Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Advise on the new flood protection standards

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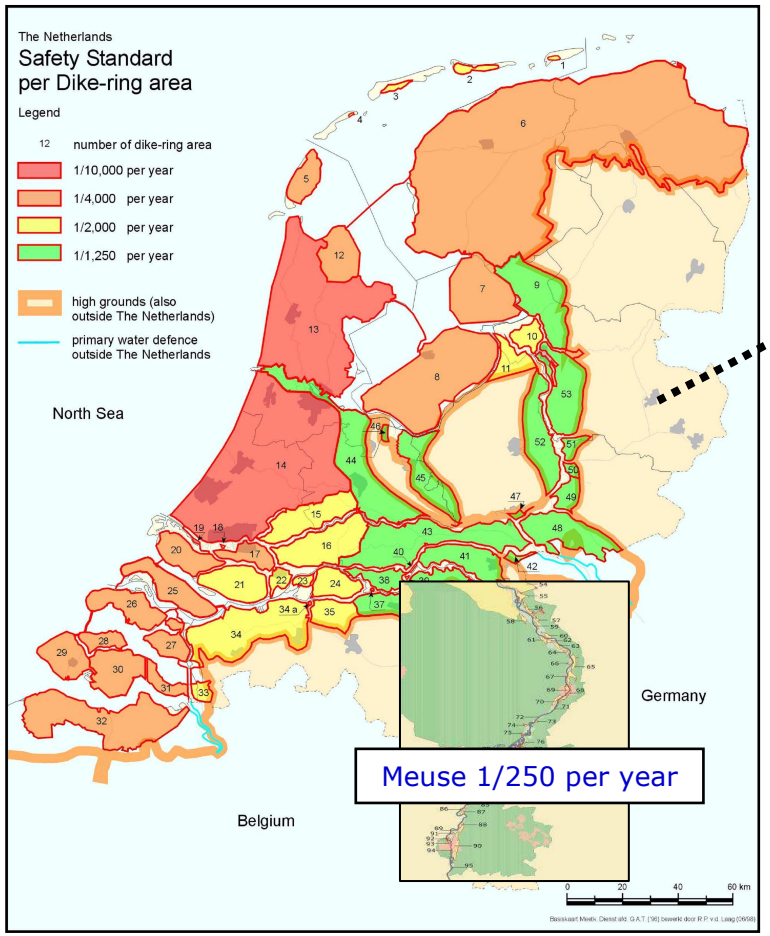
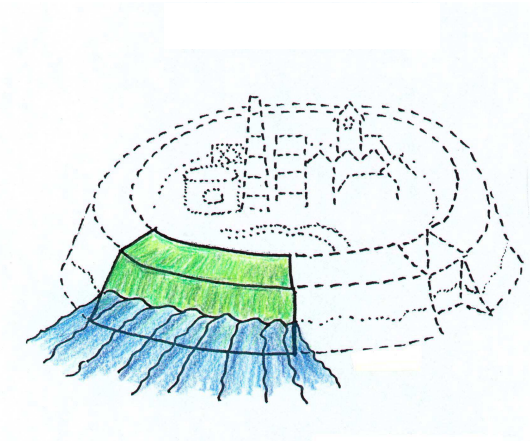
Center for Water Management

April 14th 2011

Flood protection standards



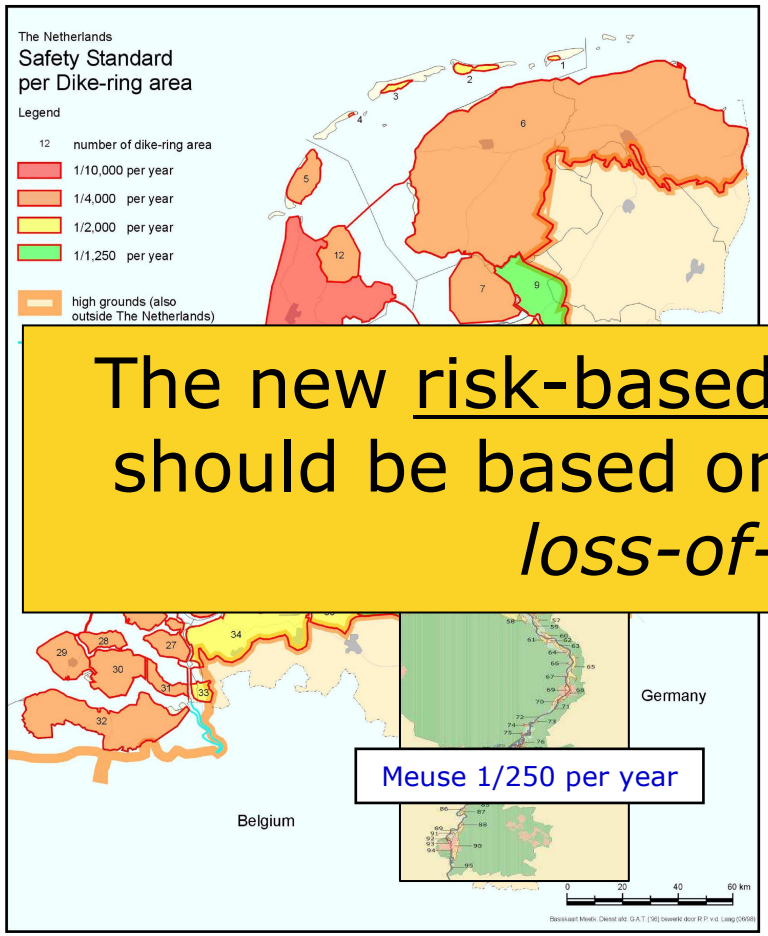


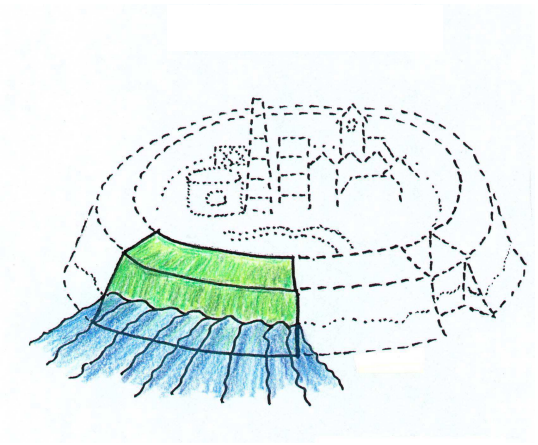
Exceedance frequency
for a levee section

2017 (?)

