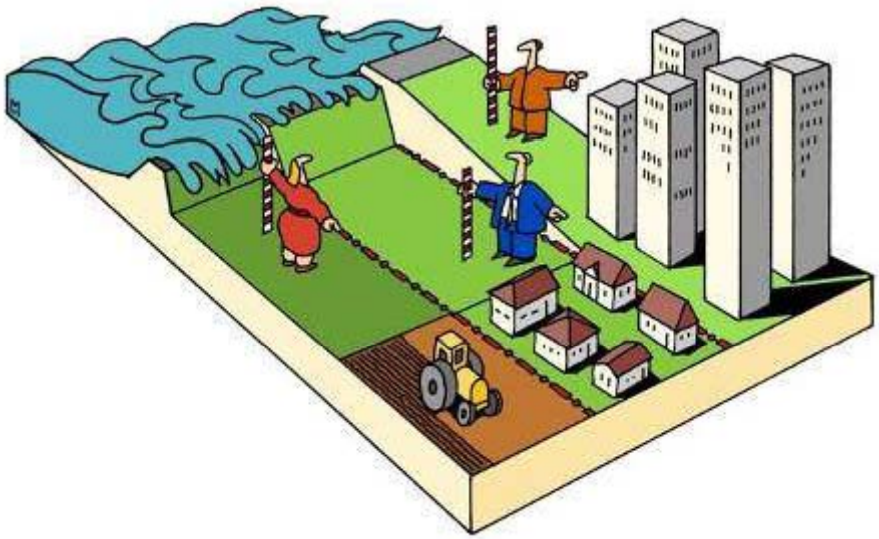
Rijkswaterstaat
Ministerie van Verkeer en Waterstaat



Towards climate proof flood risk management in the Netherlands

Jos van Alphen

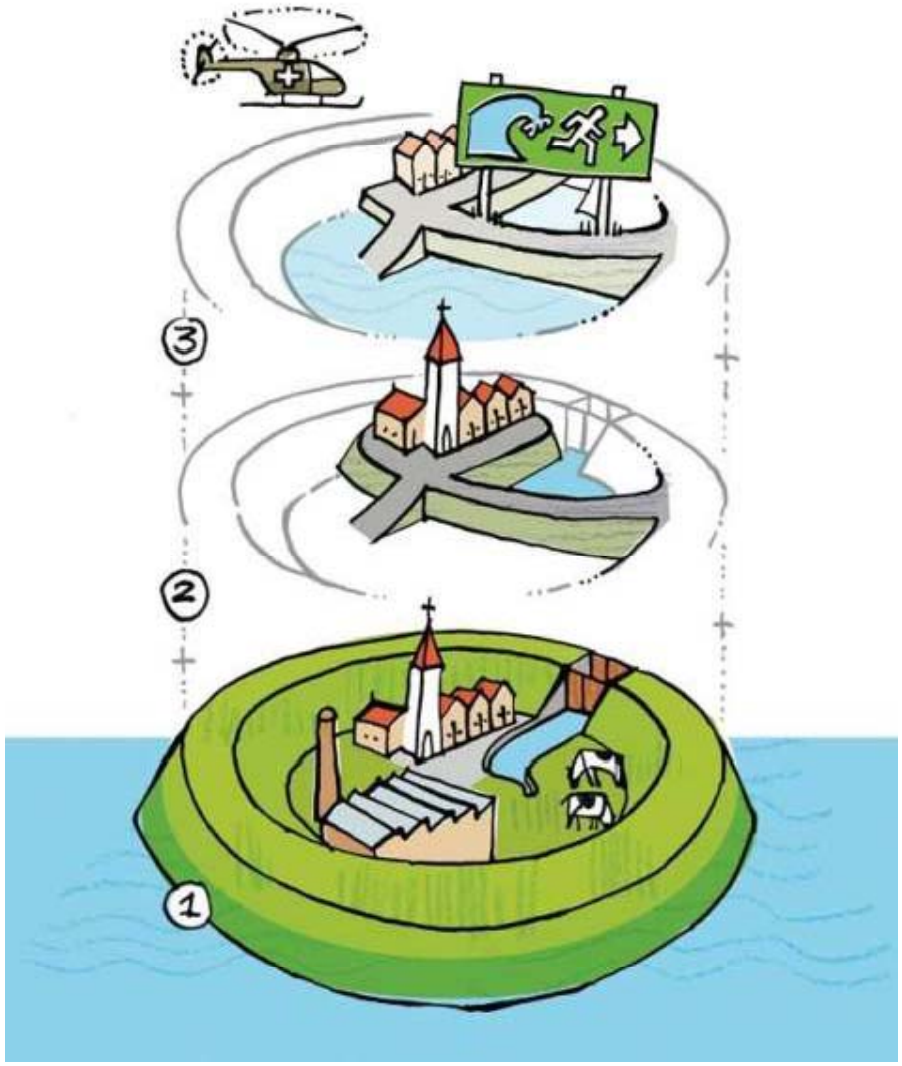
15 June 2010

EU Floods Directive, 2007
National Water Plan, 2009:
3 layered approach

Disaster management

Spatial planning

Protection (“corner stone”)



Climate change adaptation? Delta-programme!

