PORT OF ROTTERDAM AT PRESENT CLIMATE PROOF
PORT LOCATED OUTSIDE THE FLOOD DEFENCE SYSTEM, BUT RAISED

Sea level rise Delta Scenarios 2014:
2050: +0,15m to +0,35m
2100: +0,35m to +0,85m
FLOOD RISK ADAPTATION STRATEGIES

Botlek Vondelingenplaat
2015-2017

Waal-Eemhaven
2017-2018

Merwe-Vierhavens
2018

Europoort
2019-2020

Maasvlakte
2020-2021

Waal-Eemhaven
2017-2018

Dordrecht
2021
APPROACH AND STEPS
- IN PARTNERSHIP WITH COMPANIES AND PUBLIC ORGANISATIONS -

Approach:
• Creating awareness
• Information sharing + visualisation
• Joint Fact Finding
• Create common language and commitment!

Steps:
• Flood risk analysis
• Impact assessment *(workshop 1 with stakeholders)* + applying flood risk assessment framework
• Jointly building a flood risk adaptation strategy *(workshop 2 with stakeholders)*

Sea level rise Delta Scenarios 2014:
2050: +0,15m to +0,35m
2100: + 0,35m to +0,85m
STAKEHOLDER INVOLVEMENT RIGHT FROM THE START

- **Companies**
  - Chemical industry
  - Refineries
  - Tank terminals
  - Distribution centres
  - Dry bulk terminals
  - Break bulk terminals
  - Power plants
  - etc.

- **Public organisations:**
  - Municipality of Rotterdam
  - Rotterdam-Rijnmond Safety Region
  - Environmental Protection Agency
  - Ministry of Water Management
  - Rail and road authorities

- **Utility owners**
  - Electricity
  - Gas
  - Water
Average height: +5.5m
Rough indication of the chance at present for flooding somewhere in the area: 1/10,000 year

FLOOD RISK

Course of a flood:
- North West Storm wind force Beaufort 11-12
- Response time 1-2 days max
- Flood when water level > height of terrain (average +5.5m in Europoort)
- Salt water on terrain for max 1 - 2 days

Maeslant Barrier

1/100 year

1/1,000 year

Europoort area → Flood from sea → defence system
FLOOD RISK ANALYSIS

Water depth 2015 (1/1,000 year storm)*

* Dutch Flood event 1953: 1/300 year storm
FLOOD RISK ANALYSIS

Inundation [m]

2015: 1/100 year

2015: 1/1,000 year

2015: 1/10,000 year

2050 (W+): 1/100 year

2050 (W+): 1/1,000 year

2050 (W+): 1/10,000 year
IMPACT ASSESSMENT (WORKSHOP 1)

• Assessment of impact on:
  • (Deadly) casualties
  • Economy (direct and indirect)
  • Environment (air, water, soil)
  • Quantitative approach (modelling of direct and indirect economical impact)
  • Qualitative approach (workshops and interviews with stakeholders)

![Impact Map]

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct Effect [mln €]</th>
<th>Total Effect [mln €]</th>
<th>Impact [€/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015: 1/1,000 year</td>
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</table>
FLOOD RISK ASSESSMENT FRAMEWORK

1. Definition of Limit State for a specific object
   - Difference between 2 Limit States: Functionality (Service Limit State - SLS):
   - Failure (Ultimate Limit State - ULS):

2a. Determine SLS / ULS
   - What is the chance that a SLS or ULS takes place in the present time and how does it change in time as a result of climate change?

3. Assessment if the object meets the SLS / ULS during its life span
   - Based on public assessment frameworks
     (inside the flood defence system, “behind the dykes”)

Example ULS: Oil tank is damaged and causes environmental contamination of the surrounding area due to leakage of oil out of a tank. Repair will cost allot of money and months of work.

What are the consequences of exceeding the SLS / ULS?
- How acceptable is this?

<table>
<thead>
<tr>
<th>Location</th>
<th>Value</th>
<th>SLS Value</th>
<th>ULS Value</th>
<th>Consequence</th>
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<tbody>
<tr>
<td>2015</td>
<td>200</td>
<td>0.5</td>
<td>3.2 km</td>
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<tr>
<td>2050</td>
<td>2.5</td>
<td>0.1</td>
<td>5.2 km</td>
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</tr>
<tr>
<td>2100</td>
<td>10</td>
<td>0.01</td>
<td>10 km</td>
<td></td>
</tr>
<tr>
<td>2150</td>
<td>50</td>
<td>0.001</td>
<td>100 km</td>
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</table>

Result: acceptable SLS / ULS of an object

Result: insight if an object meets the acceptable SLS / ULS and if not, when does it become unacceptable in time (e.g. in 2060 in example above).
APPLICATION OF THE ASSESSMENT FRAMEWORK
- COMPARISON OF THE IMPACT WITH THE ACCEPTABLE LEVEL OF RISK -

<table>
<thead>
<tr>
<th>Deelgebieden</th>
<th>Nu</th>
<th>2050</th>
<th>2100</th>
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</thead>
<tbody>
<tr>
<td>Europoort</td>
<td></td>
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<tr>
<td>Deelgebied 1</td>
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<tr>
<td>Deelgebied 6</td>
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</tr>
</tbody>
</table>

- Green: impact = still acceptable
- Yellow: impact = close to unacceptable
- Red: impact = unacceptable
“Risk dialogue”

- Combining preventive measures with spatial adaptation and emergency response.
- Cost-benefit analysis
- Gives insight in necessity of collaborative approach.
- Commitment and first steps to jointly follow up on the strategy.
EUROPOORT FLOOD RISK ADAPTATION STRATEGY

- Elevate quays/slopes
- Elevate land/dry proofing
- Wet/dry proofing assets, emergency & recovery plans
- Europoort emergency and recovery plan

- Short term
- < 2050
- < 2100
- > 2100
MEASURES IN PROGRESS

new embankment

elevated quay
A SAFE PORT, NOW AND IN THE FUTURE!