Flood probability
for a levee system

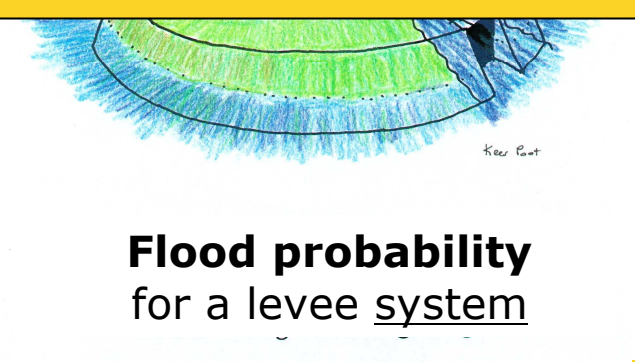
Flood protection standards





Exceedance frequency
for a levee segment

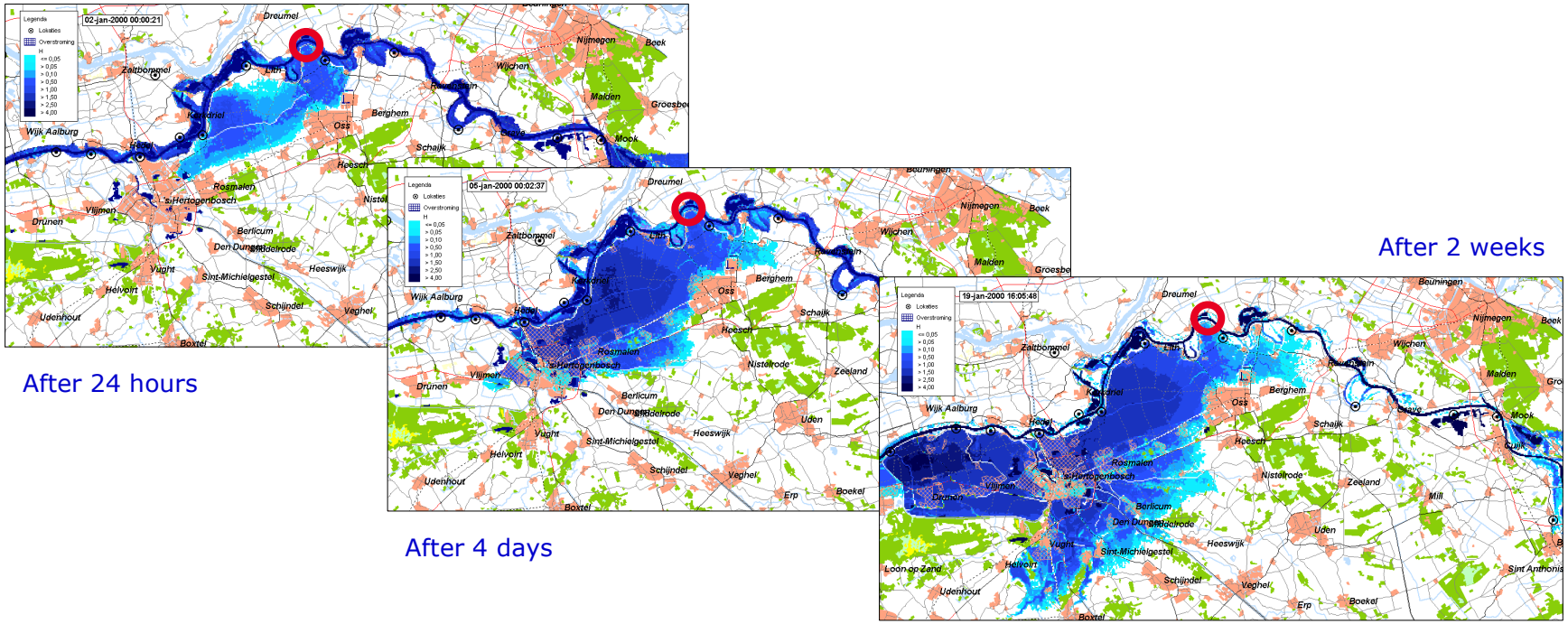
The new risk-based flood protection standards should be based on *cost benefit analyses* and *loss-of-life* calculations