Five key decisions (< 2015)

- Flood protection standards (2011)
- Fresh water supply
- Spatial planning and urban redevelopment

- Tidal rivers area (Rotterdam-Dordrecht)
- Future water level Lake Ijssel

Towards new flood protection standards

Deltacommittee II (recommendation 1) and National Water Policy plan,2009:

1. Actualize <u>risk based</u> standards of flood protection
2. Anticipate on the future (2050)
3. Prevent fatalities and large scale disruption (→ "societal risk")
4. Include new knowledge on failure mechanisms, flood patterns and damage

Expected outcome (early 2011)

Proposal to Parliament on new protection standards for flood defences (type & level)

- Type:
  - exceedance frequency of dike section
  - probability of flooding of dike-ring
- Level: to be based on probability and consequences: damage, fatalities, societal disruption, (no decrease compared to present);

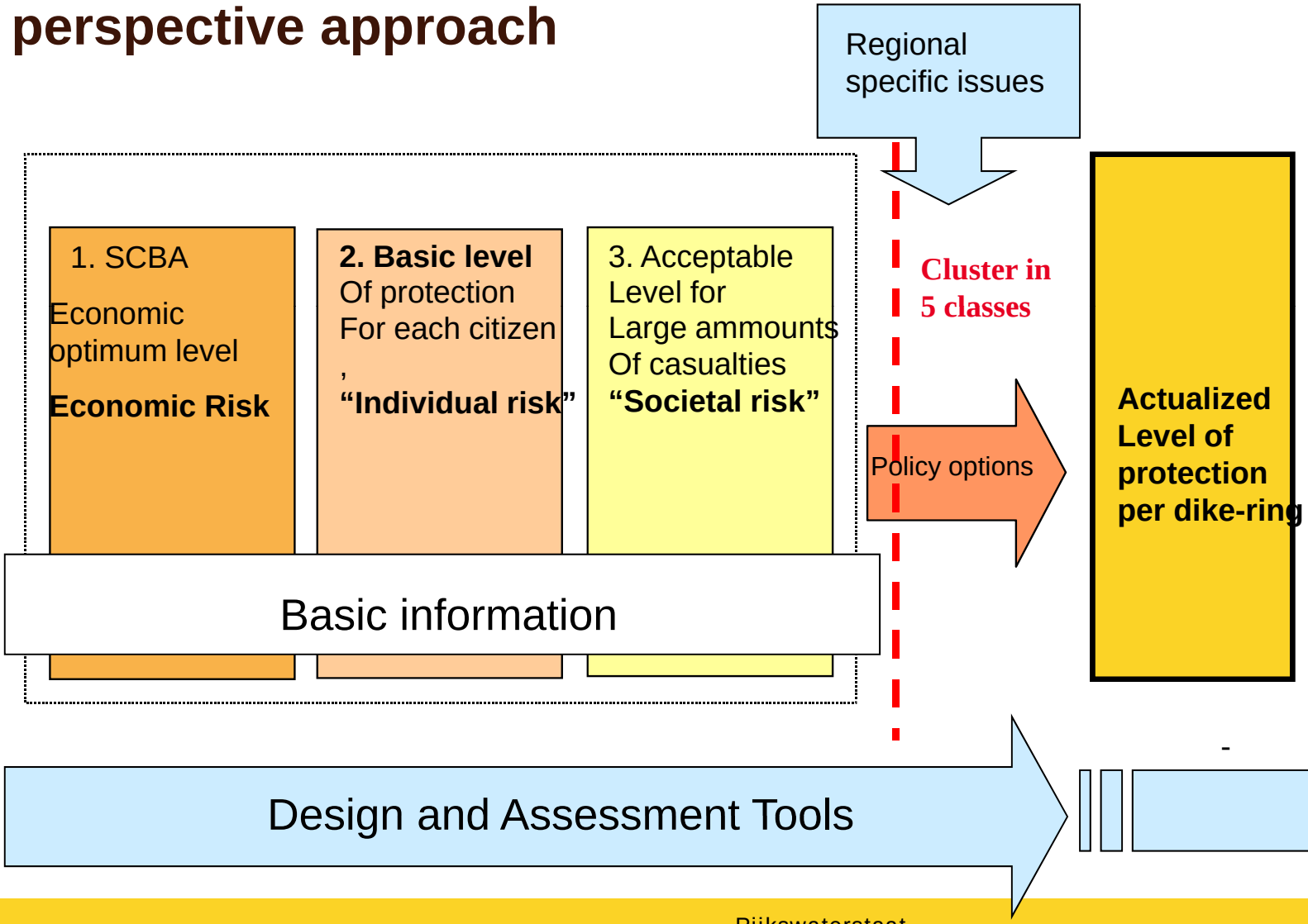
N.B:

- Spatial differentiation, however limited number classes (5);
- practical/assessable;
- Robust, → anticipate on climate change and developments in land use 2050.

Process

- “dry swimming” with involved authorities regarding expected type of standards, level, practical aspects, knowledge required,… (2009)
- Inform and consult regional authorities (spring 2010)
- Inform and consult non-governmental organisations (spring 2010)
- Inform and consult public (regional panel groups) (summer/autumn)
- Inform and consult technical experts (ENW) (regularly)

