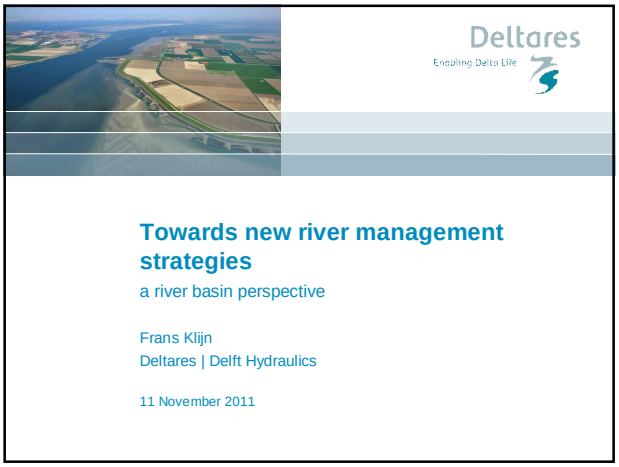


Deltares
Enabling Delta Life

Towards new river management strategies

a river basin perspective

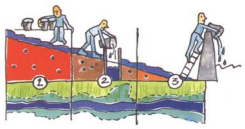
Frans Klijn
Deltares | Delft Hydraulics

11 November 2011

Principles of flood control (WB21)

Consider the possibilities of (in order of preference):

- **Retention** in the catchment
- **Storage** in detention areas
- Enlargement of **discharge** capacity



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Conclusions IRMA-SPONGE (2001)

Land use change has effect on discharge, but almost negligeable during extreme events (< 1:100)

Influence of climate change is significant

Land use change cannot counteract the effect of climate change (only about 4 % of area, saturated or frozen soil)

Upstream retention cannot entirely prevent downstream floods (controlled detention may help)

In large complex basins, complex interactions must be studied (flood simulations for different scenarios)

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Statement 1

As country with the best protection against floods in the world we must stop pointing upstream, requiring that areas which are already confronted with huge floods solve our problem

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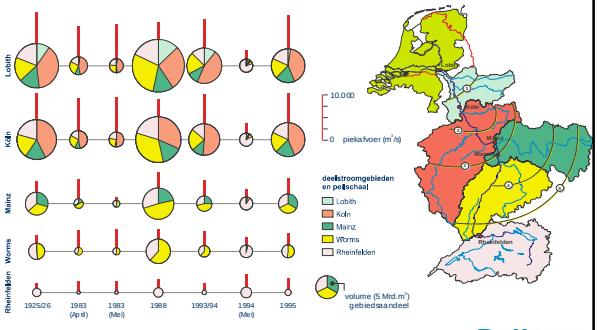
Complex basins, complex interactions



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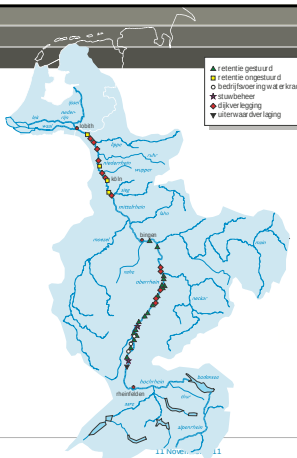

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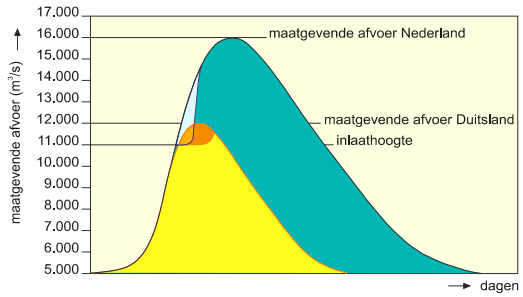
Effect of detention in Germany: negligable



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Findings on measures in Germany

general: they do not worsen things

general: effect at medium high to high discharges (1/200 – 1/500)

land use change: no effect

tributaries: local effect (on Rhine: plus or minus), depending on genesis

best measure (from Dutch perspective): don't act (i.e. allow flooding)

Deltares

Statement 2

The high safety levels applied in the Netherlands are unwise from an economic point of view and from a psychological point of view

Deltares

Present: flood control strategy

Wet op de Waterkering (Law on flood protection → Water Law/ Act): dike ring areas and design discharge (probability)