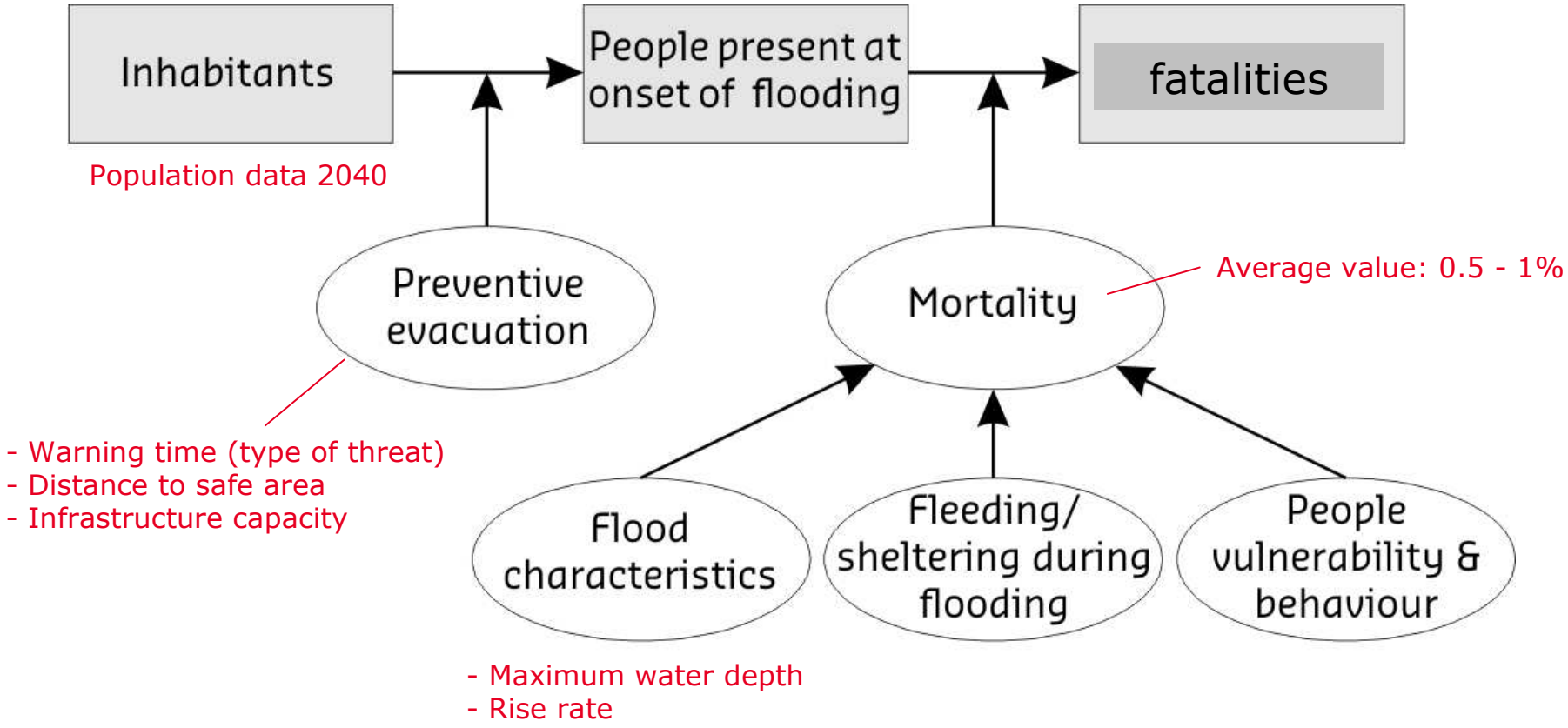
Flood probability
for a levee system

Method

- All levees just comply to the current protection standards
- One failure mechanism considered (overflow and wave overtopping)
  - In the FLORIS research project 9 mechanisms are considered
- Flood simulations: single and multiple breaches

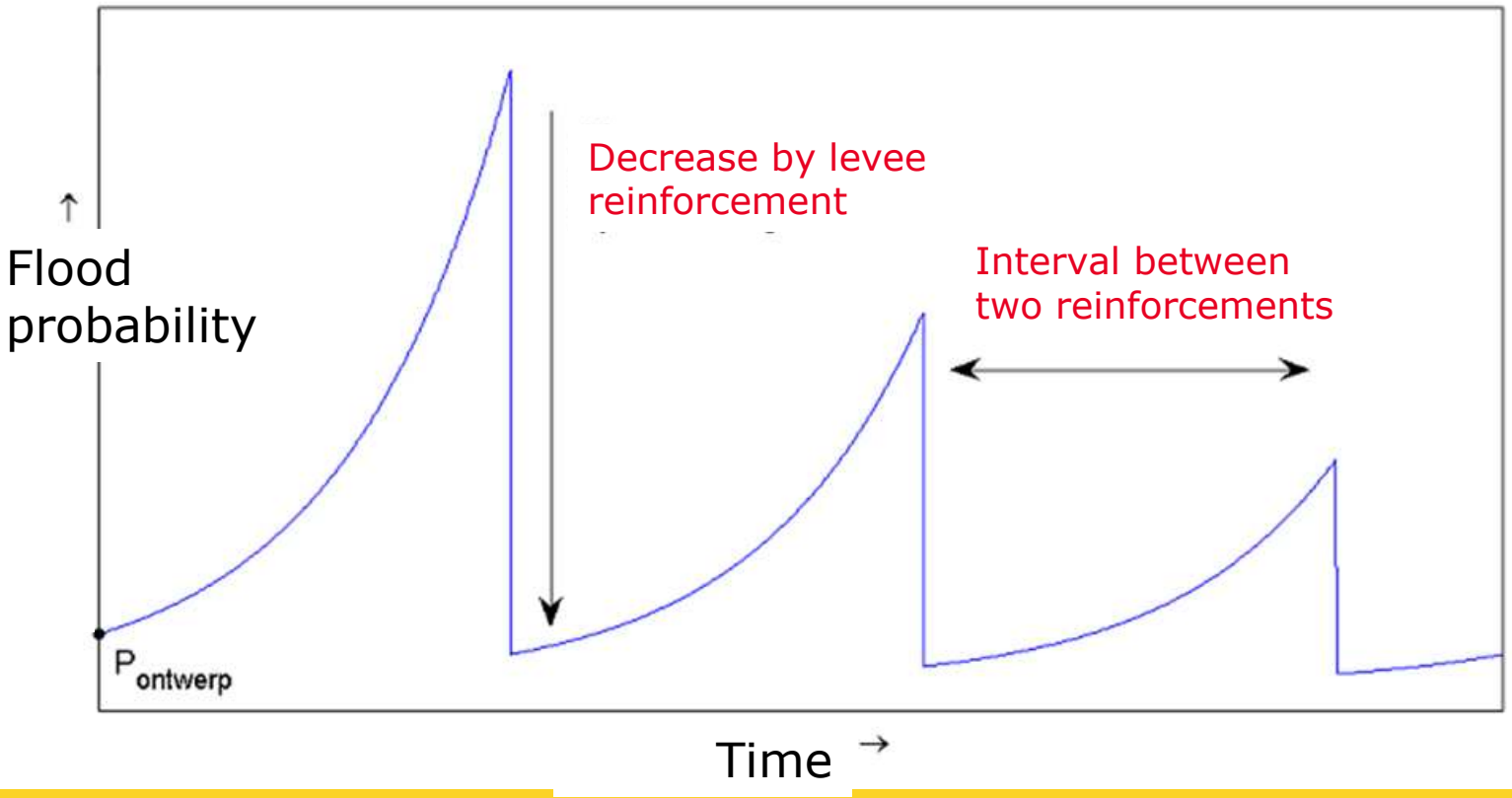


Loss-of-life calculations



Cost benefit analysis

- Economic growth rate 1,9%
- Discount rate 5,5%
- Value of a statistical life $ 10 million (5 persons being hospitalized included)



