

Academy **cademu**

Deltares
Enabling Delta Life

Flood (Risk) Management in the Netherlands

Introduction: a history of flood defence

dr Frans Klijn, Deltares | Delft Hydraulics



core business

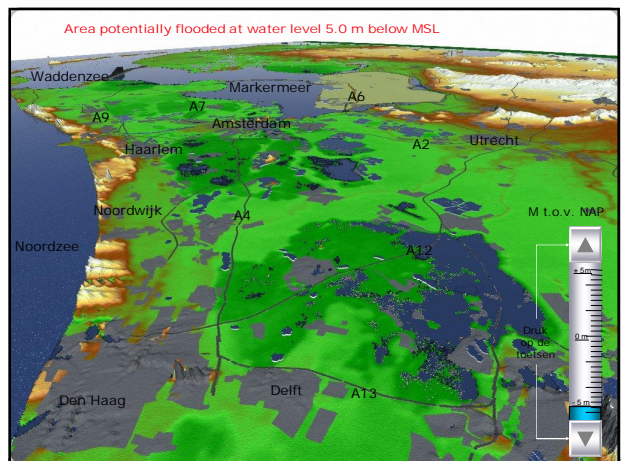
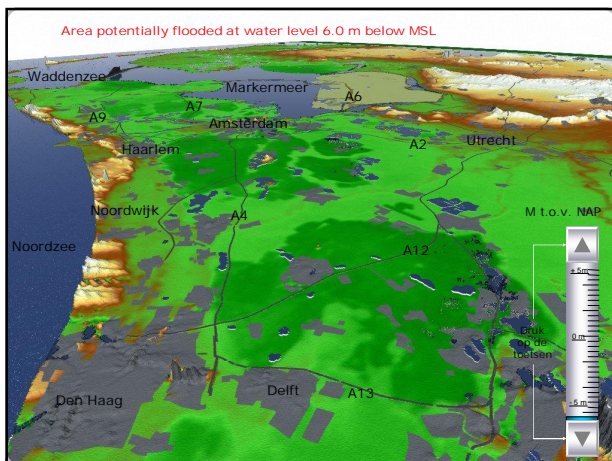
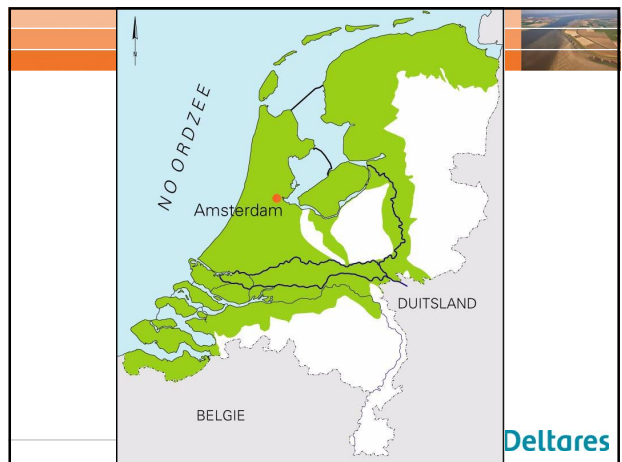
$$\frac{\partial}{\partial t} u_i + \sum_{j=1}^n u_j \frac{\partial u_i}{\partial x_j} = \nu \Delta u_i - \frac{\partial p}{\partial x_i} + f_i(x, t) \quad (x \in \mathbb{R}^n, t \geq 0)$$