Design discharge: uncertain

Location of breach/ overflow unknown: Russian roulette

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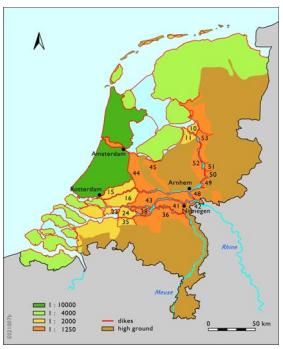
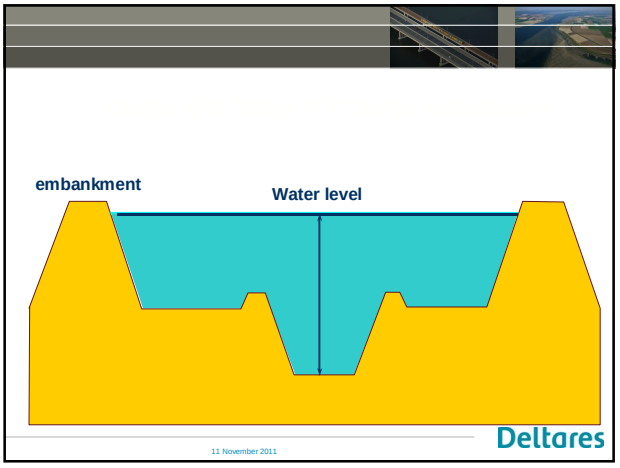
Protection against flooding

based on design discharge (1/ 1250 per year)

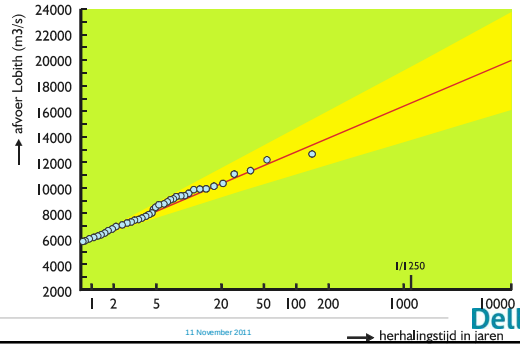
based on dike rings



Deltares



Design discharge uncertain



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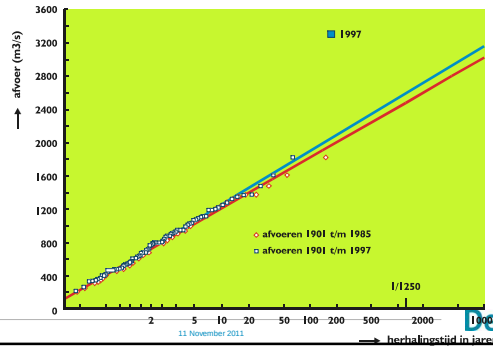
Oder before and after 1997 flood



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So what is a design discharge worth?

just statistics
1: 1250 year (16.000 m3/s)
surrounded with uncertainties (13.000-18.000 m^3/s)
hard to communicate (lay-expert conflict: 6% in a life-time)
can be next year
in a definitely changing climate

not suited for the *uncertainties* modern society wants to evade

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is so much discharge possible?

catchment area: 185,000 km^2
7,5 mm / day during one week on the entire catchment
assume: it all attributes to discharge

result: discharge at Lobith is 16.000 m^3/s

(185000 * 1000000 * 7,5 / 1000 / 24 / 3600)

Deltares

highest possible and highest measured discharge (period 1880 - 1995) in tributaries

Rivier	maximale afvoer* (m^3/s)	hoogst gemeten afvoer (m^3/s)	Meetstation	Datum
Oberrhein (Worms, incl. Neckar)	6.300	5.600	Worms	550117
Main	3.000	1.980	Frankfurt	950130
Nahe	1.200	1.150	Grolstein	931221
Lahn	950	840	Kalkofen	460210
Mosel	4.800	4.170	Cochem	931221
Nette und Wied	400	202	Nettegut, Friedrichshal	840207
Ahr	300	194	Reimerzhoven	840530
Sieg	1.600	1.053	Menden	840207
Wupper	300	181	Opladen	570923
Erft	80	55	Bliesheim	840531
Ruhr	2.300	907	Hattingen	940101
Emscher	430	200	schatting !	--
Lippe	1.200	370	Schermberg	950131
Totaal	**22.860**	**16.902**		

* Schatting van de afvoer die maximaal naar de Rijn kan stromen. Deze afvoercapaciteit is afgeleid uit de hoogst gemeten waarde en gegevens over de maximale afvoer aan de monding.