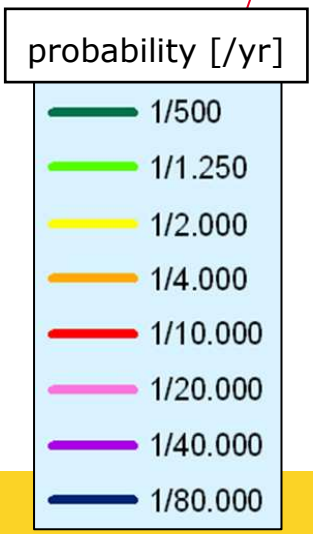
Cost benefit analysis results

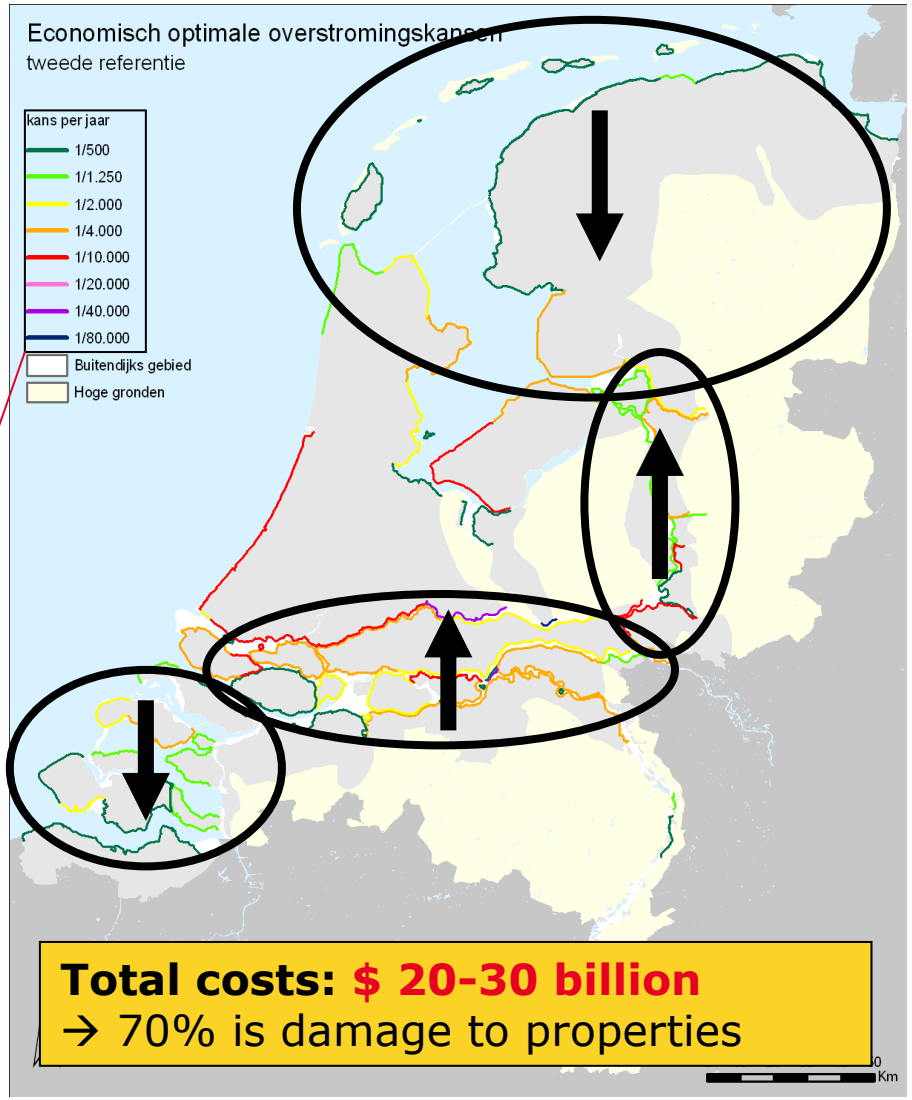
Economical optimal flood probability in 2050 [per year]

higher protection standards needed
- along the upper and tidal rivers

lower protection standards are more cost effective
- in the north part
- south-west delta

other areas: maintain current protection standards

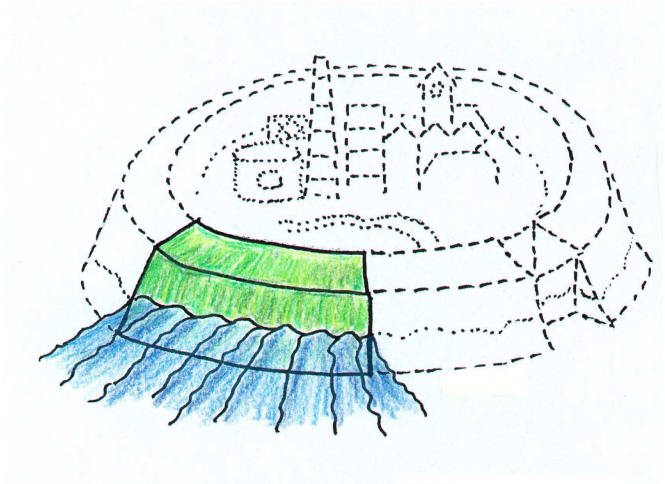




Total costs: $ 20-30 billion
→ 70% is damage to properties

Exceedance frequencies values do NOT represent the same protection level compared to flood probabilities values !!!

Exceedance frequency
for a levee section



Flood probability
for a levee system

1/1,250 exceedance frequency ≠ 1/1,250 flood probability
but about 1/250 per year

Loss-of-life considerations

Useful indicators are:

- Individual risk
  - A person's probability to die at a certain location
  - measures a base level of protection for everyone

- Societal risk
  - Is related to many fatalities due to one flood event
  - measures the extent of economic and social disruption

→ These indicators have been used for our industrial safety policy for many years (and have legally bound limit values)

Individual Risk - considerations

- Based on
  - Maximum of average value (for each levee system)?
  - For populated areas only of complete 'dike ring'-areas?
  - With or without evacuation possibilities taken into account?

- Tolerable limit value
  - 1/100,000 per year?
  - 1/million per year (like legal industrial safety limit value)?

