

# Consequences of Climate Change on Ports and Inland Waterways in The Netherlands

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# Ports and Waterways in the Netherlands



# Port of Rotterdam

## Key figures for 2006:

- Throughput 382 million tons
- Total Added Value 17.5 billion Euro
- Total employment 140,000 persons

# Port of Rotterdam



# Maeslant Barrier Rotterdam

Sea Level Rise  
0.5 m

1/10 year  
closure



# Amsterdam Ports

## Key figures 2006

- Throughput 84.5 million tons
- Total Added Value 5.8 billion Euro
- Total employment 56,000 persons

# Amsterdam Ports



# Other Ports

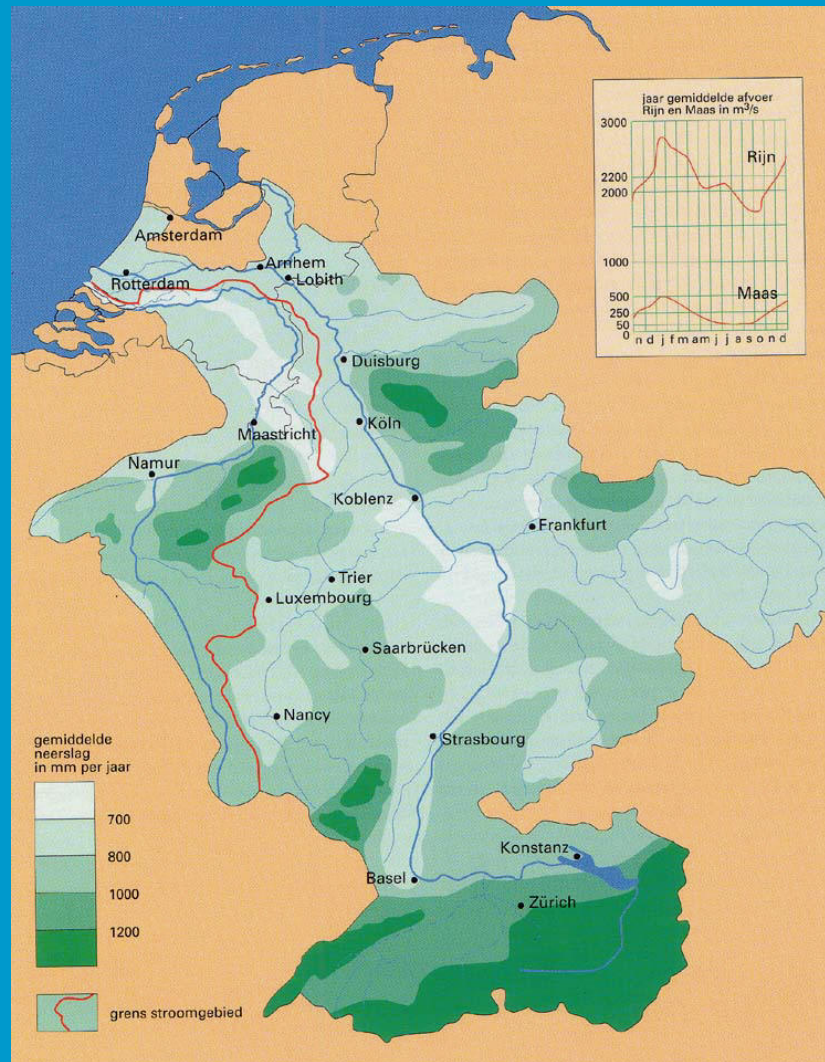


Zeeland Seaports (30.4 mio ton)  
Groningen Seaports (4.6 mio ton)  
Seaport Moerdijk (13.0 mio ton)





# Rivers Rhine and Meuse



# Rhine River

Barge transport 2006: 200 million ton (nat. and internat.)  
about 235,000 ships passing Lobith  
per year

Design discharge : 15,000 m<sup>3</sup>/s (1/1250 yr)

Transport capacity : at 2.5 m depth 20% reduction  
at low water (1000 m<sup>3</sup>/s)

# River Meuse

Barge transport 2006: 51 million ton (nat. and internat.)

