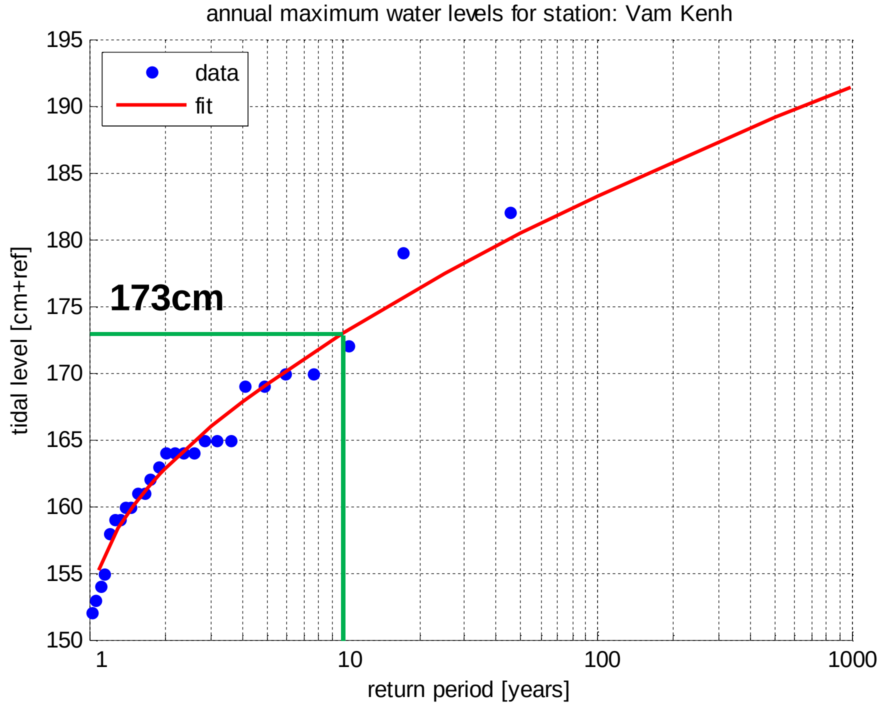
Forcing statistics: sea level



GEV-fit of the observed water level at station Vam Kenh



GEV-fit of the detrended water level at station Vam Kenh

Detrending increases the 10yr tidal level with 7cm

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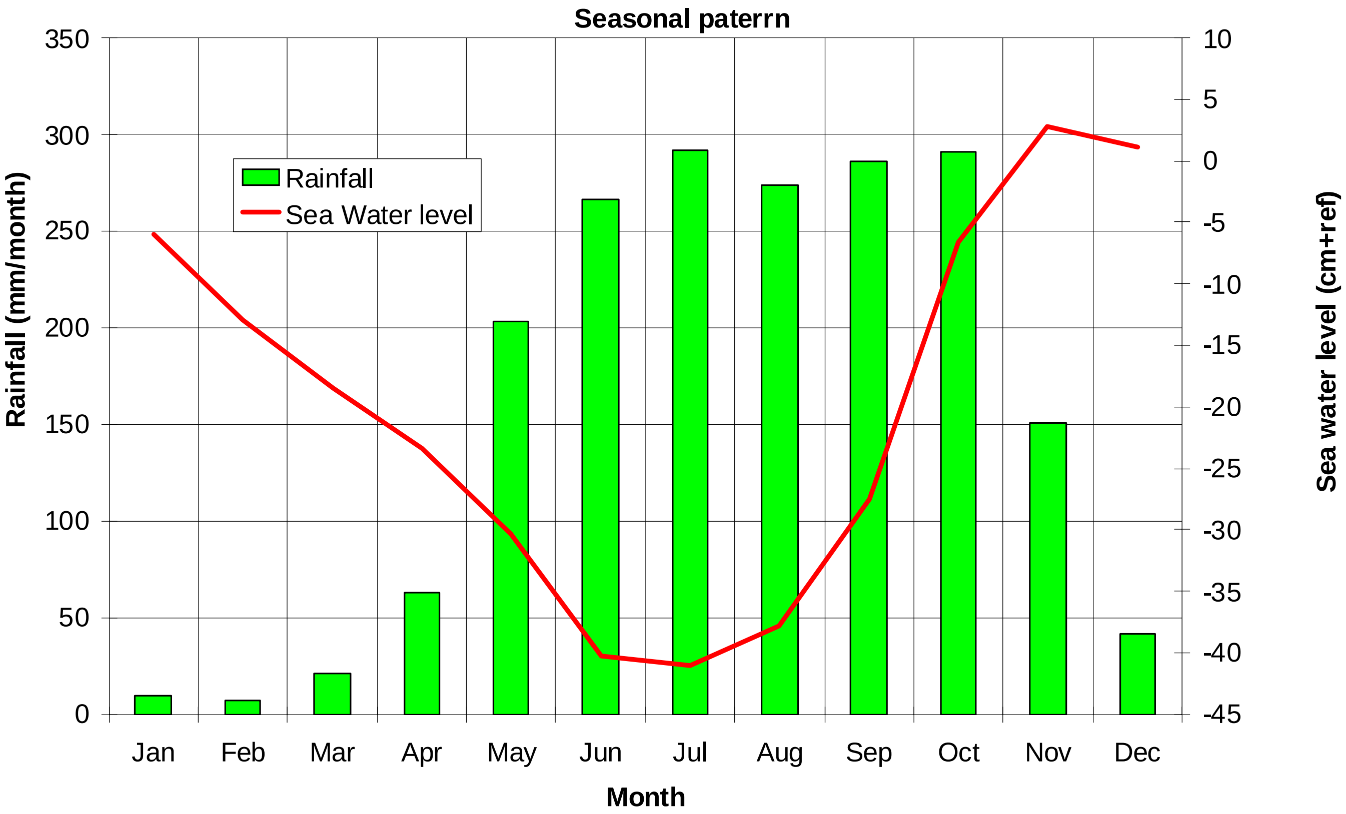
Forcing statistics: rainfall, monthly pattern