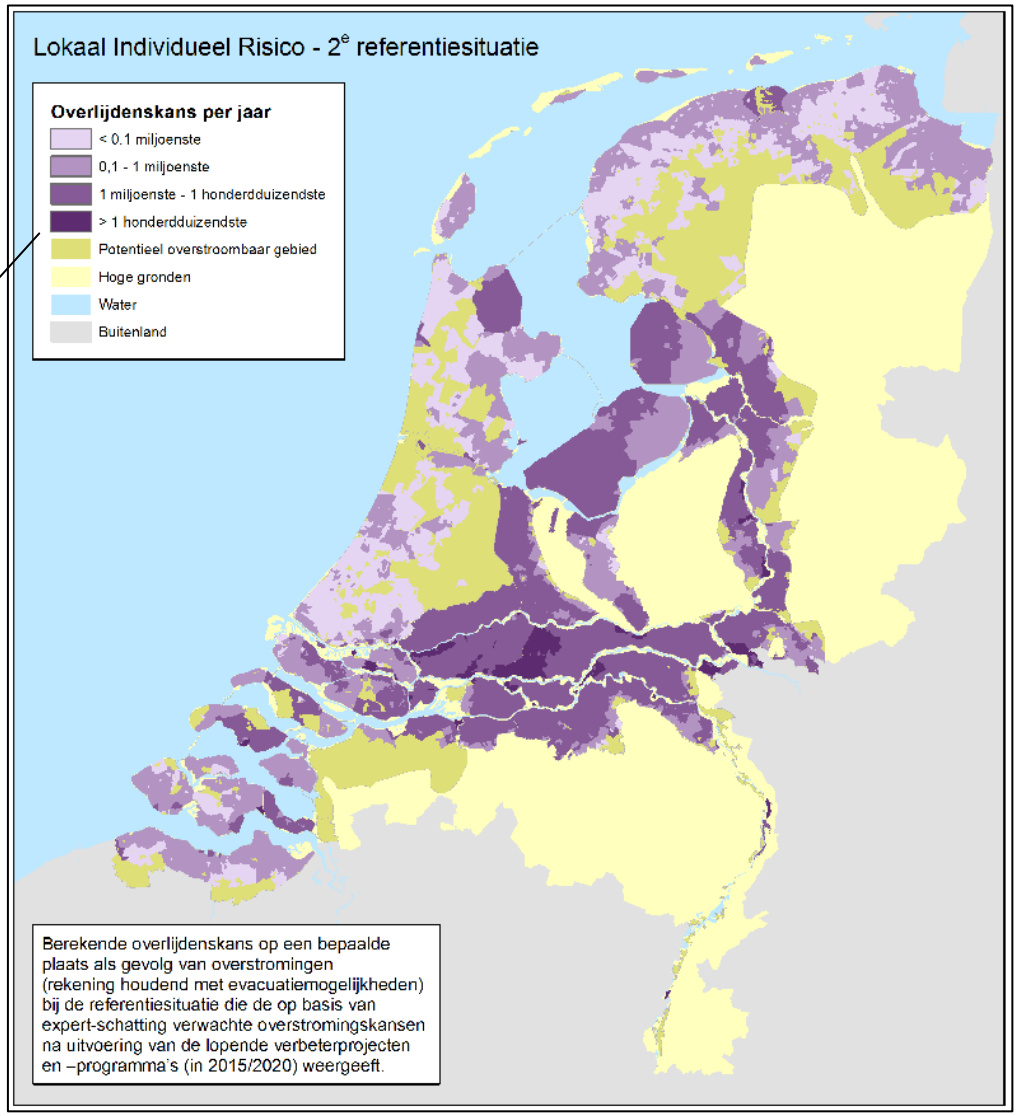
- <u>Proposal</u>
  - Flood probability should depend on the number of people living within a 1/100,000 /year (or 1×10^{-5}) level area

Individual Risk results

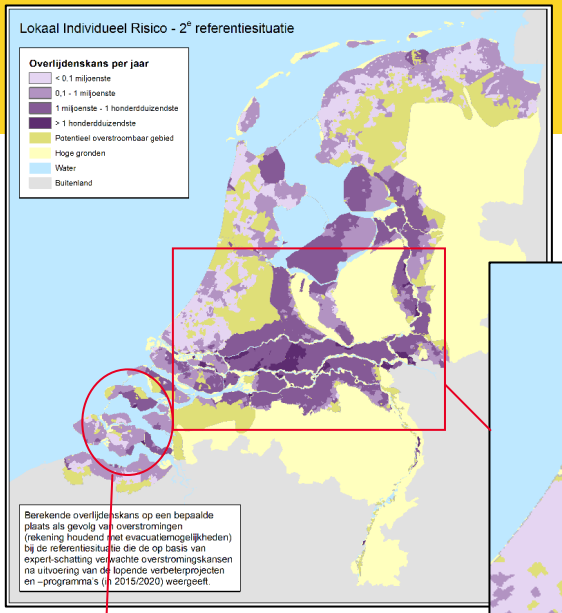
→ Situation in 2015–2020 after completion of the current levee reinforcement program

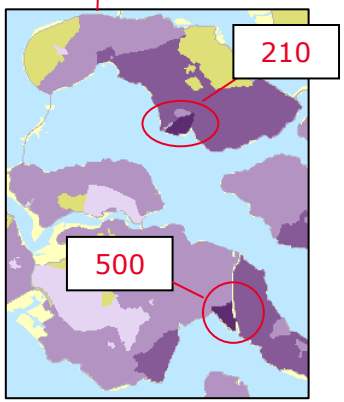
Individual Risk [per year]

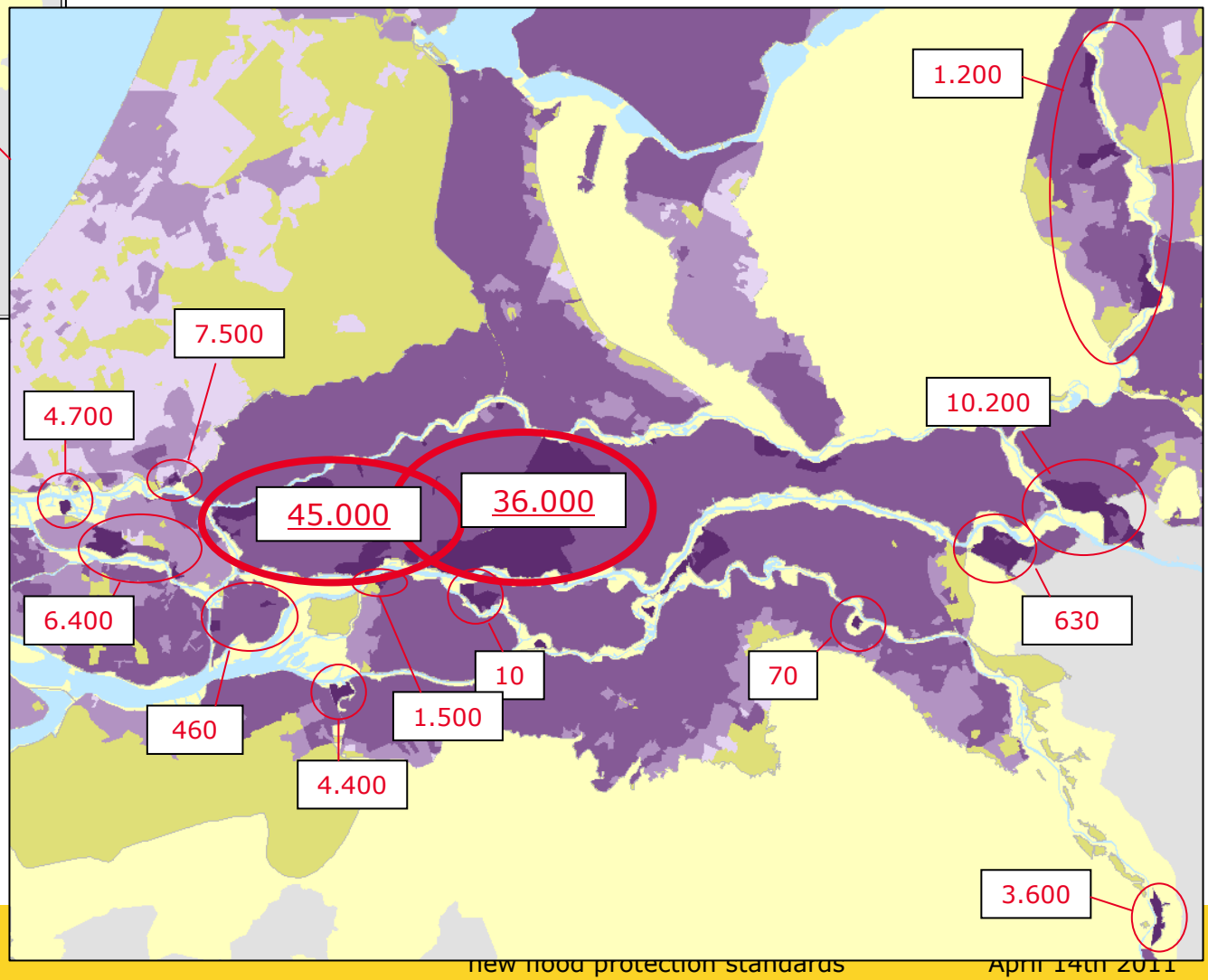
- $< 10^{-7}$
- $10^{-7} - 10^{-6}$
- $10^{-6} - 10^{-5}$
- $> 10^{-5}$