Design discharge : 3800 m<sup>3</sup>/s (1/1250 yr)

Low water limitations : nil, because the river is canalized  
(7 ship locks in NL)

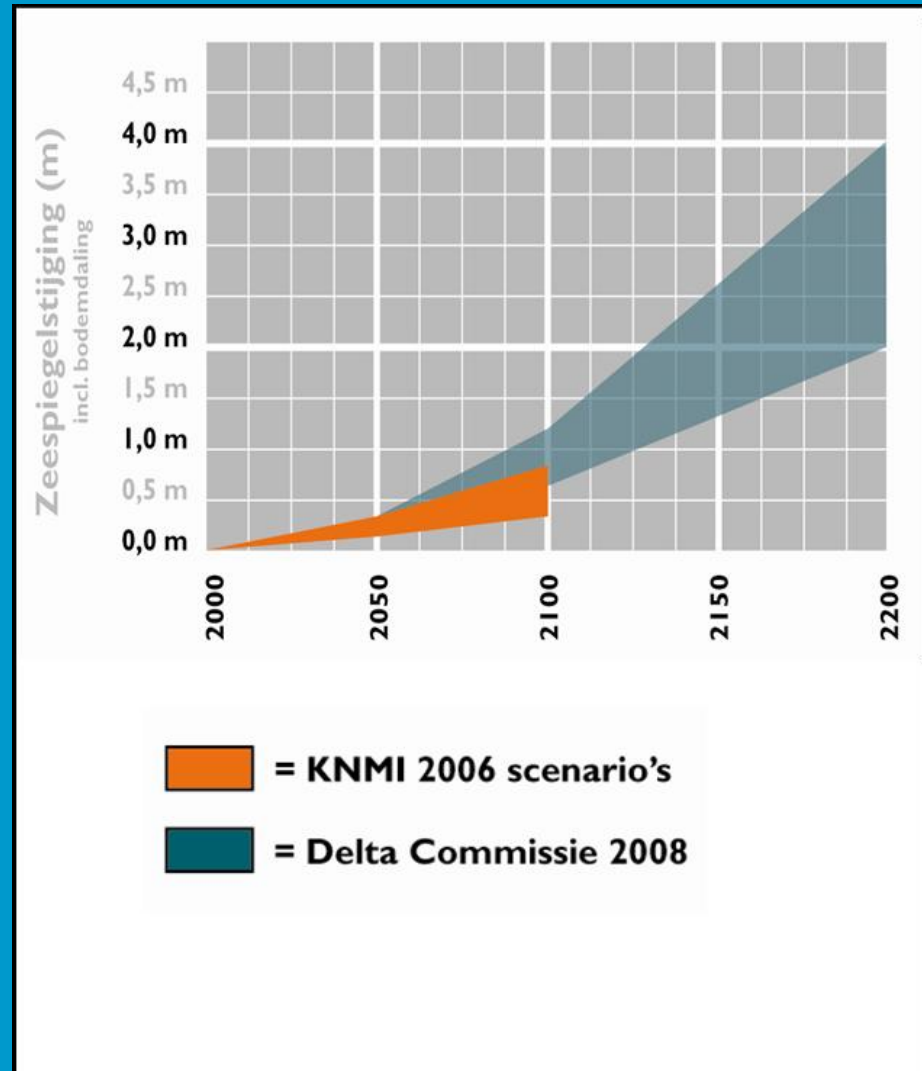
# Relevant Climate Effects

## Sea Level Rise\* (m)

Prediction	2050	2100
KNMI 2006	0.15-0.35	0.35-0.85
IPCC A1FI/Delta Comm.	same	0.55-1.20

\* excl. subsidence

# From report Delta Commission 2008



## Relevant Climate Effects (2)

River discharges (m<sup>3</sup>/s)

### *High discharge (1/1250 yr)*

	2008	2050	2100
Rhine (Lobith)	15,000	16,000	18,000
Meuse (Borgharen)	3,600	4,200	4,600

### *Low discharge*

Rhine: strong increase periods of low water

Meuse: no effect

# General consequences 2050

## Winter

- Flooding along the Meuse
- More frequent closure barrages
- SW and N dikes inadequate

## Summer

- Shortage of fresh water (for agriculture)
- Increase salinity levels in western provinces
- Increase periods of draft restriction on the Rhine

# General consequences 2100

## Winter

- Flooding along all rivers
- Barrages become insufficient
- All dikes and dunes inadequate

## Summer

- Severe shortage of fresh water
- Salinity levels increase
- Unacceptable draft restrictions on the Rhine



# Consequences for the ports

## Rotterdam

- closure Maeslant Barrier on average 1/yr (2050) and 7 times per year (2100, SLR 1.3 m) → unacceptable for shipping
- High waterlevels in the Rotterdam area (coincidence of storm surge and high river discharge → more barrages at the landside

## Amsterdam and other ports

- Limited measures against flooding

# New landside barrages



# Mitigation draft restrictions Rhine

MSc-thesis 2005 on integral solutions for climate effects  
(higher **and** lower discharges)

- Most alternatives for higher discharge aggravate the draft restrictions at low discharge
- Most promising alternatives:
  - barge design, reduced draft
  - operational measures, improved RIS, 24-hrs operation in periods of low discharge

# Conclusions

## Ports

- Mostly “limited” measures against flooding
- Rotterdam: adaptation Maeslantkering by 2100 and additional landside barrages

## Waterways

- Mostly “limited” measures against flooding
- Rhine: measures to reduce the draft restrictions