3 perspective approach



Basic assumptions

Some examples

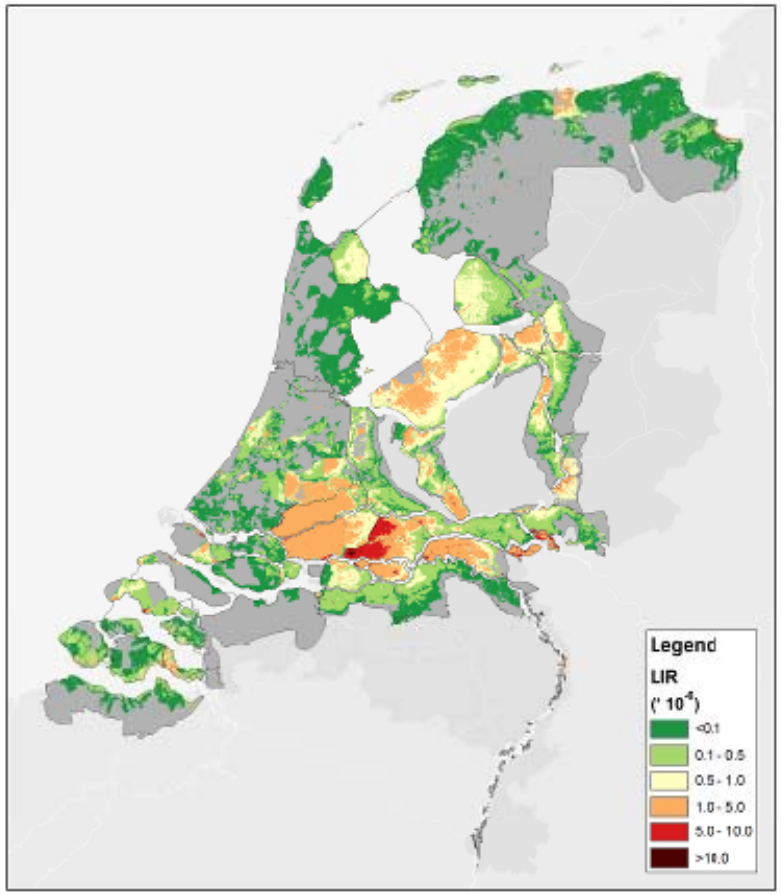
- Frequency of exceedance = probability of flooding
- Sealevel in 2050 and 2100: + 35 and + 85 cm (max., ref. 1990)
- Failure due to overflow and overtopping, > 1 l/m/s
- Economic growth 1.9 % per year
- Disconto rate: 4%
- Value of Statistical Life (VOSL): 7 million euro

Perspective 1: Societal Cost Benefit Analysis (SCBA)

Optimization per dike-ring
of costs to improve the dikes
and avoided damage (2050) →

- Costs of dike-reinforcement (buildings!!)
- Anticipated flood levels
- Flooding scenario's + HIS-SSM
  - Economic damage
  - Economic value of fatalities (7 million euro)
- Values of landscape, nature and culture, damage to vital infra, indirect damage: x 1,5 to 2
- Disconto-rate

Perspective 2: Basic level of protection for each citizen / Local Individual risk



Local Individual Risk (LIR) =

Evacuation %

X

Probability of flooding

(= design exceedance frequency)

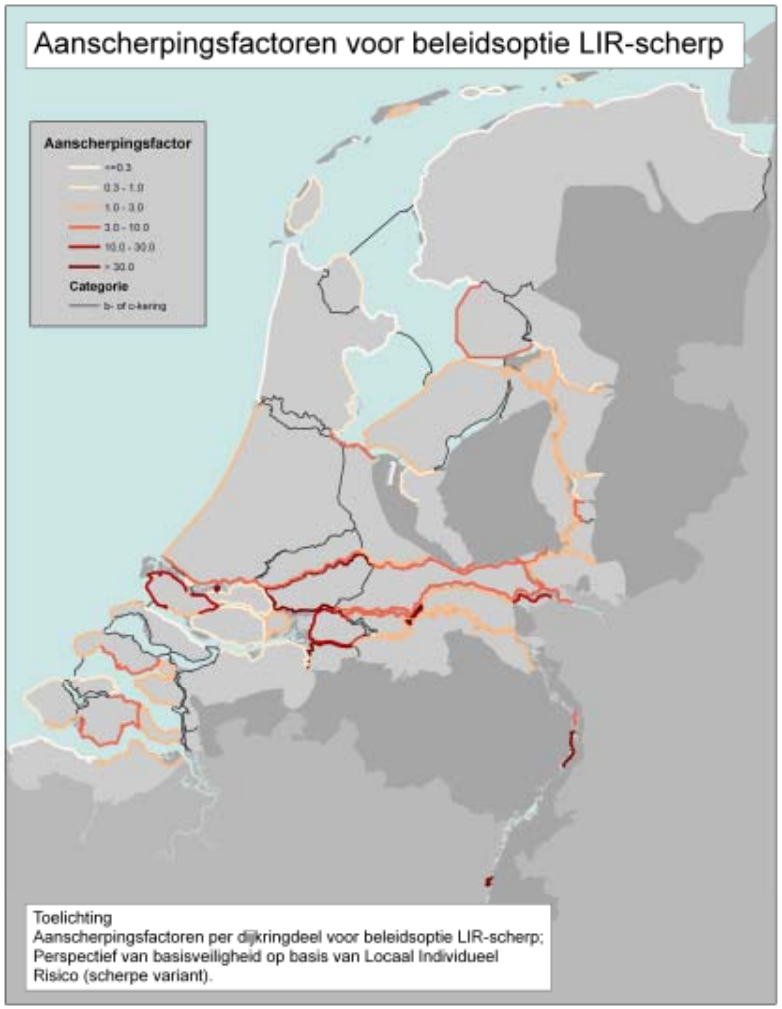
X

Flooding pattern (depth, rate of rise)