- Flood risk varies per month
- Different for rainfall and sea water level
- This needs to be taken into account in the simulations

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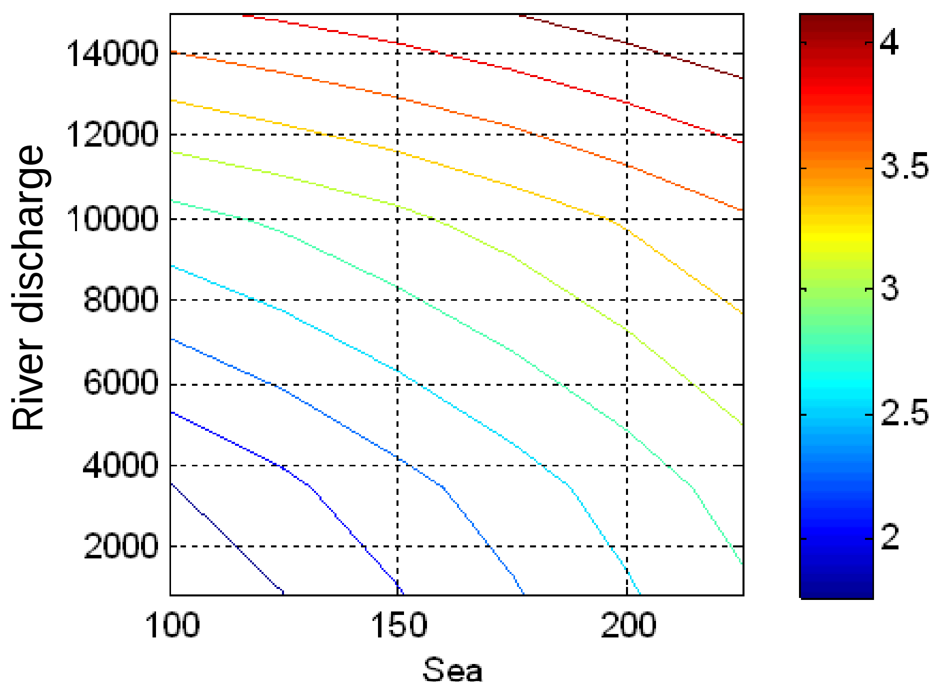
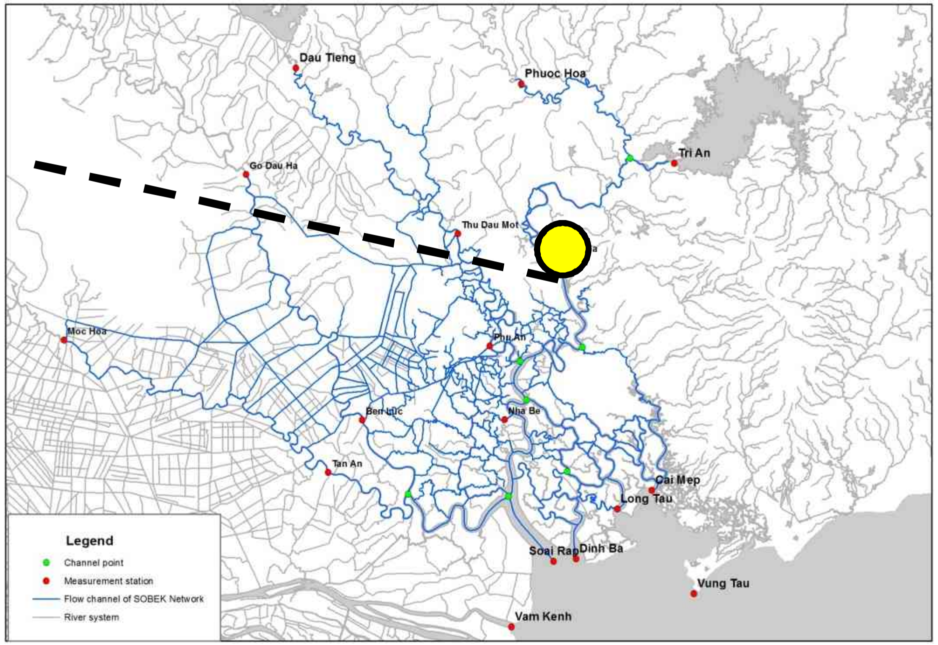
Combining forcing variables