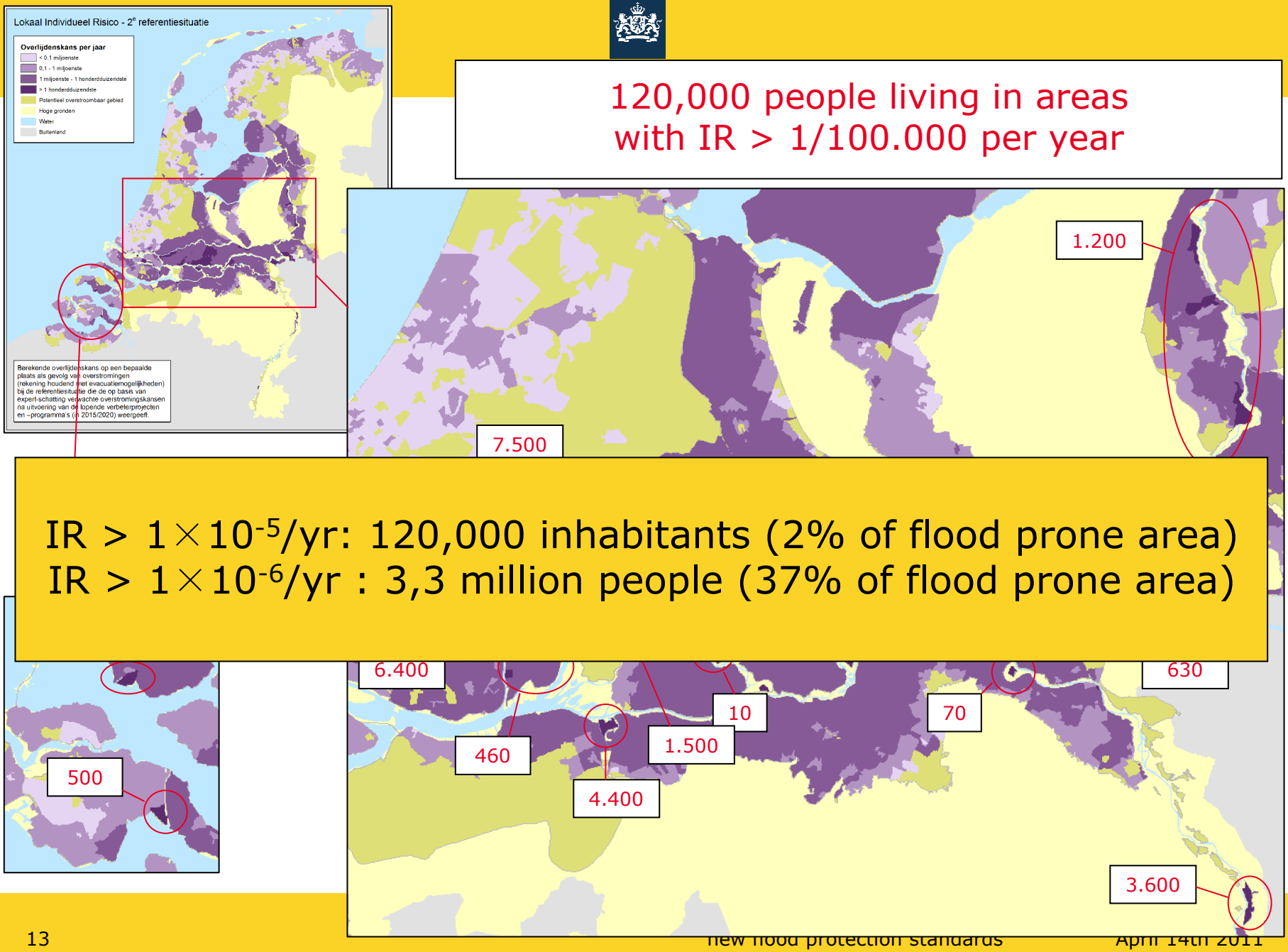


120,000 people living in areas with IR > 1/100.000 per year









120,000 people living in areas with IR > 1/100.000 per year

IR > 1×10^{-5}/yr: 120,000 inhabitants (2% of flood prone area)
IR > 1×10^{-6}/yr : 3,3 million people (37% of flood prone area)