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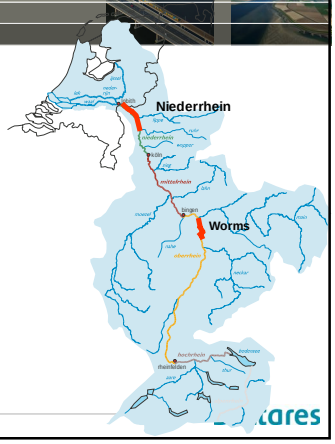
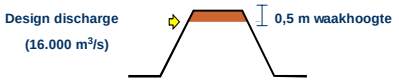
Decisive stretches



Deltares

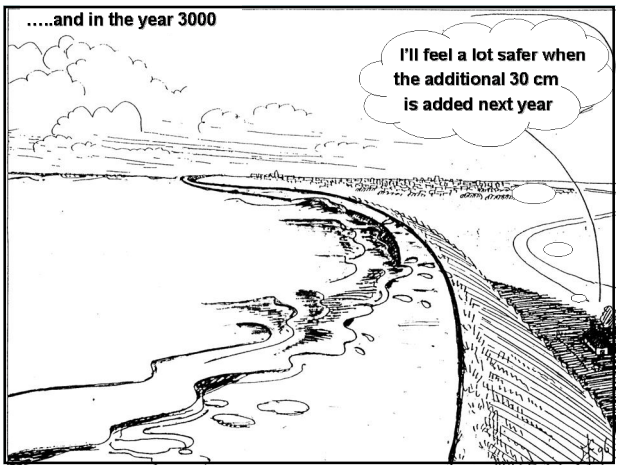


dike design Netherlands – Germany

Deltares

> 16.000 m^3/s in the present situation
about 18.000 m^3/s in 2015 and after that … ?

Deltares



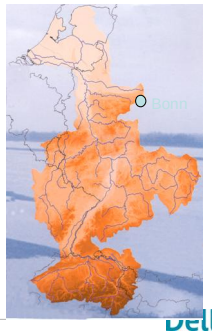
IRMA-SPONGE Living with floods: objective

Design and evaluation of flood risk management strategies

based on resilience

to enhance discussion

on the Lower Rhine



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Characteristics of project

Emphasis on planning/ normative discussion (creative design of measures and evaluation: policy analysis)

Long-term (analysis of *strategic* choices; 2050-2100)

Flood risk central concept; *not* design discharge

Not bound by existing dike-rings

Deltares

Flood risk

Risk = hazard * (exposure) * vulnerability

or

Risk = probability * damage

So either lower the probability or the damage potential

but what happens meanwhile in practice?

- economic growth: double each 30 years
- negative spiral: raise the dikes!

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Likely dike breaches?

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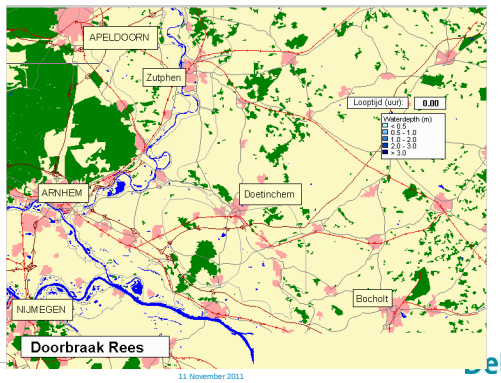

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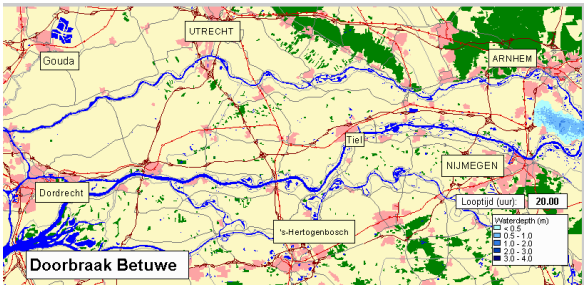

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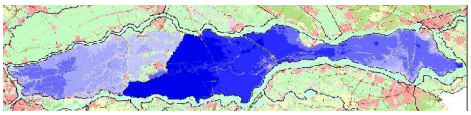
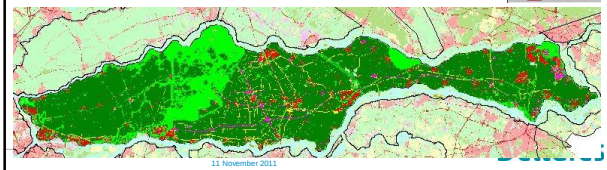
Max water depth (m)



Flood damage (m)



What happens if an extreme discharge occurs?