Bien Hoa water level



Sea water level

local water level influenced by 2 variables: river discharge and sea water level



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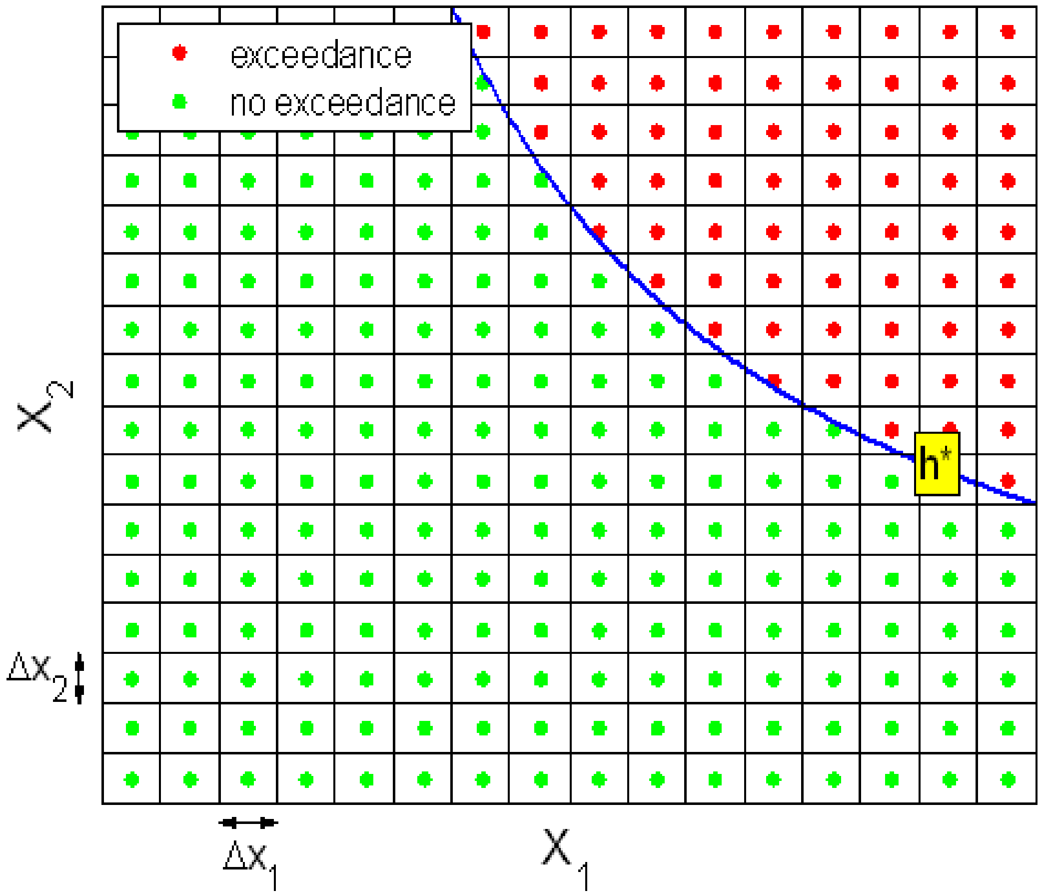
Selected method: numerical integration