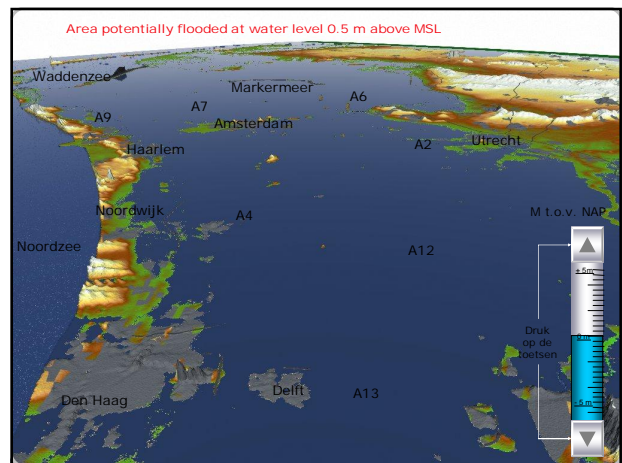
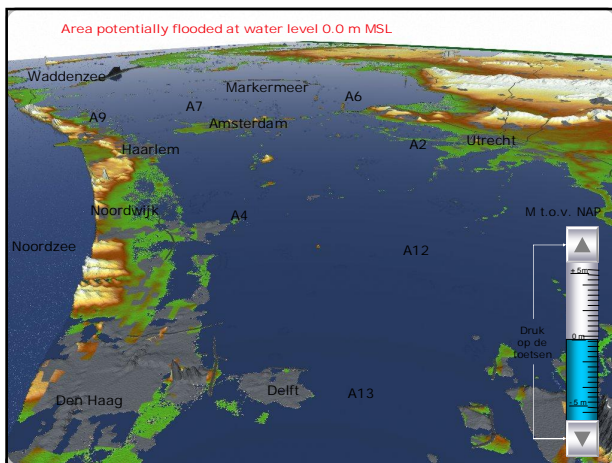
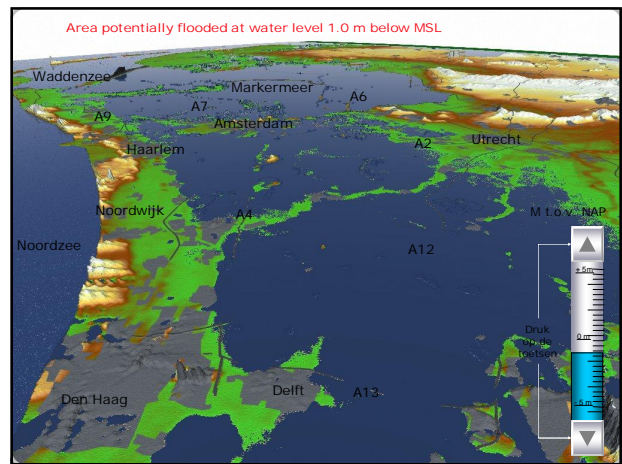
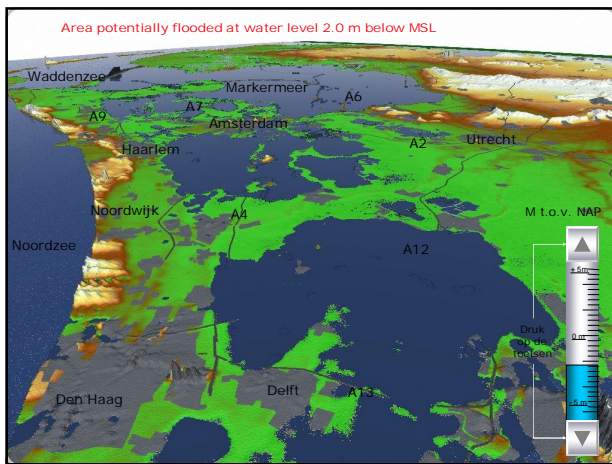
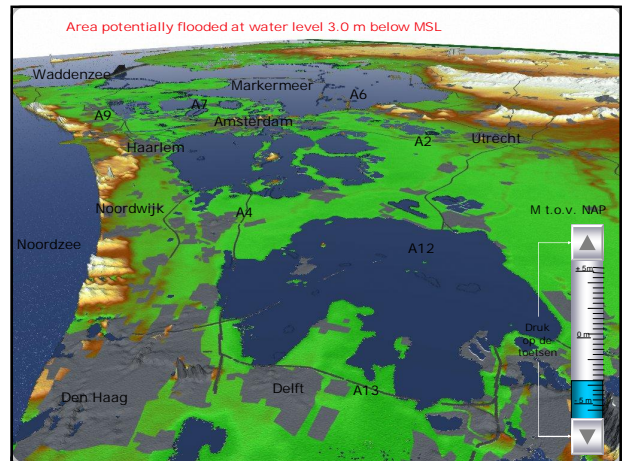
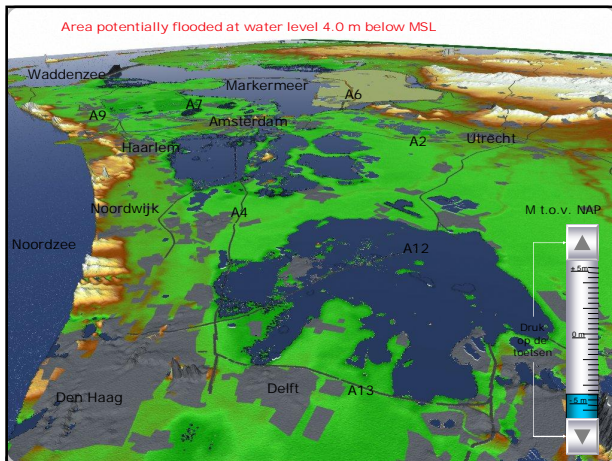
$$\text{div } u = \sum_{i=1}^n \frac{\partial u_i}{\partial x_i} = 0 \quad (x \in \mathbb{R}^n, t \geq 0)$$