Damage (*10^9 €)

Discharge	16000	18000	20000
Rees	8.8	9.5	10.1
Kalkar	4.4	4.5	4.5
Lobith/ Rijnstrangen	1.5	2.4	3.3
Betuwe	17.3	22.7	35.9
Maas en Waal	4.4	4.7	5.0

***based on damage module of DWW-RWS**

is the capacity of the individual dike-rings exceeded?

Deltares

Conclusions

Flood probability can never be zero

Flood risk presently does not affect economic development and growth: damage potential doubles every 30 jaar

All dikes equally high does not mean equal risks

There are dangerously large dike rings

Deltares

Way out of the Russian Roulette?

Robustness = f (resilience, resistance)

Resilience is the ability *of a system* to persist by recovering after a (gradual) response to an external disturbance

Resistance is the ability *of a system* to persist by not responding to an external disturbance at all

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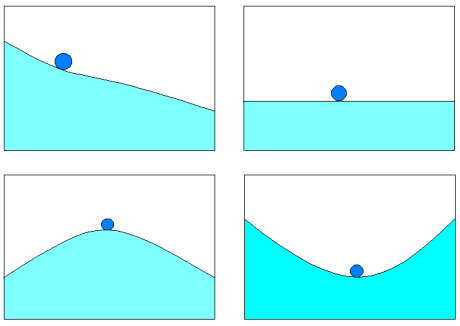
Stability concepts



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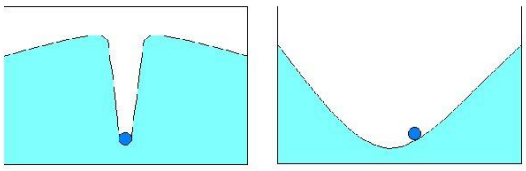
Resistence versus resilience



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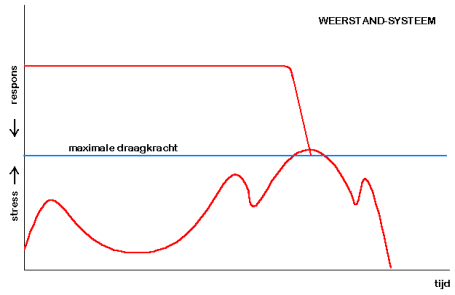
Stability or resistence ?



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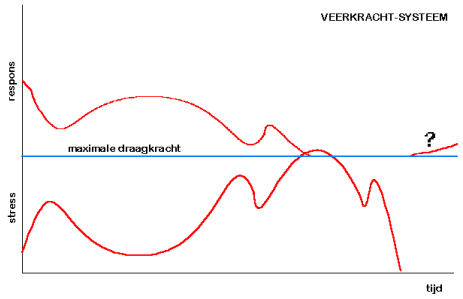
Resilience: recoverable ?



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Resilience = flexibility ?

flexible response to stress
recovery?

temporary stress (dynamics, within a range which is known in principle), or:
gradually increasing stress (trend)
so: … (instantaneous characteristic of a system)

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Flexibility

adaptation in time (i.e. response without recovery)
stress may increase: developments can be coped with and kept up with

flexible initial response is prerequisite for resilience

Deltares

So what is resilience in practice ?

not one design discharge but differentiation
- in view of hydraulic functioning

regain control over flood pattern
- by purposeful inundation (more frequent)

compartmentalisation of large dike-rings
- in view of limiting the damage potential (gradual)

risk-based land use planning
- adapt to flooding in some compartments (rapid recovery)

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Strategies for a sustainable future

More room for the river (hydraulic functions)
More room for natural developments: enhance *flood pulse* (naturalness) and *river continuum* (diversity and connectivity)
More resilience in view of uncertainties