X-variables:

- Rainfall
- Sea water level
- Saigon river discharge
- Vam Co river discharge
- Dong Nai river discharge

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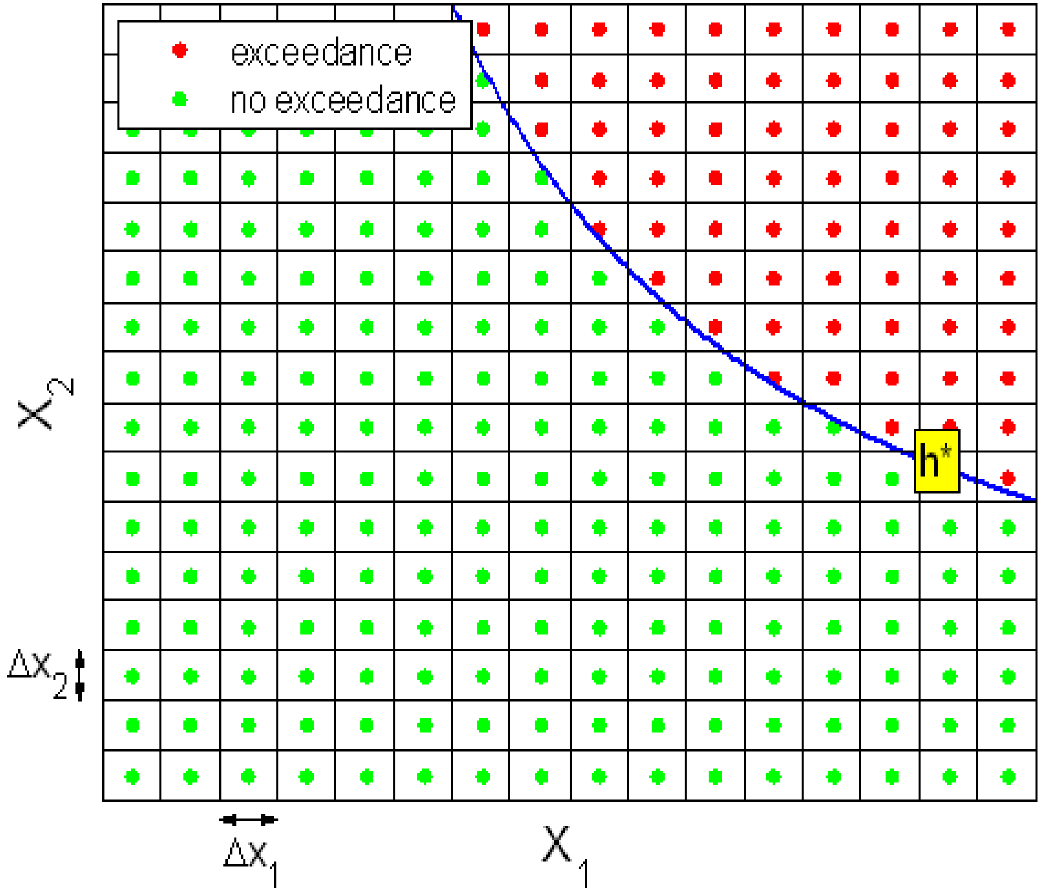
Selected method: numerical integration



-Each grid cell represents a combination of realisations of the 5 X-variables:

- each grid cell can be seen as an “event”

- for each event/grid cell, a numerical model run is carried out to determine flood levels