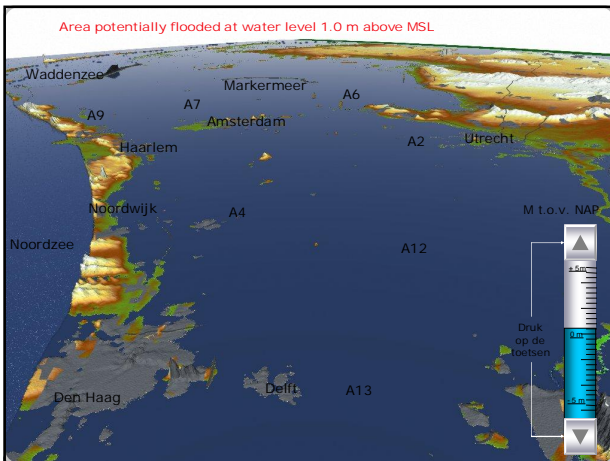
$$u(x, 0) = u^0(x) \quad (x \in \mathbb{R}^n)$$

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Types of flooding

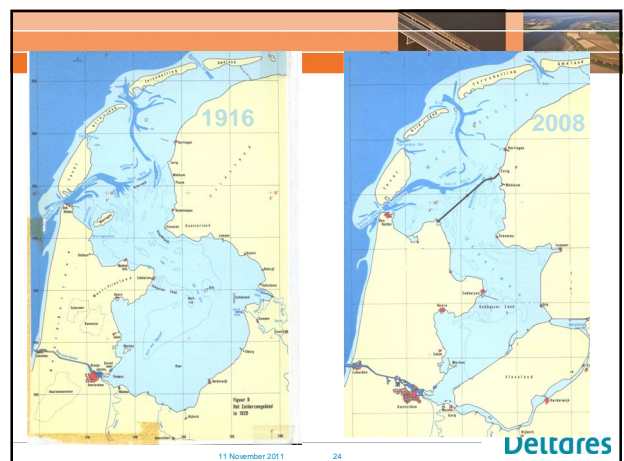
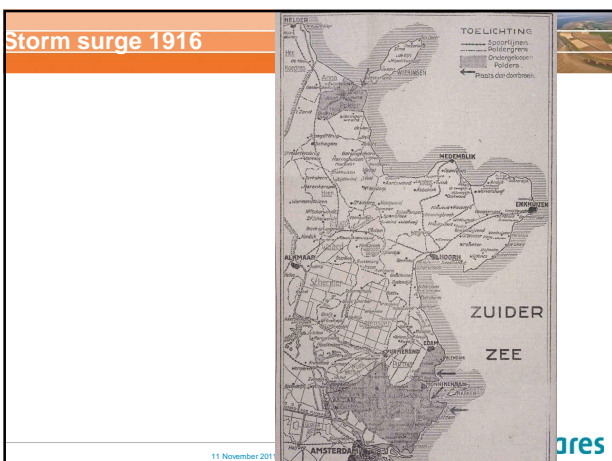