X

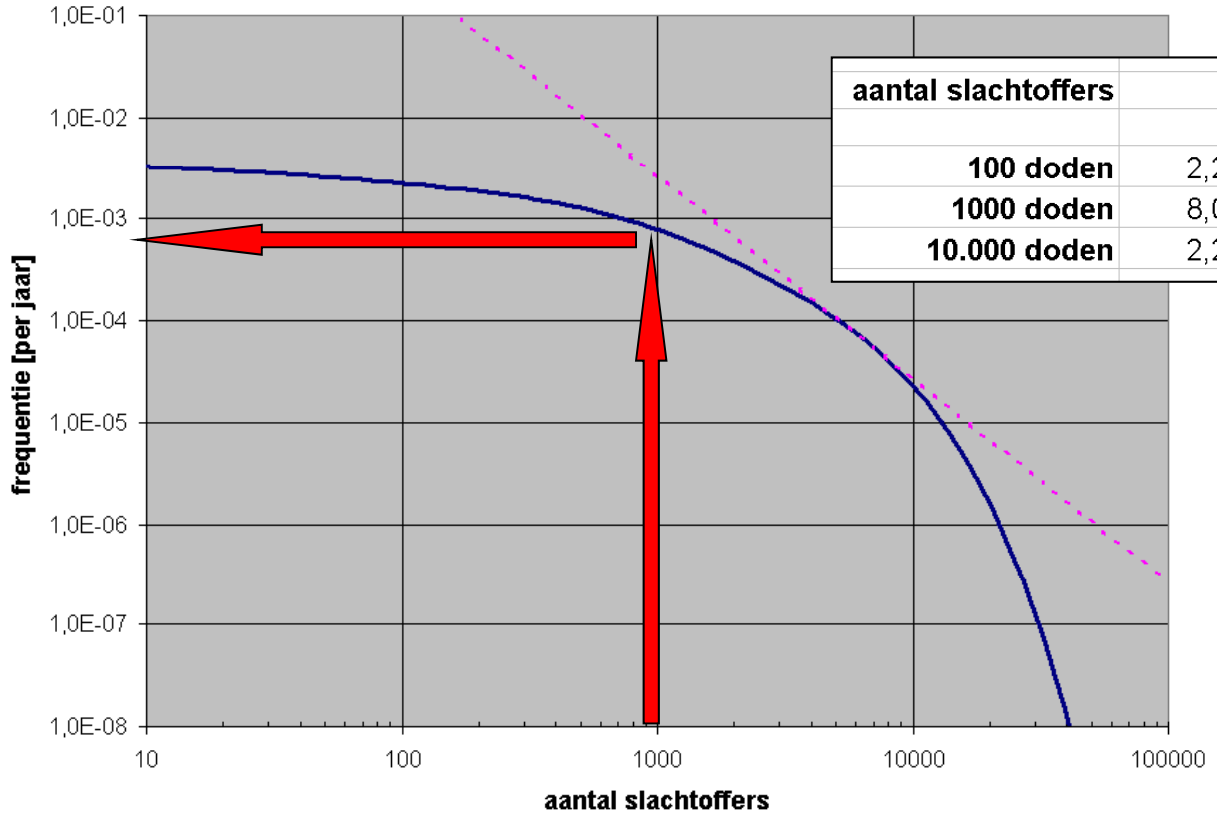
Mortality of non-evacuated (HIS-SSM)

Improvement of flood protection standards/ LIR



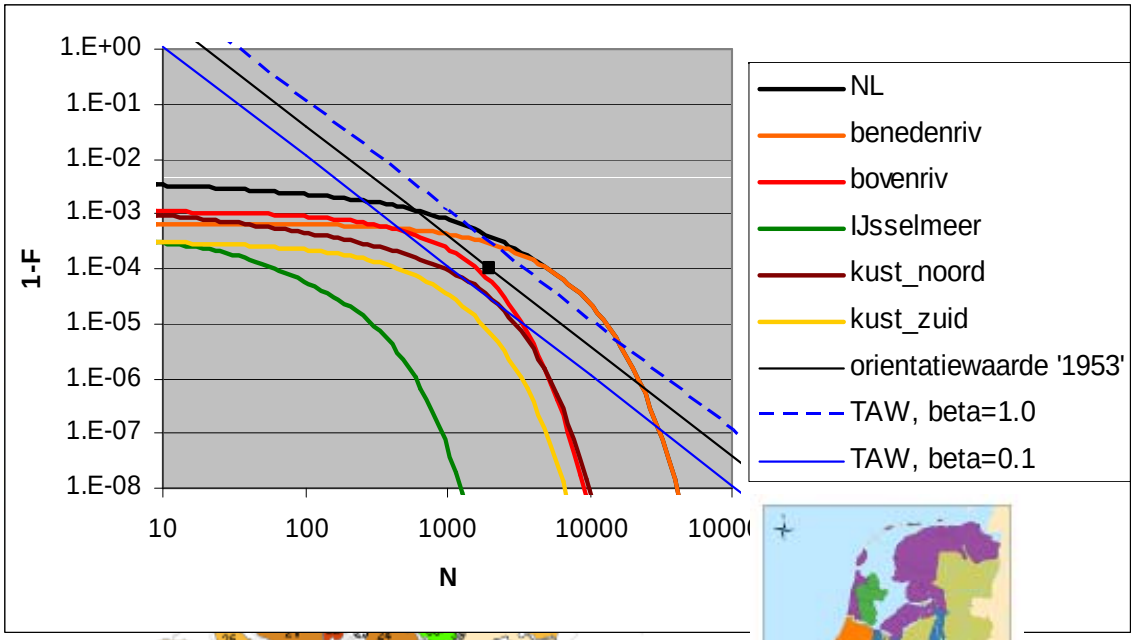
Degree of improvement	Ammount of dike-ring sections	
	LIR-light 10^{-5}	LIR-stringent 10^{-6}
factor < 1.0	62	23
1.0 < factor < 3.0	4	25
3.0< factor < 10.0	5	14
10.0< factor < 30.0	1	4
factor > 30.0	3	9
Total	75	75

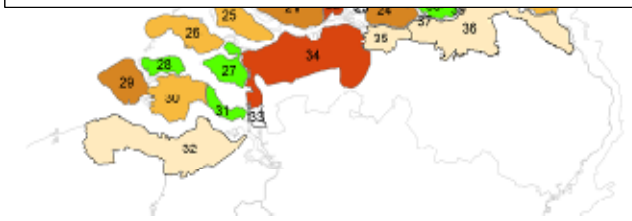
Perspective 3: Large numbers of fatalities / Societal Risk



aantal slachtoffers	kans	
100 doden	2,2 x 10^{-3}/jaar	1/450 per jaar
1000 doden	8,0 x 10^{-4}/jaar	1/1250 per jaar
10.000 doden	2,2 x 10^{-5}/jaar	1/45.000 per jaar