- 2016 model runs for 1 case

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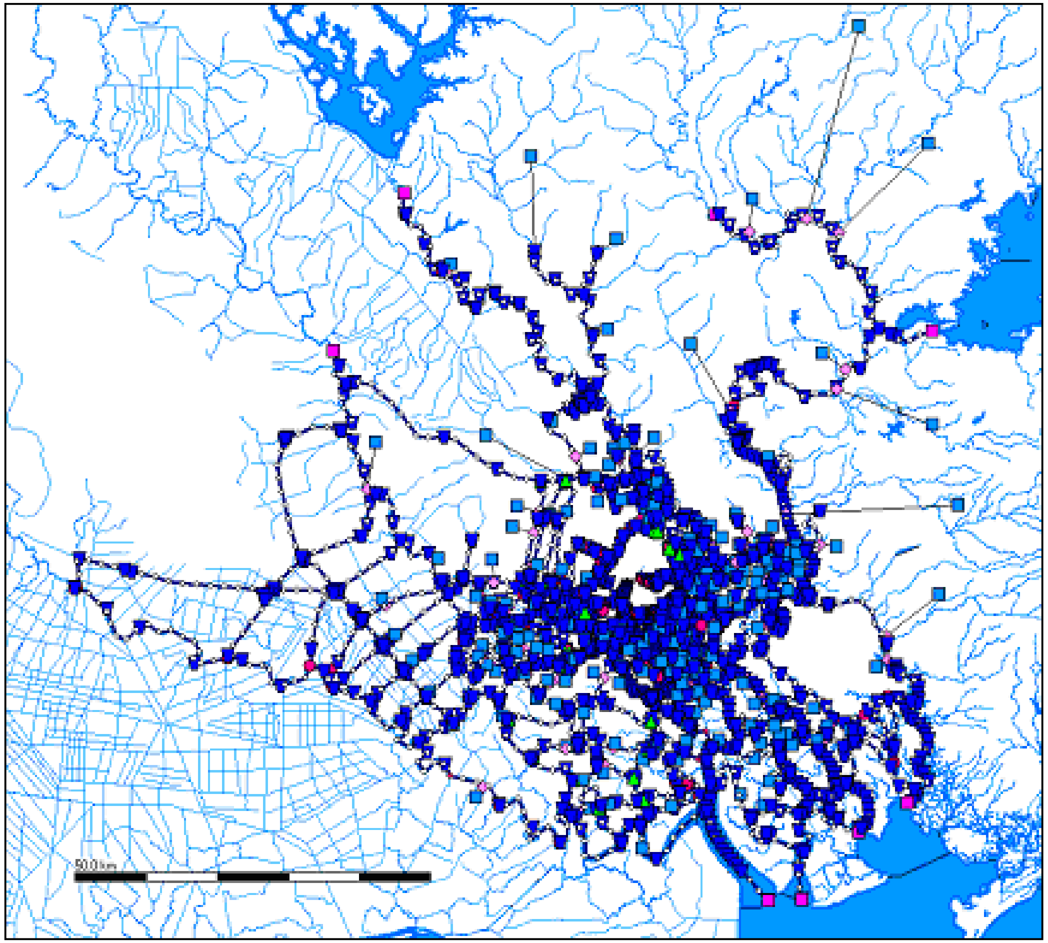
Hydrodynamic and hydrologic model

Sobek model set up

- Catchment area ~2100 km^2
- > 2.250 km of rivers, channels, and drains
- Hydrological processes schematized with NAM



Multiple batch runs: database with model results

Current situation	Measure 1	Measure 2	Subsidence scenario	
Event/Run 1	Event/Run 1	Event/Run 1	Event/Run 1	
Event/Run 2	Event/Run 2	Event/Run 2	Event/Run 2	…
⋮	⋮	⋮	⋮	
Event/Run N	Event/Run N	Event/Run N	Event/Run N	

N=2016

Multi-Criteria analysis

Multi-Criteria analysis criteria:

- Technical and hydraulic performance
- Environmental impacts
- Socio-economic impacts
- Costs and benefits

Conclusions

- A successful application of the probabilistic framework for flood hazard and risk assessment of flood management strategies for HCMC.
- The frameworks' results support the selection of a preferred flood management strategy to increase HCMC's flood resilience.
- The probabilistic nature of the framework enables the quantification of expected annual damage.
- Mitigating measures could be compared with expected annual damage reduction as various strategies assessed with the model.
- The framework has specific added value for deltaic areas, where multiple flood forcing factors interact.

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