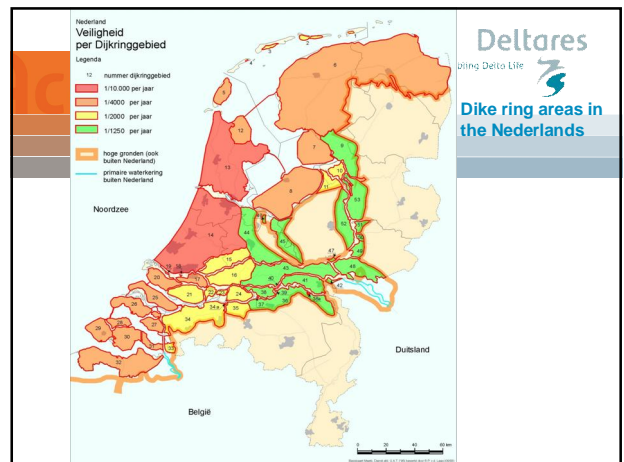
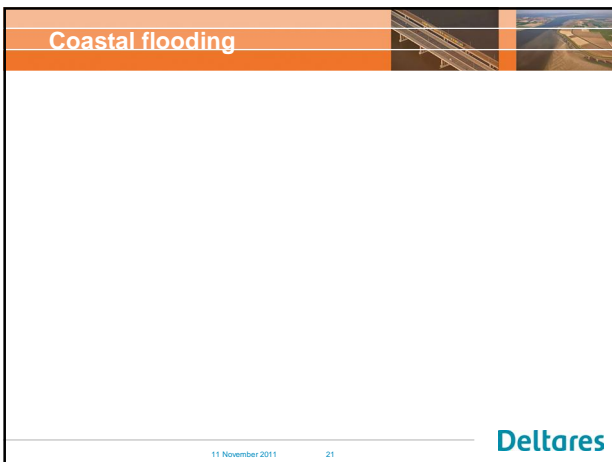
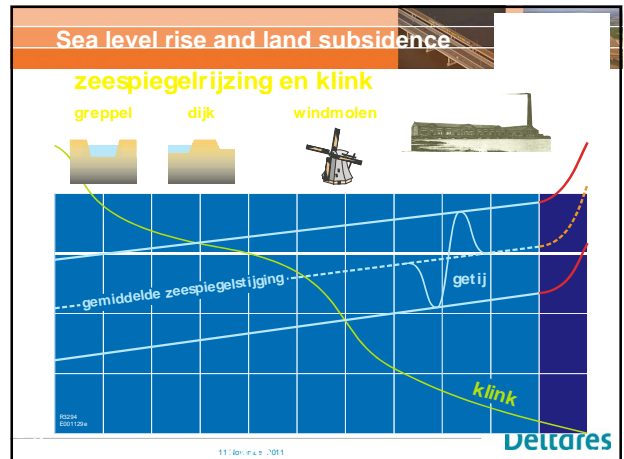
- Local rainfall: drainage
- Coastal flooding
- River flooding: Rhine River, Meuse River