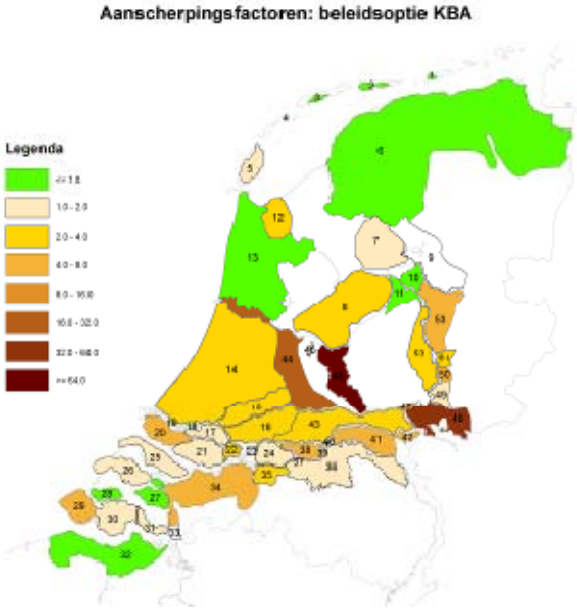
Societal Risk



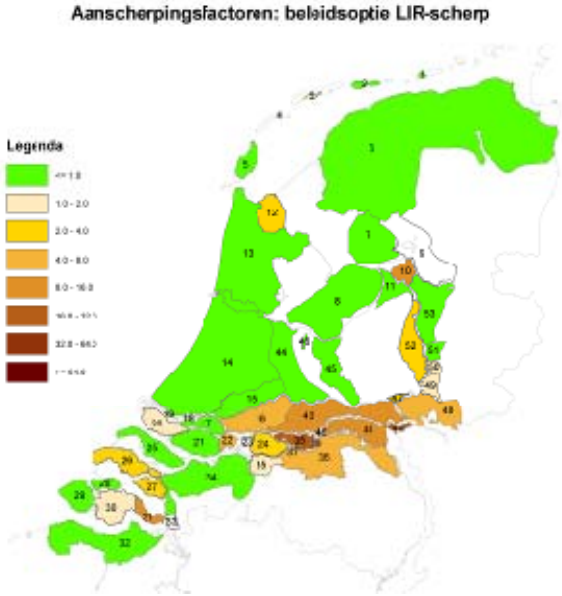


- Aggregation of regions to a national FN curve;
- Confront with tolerable risk limit (risk-averse)
- → Desired flood protection level per dike-ring
- → Priority towards tidal rivers region

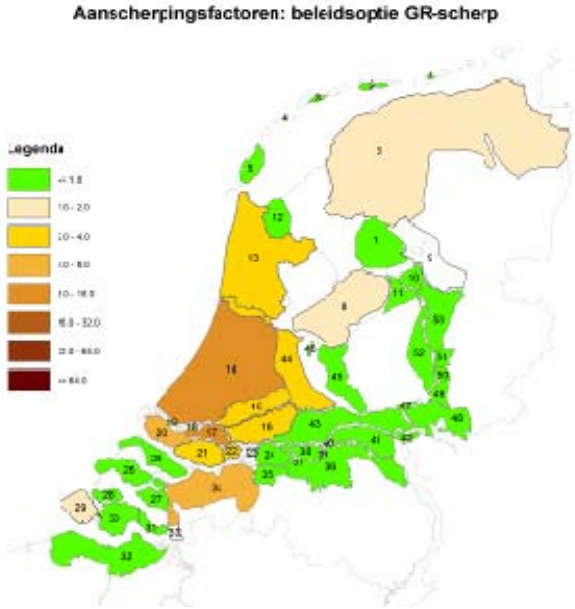
Optional improvement of flood protection standards, 3 perspectives



SCBA



LIR



SR

Effects of perspectives

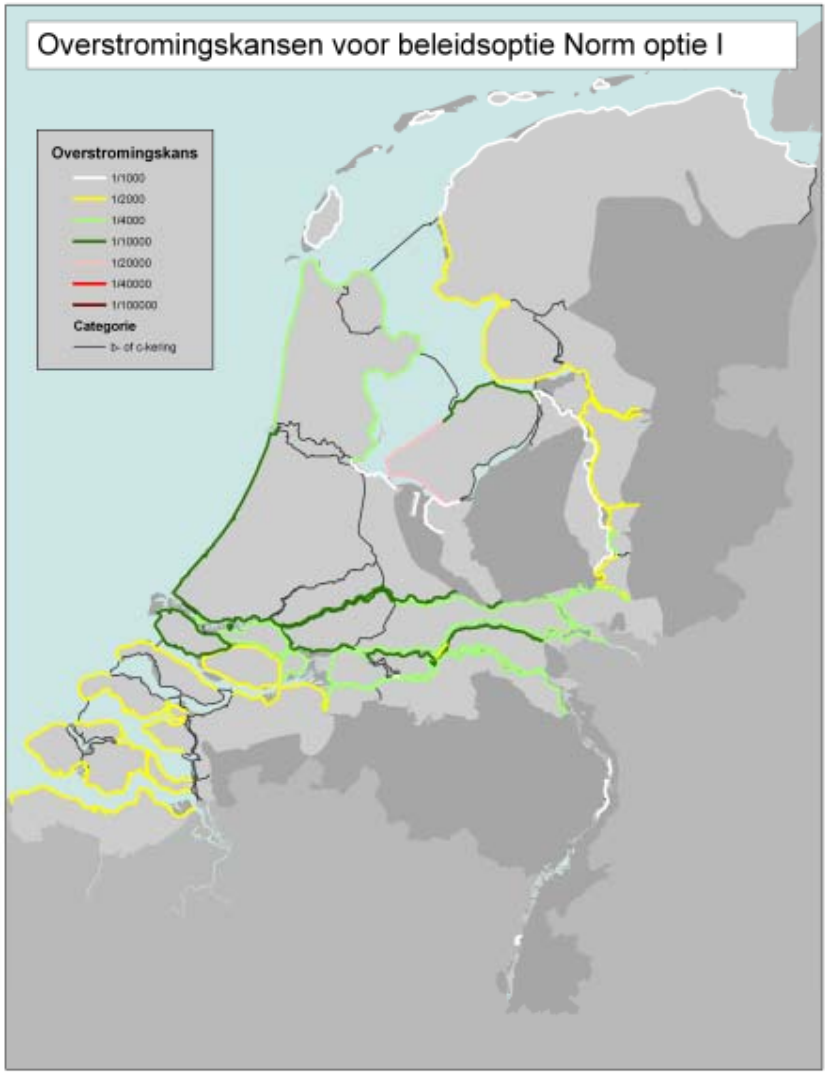
Economic effects (in 10^{-9} Euro)	REF	SCBA	LIR (light)	LIR (stringent)	SR (light)	SR (stringent)
Investment *)	8,9	9,1	5,0	12,5	9,8	13,1
Residual risk damage	11,1	3,6	23,3	3,2	9,2	2,9
Total	19,9	12,7	28,3	15,8	19	16