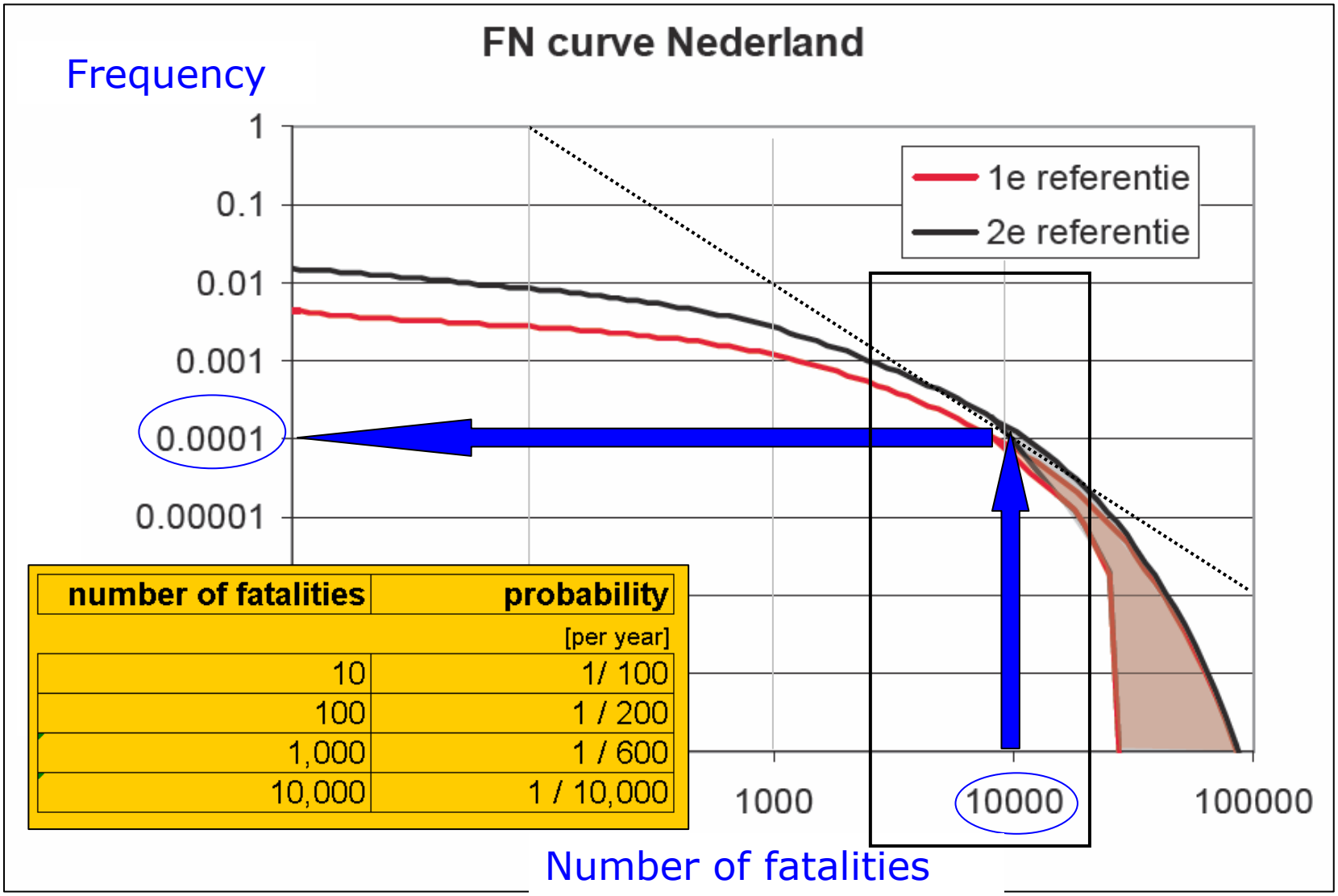
Societal Risk - considerations

→ "Societal Risk = Individual Risk + population data"

- Based on
  - 'dike ring'-area of a national scale?
  - Risk neutral or risk averse?
  - With or without evacuation possibilities taken into account?

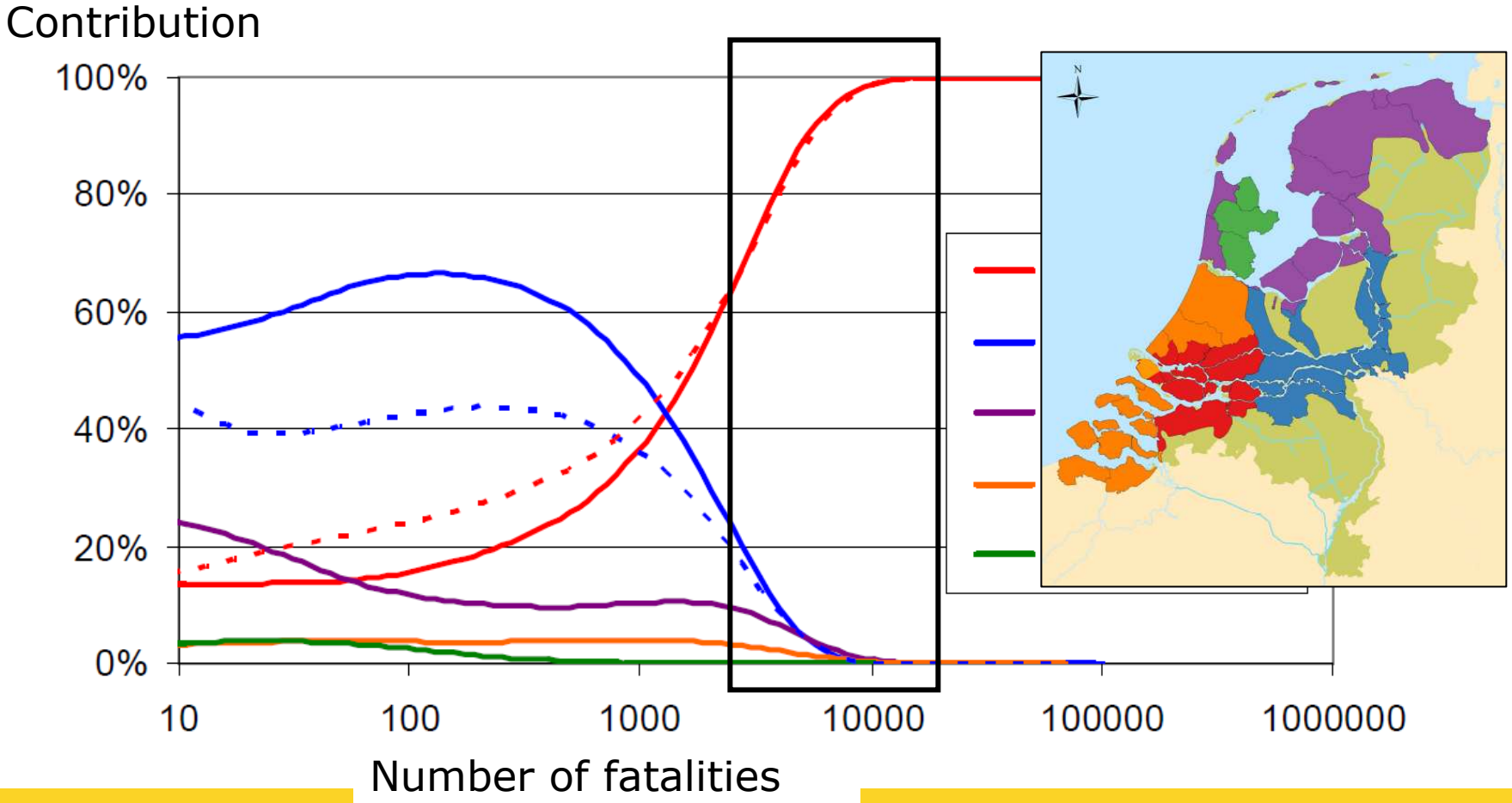
- Tolerable limit value?
  - legal industrial safety limit value not useful …
  - Based on a general framework of the *Expertise Network on Flood Protection* in which acceptance of risk in terms of voluntariness and direct benefit are key factors?