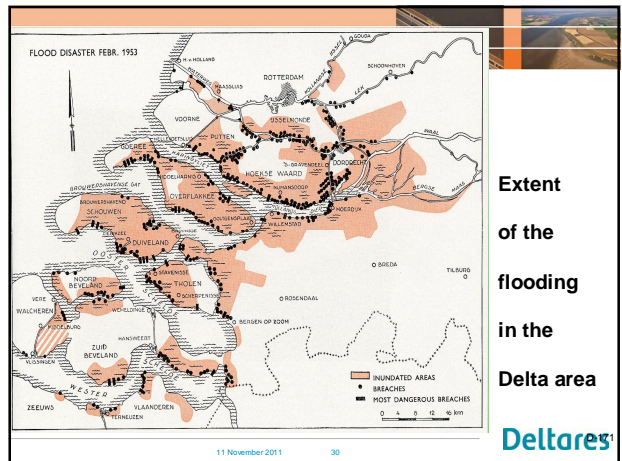
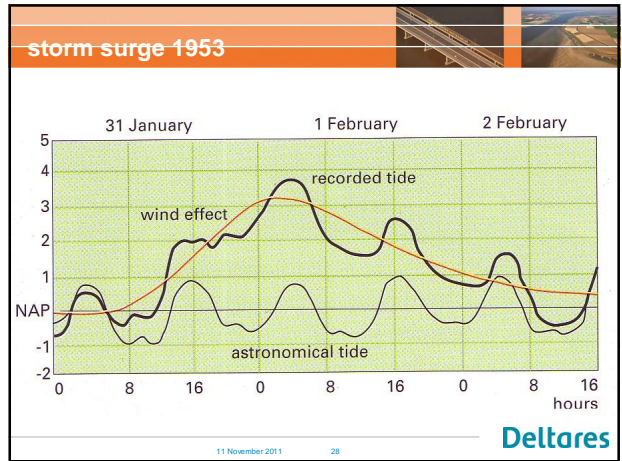
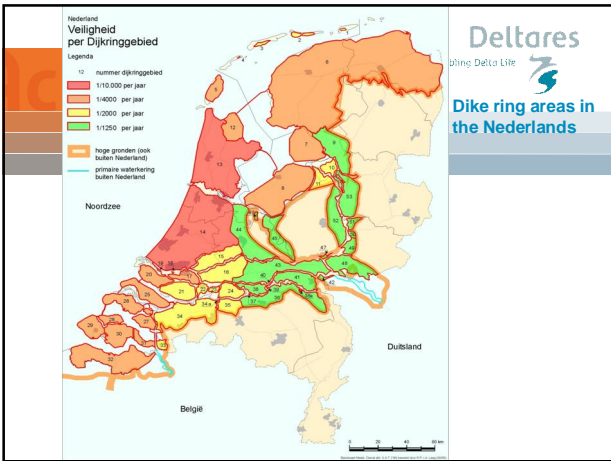
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Local rainfall

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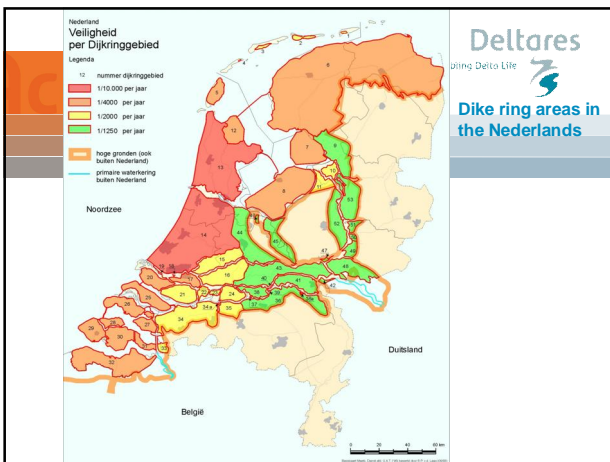