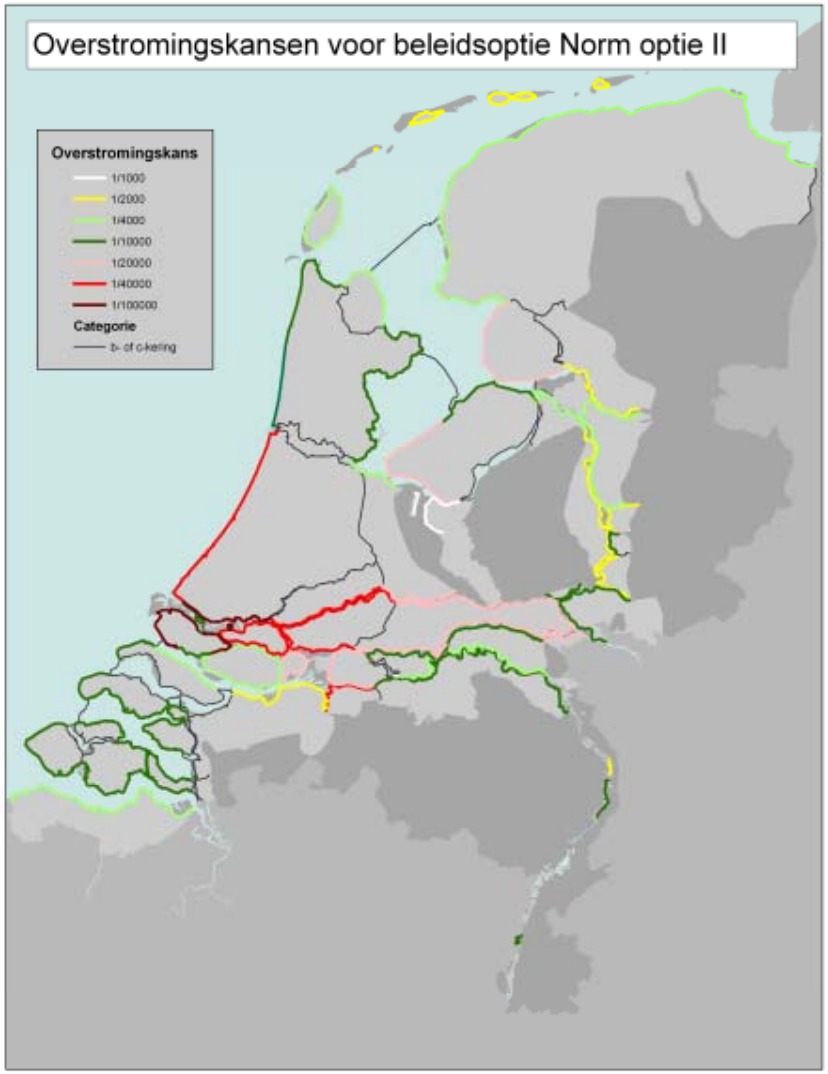
*) until 2050, expressed in euro's in 2010

2 options to combine SCBA, LIR and SR

characteristics	**Option I**	**Option II**
Focus on:	Optimize investments	Reduce fatalities
Fatalities	***Light***, i.e. LIR: 10^{-5}/y SR: ß=2	***Stringent***, i.e.LIR: 10^{-6}/y SR: ß =1
"No decrease of protection level"	Results of SCBA determine level of protection, decrease might occur	Protection level is at least similar to present situation
Classes in protection level	5 (1/1000 - 1/20.000)	7 (1/1000 - 1/100.000)