Societal Risk results (2015–2020)



number of fatalities	probability [per year]
10	1/ 100
100	1 / 200
1,000	1 / 600
10,000	1 / 10,000

‘Dike ring’-areas along the tidal rivers have the largest societal risk contribution



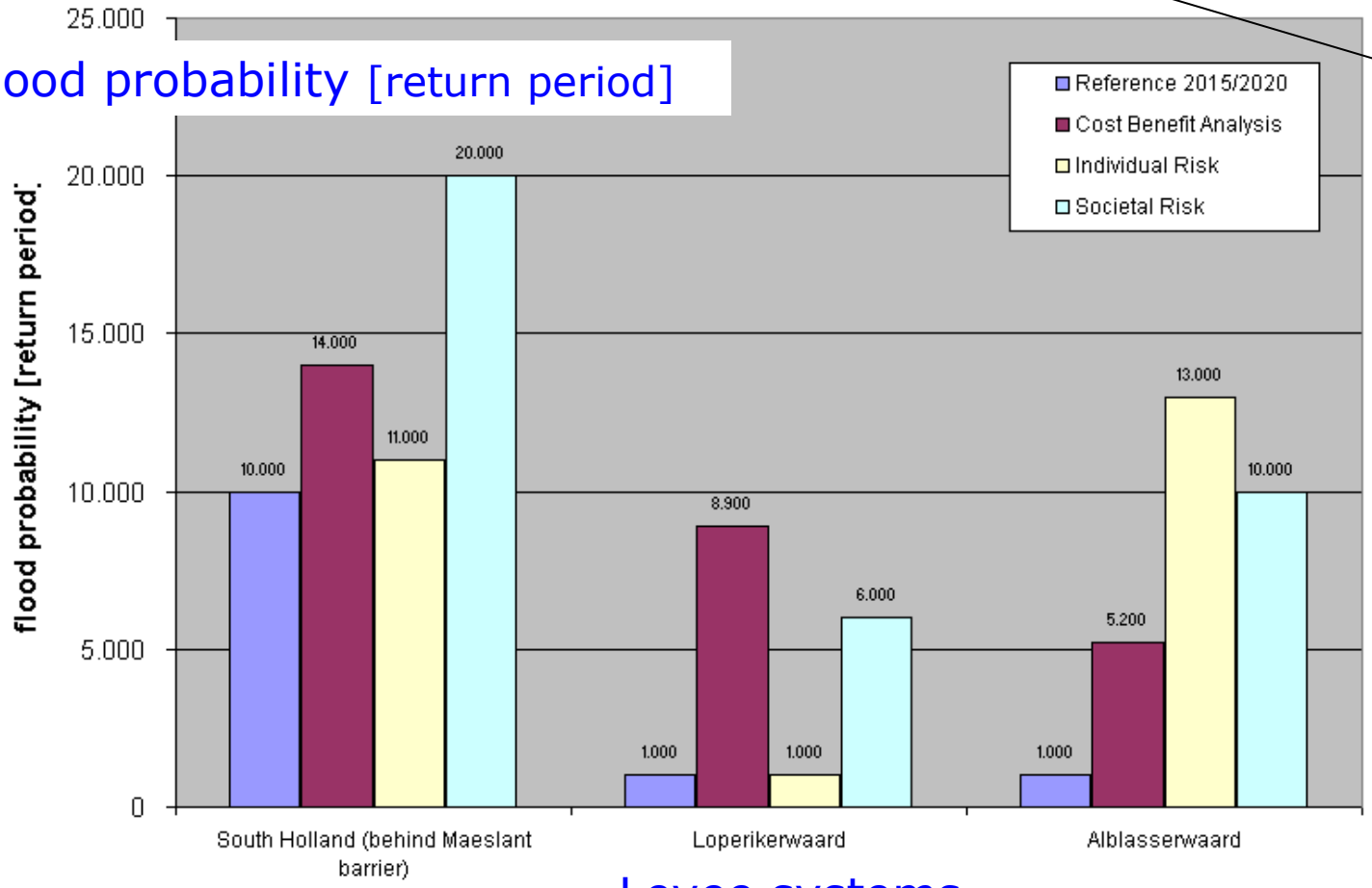
Summary

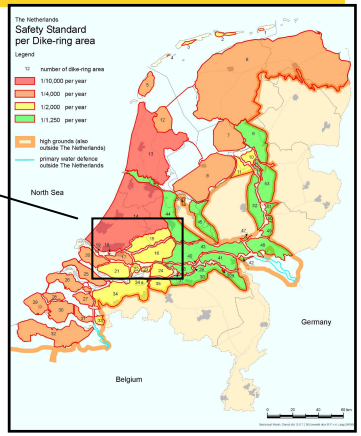
Possible higher protection standards necessary …

- Cost Benefit Analysis
  - Dike ring areas along the upper and tidal rivers
  - Flevoland (south-west)
- Individual Risk
  - Upper and tidal rivers
  - A few areas in the south west delta
- Societal Risk
  - Some ‘dike ring’-areas along the tidal rivers

→ **example** based on chosen IR and SR limit values …

New flood protection standards based on CBA and loss-of-life?





Flood protection standards 2050 - considerations

→ new classes of protection standards

- Most stringent criterium: CBA, Individual or Societal risk?
- Based largely on cost benefit analysis results?
  - With some minor risk reduction by loss-of-life analysis?
- Based largely on loss-of-life calculations (IR and/or SR)?
  - With some minor risk reduction by CBA analysis?
- Allow large differences between levee systems within a region?

→ Suggestions?

Planning 2011

- March 31th 2011: CBA and loss-of-life analysis finished
- April 2011: proposal Ministry (for each Delta Program region)
  - whether higher flood protection standards are recommended?
  - and if: how much more stringent should these become in 2050?

Planning 2011

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- April 2011: proposal Ministry (for each Delta Program region)
  - whether higher flood protection standards are recommended?
  - and if: how much more stringent should these become in 2050?

- May – October 2011: consultation with stakeholders
  - Water Boards, Provinces, Municipalities, other Ministries ..

- End 2011: "Policy statement" of the Secretary of State concerned with Water Affairs
  - for the Delta program (regions)