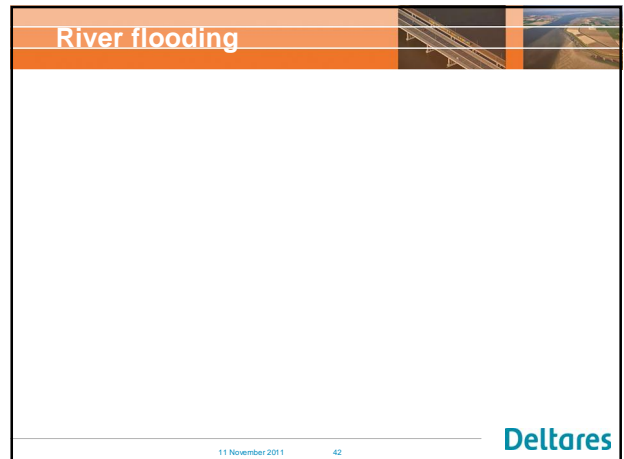
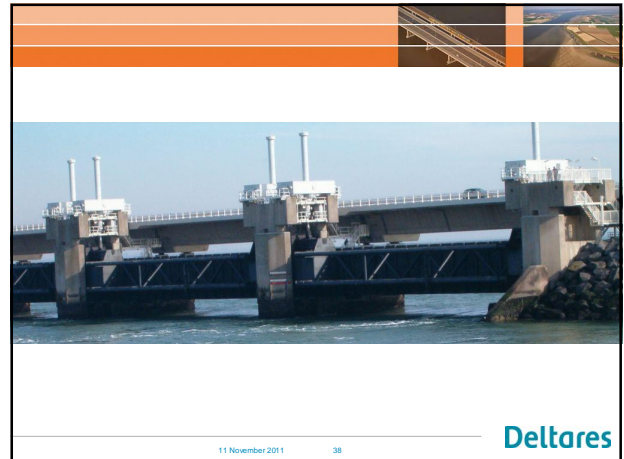
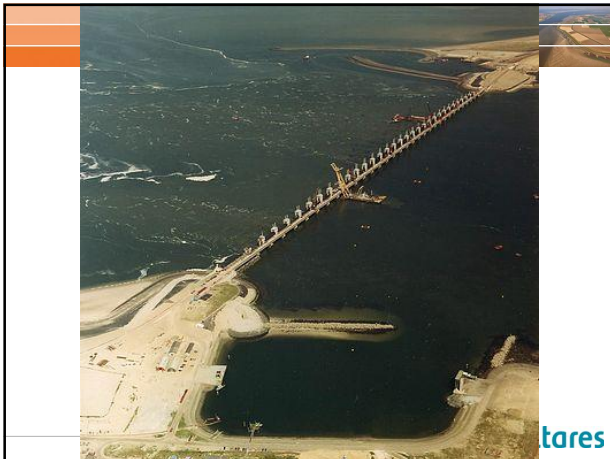
Characteristic damage data for The Netherlands