Flood protection levels

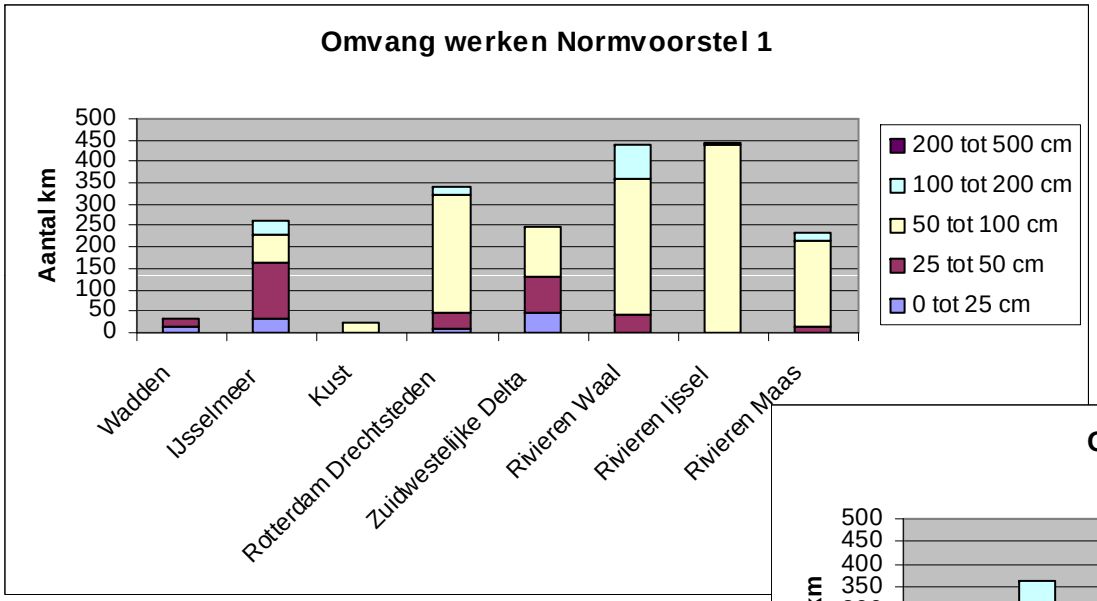


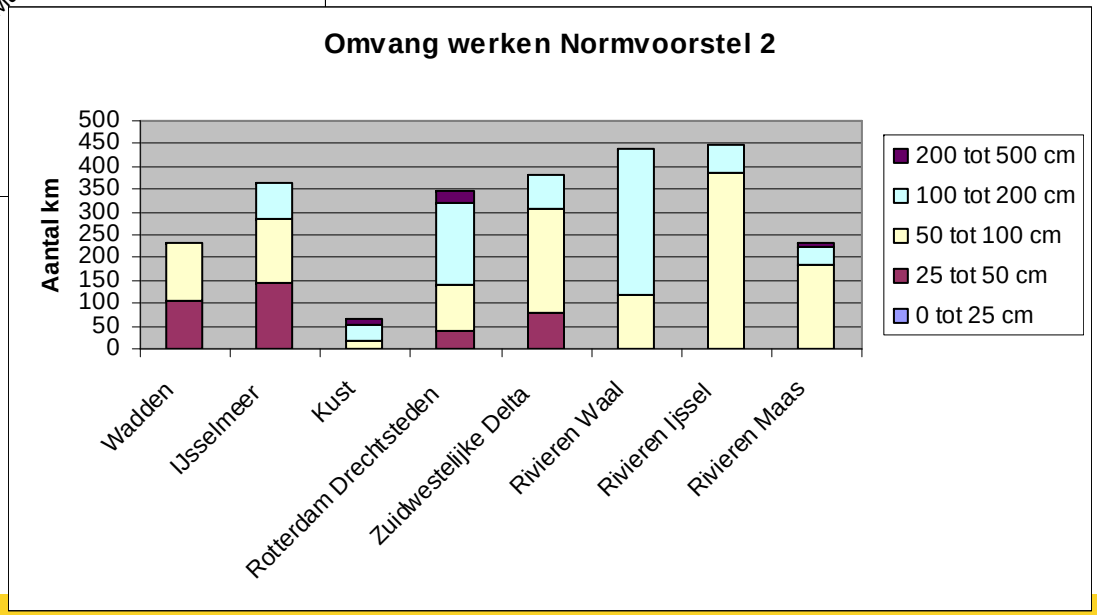


Improvement of flood protection level

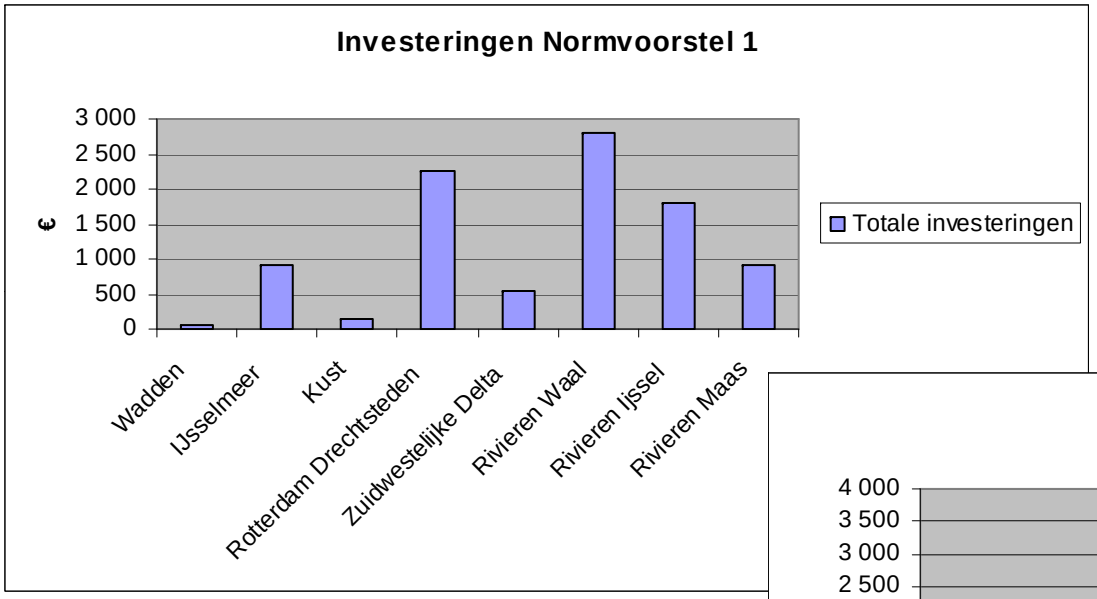
	Number of dike-rings to be improved	
	option I	option II
factor < 1.0	40	21
1.0 < factor < 3.0	12	18
3.0< factor < 10.0	22	22
10.0< factor < 30.0	1	10
factor > 30.0		4
Total	75	75

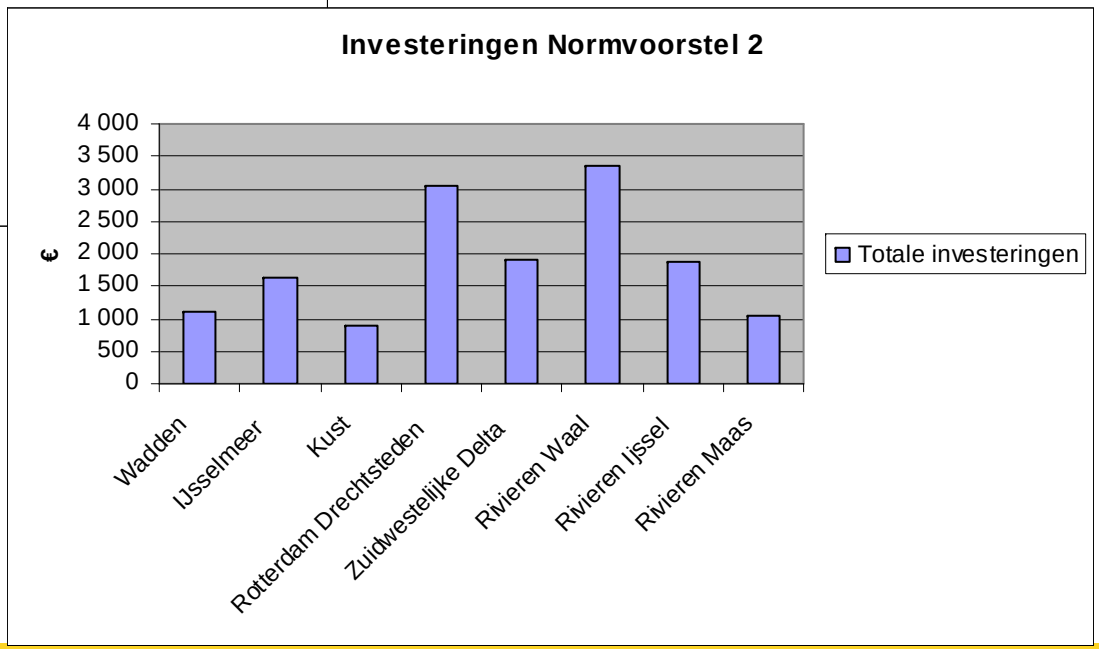
Dike reinforcement involved (height, km's)





Required investments





Option I and II compared

(10^9 Euro, 2010)		SCBA	option I	option II	Delta Com. (f*10)
Investments		9,1	10,3	15,5	19,5
Residual risk damage		3,6	3	1	0,5
Total		12,7	13,3	16,5	20

Dike reinforcements (in km raising with ..cm)		SCBA	Option I	Option II	Delta Com. (f*10)
25 - 50 cm		280	330	370	60
50 - 100 cm		1380	1440	1300	1270
100 - 200 cm		100	150	790	1210
Total		1830	2020	2510	2570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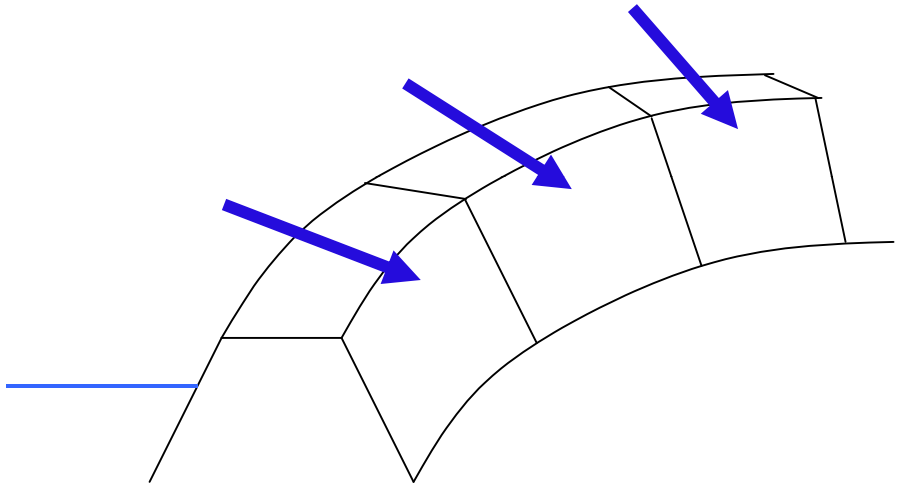
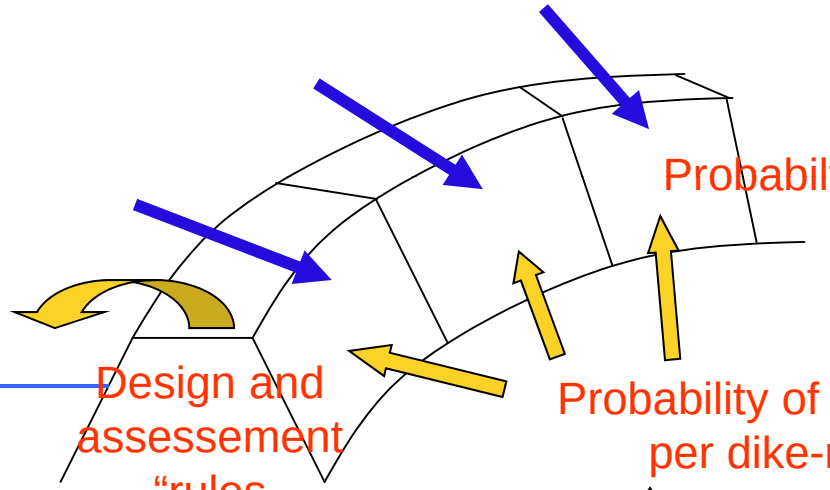
Exceedance frequency of extreme flood conditions



Probability of flooding



Probabilty of flooding per section

Exceedance frequency of extreme flood condition

Design and assessement "rules

(faïlure mechanisms & "length effect")

Probability of flooding per dike-ring

Protection level, based on SCBA, LIR and SR

Policy goal: a safe delta