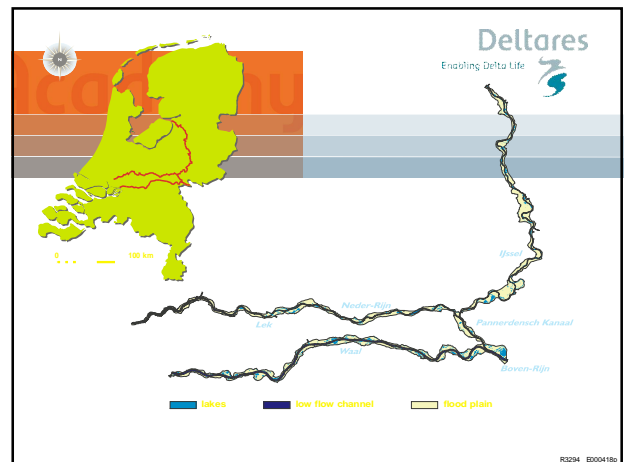
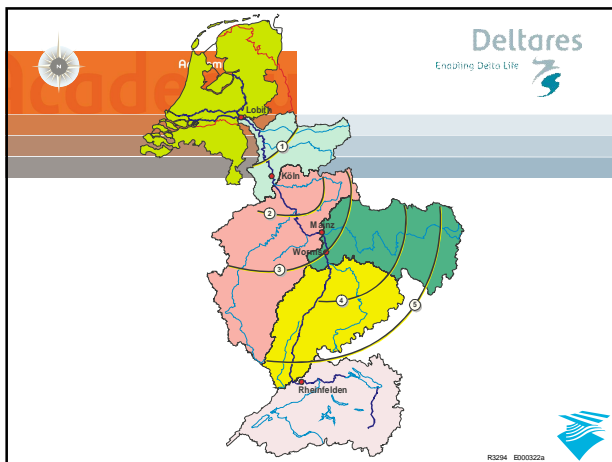
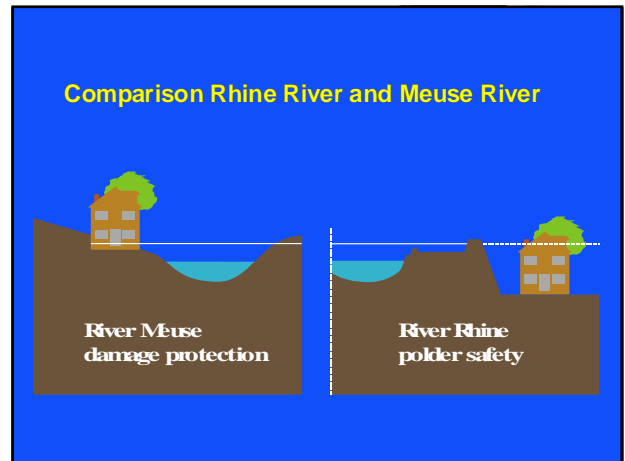
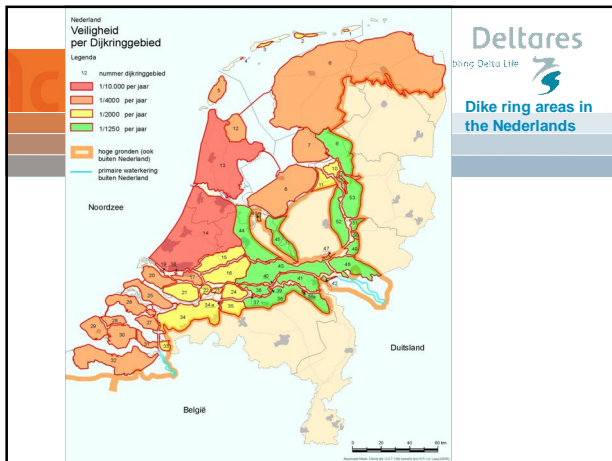
Inundated area:

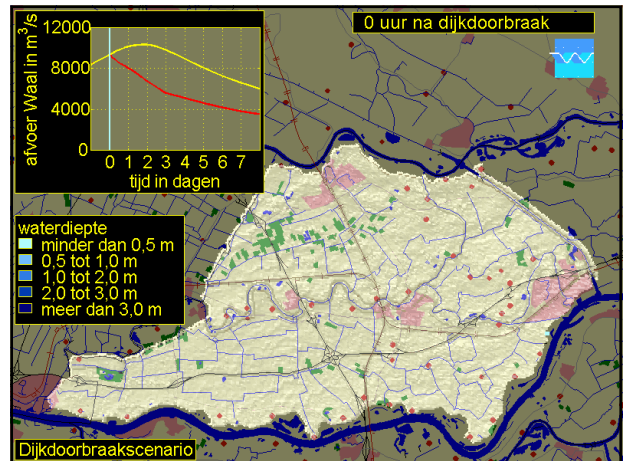
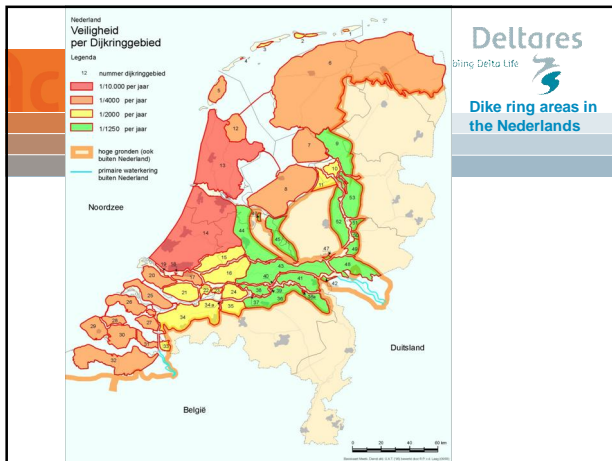
North Holland:	250 ha	> 150 dike breaches, of which
South Holland:	53,500 ha	89 tidal gaps (closed after 1 March)
Zeeland:	37,000 ha	120 km dike was seriously damaged
Noord Brabant:	45,500 ha	42 km dike was extremely seriously damaged
Total:	136,500 ha	1835 (1836) casualties
		Lost cattle: > 34,000
People affected:	750,000	(Near)-destroyed buildings: 10,000
		Damaged buildings: 37,300

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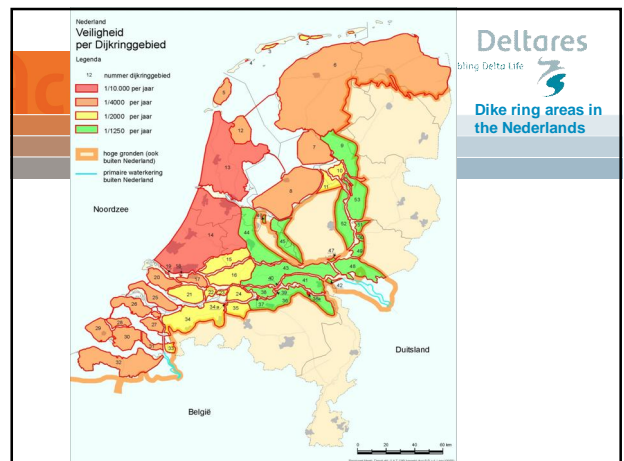






Delta Committee (1958): safety levels based on cost benefit analysis for dike ring 14 (Central Holland).
 Outcome CB-analysis for dike ring 14: acceptable flooding probability 1 / 125,000 per year
 Related storm conditions (design water level): 1 / 10,000 per year
 Scaled down to other dike rings based on population density and flooding threat

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Delta Committee (1958): protection levels based on cost benefit analysis for dike ring 14 (Central Holland).
 Outcome CB-analysis for dike ring 14: acceptable flooding probability 1 / 125,000 per year
 Related storm conditions (design water level) 1 / 10,000 per year
 Translated to other dike ring areas based on population density and flooding threat

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 Dike ring areas in the Netherlands

Current situation of flood protection in NL

Flood Protection Law (1996):

- safety levels (probabilities)
- every 5 years, evaluation hydraulic design parameters (design discharges, etc.)
- every 5 years: check infrastructure
- report to Parliament

2001: new round: Rhine design discharge up from 15.000 to 16.000 m³/s

Policy: heighthening levees only a last resort. Instead: make 'room for rivers'

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Costs

excluding costs for waste water treatment
 excluding costs for drinking water supply

annual budget 1600 million euro

- 800 million euro: central government
- 800 million euro: water boards

for investments, operation and maintenance of all water management infrastructure

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Costs

excluding costs for waste water treatment
 excluding costs for drinking water supply

annual budget 1600 million euro

- 800 million euro: central government
- 800 million euro: water boards

for investments, operation and maintenance of all water management infrastructure

equivalent to 100 euro / person / year

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