By a risk approach: not only control the hazard, but also reduce the vulnerability
Through splitting-up large dike-rings and adapted land use

Deltares

Statement 3

Making room for rivers offers good opportunities for enhancing natural and scenic landscape qualities; it also helps to sustain the public awareness that natural risks cannot fully be controlled by 'the authorities'

Living with Floods' (IRMA-SPONGE project)
and robust blue-green corridors

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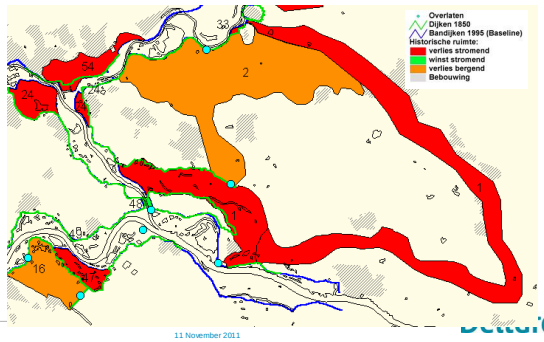
Recent losses of surface area for hydraulic functions (1850-2000)



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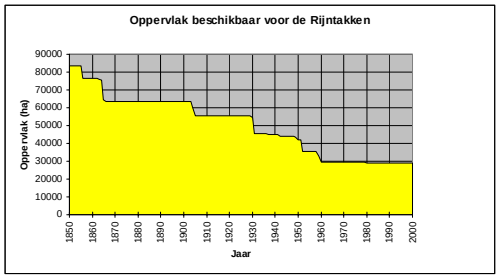
Loss of room Rhine, Netherlands 1850-2000



Zie Het Waterschap 12 juli 2002

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Resilience strategies for the long term

Alternatives based on:

- compartmentalisation aimed at detention/ damage mitigation ('compartments')/ 'economy'
- compartmentalisation aimed at discharge and lowering water levels ('green rivers') / 'ecology'

Comparison with:

- autonomous development

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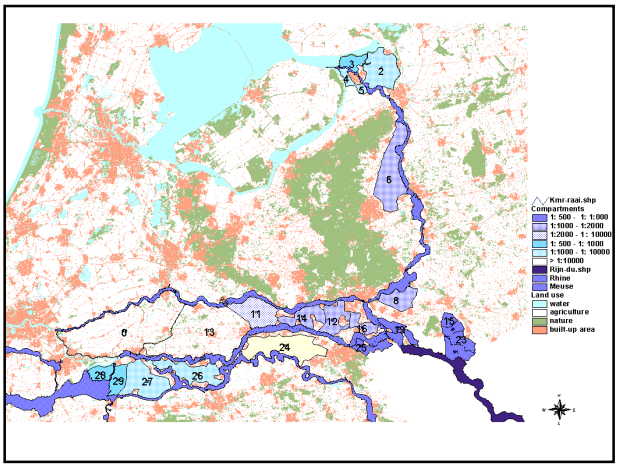
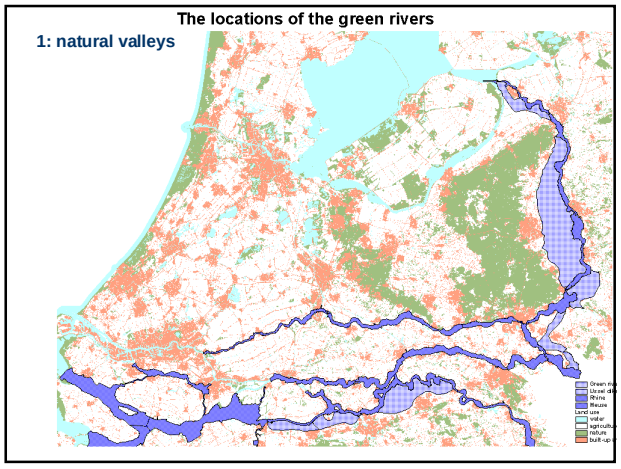
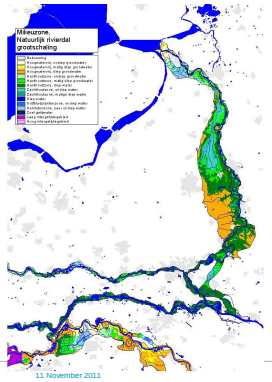




Eco-series



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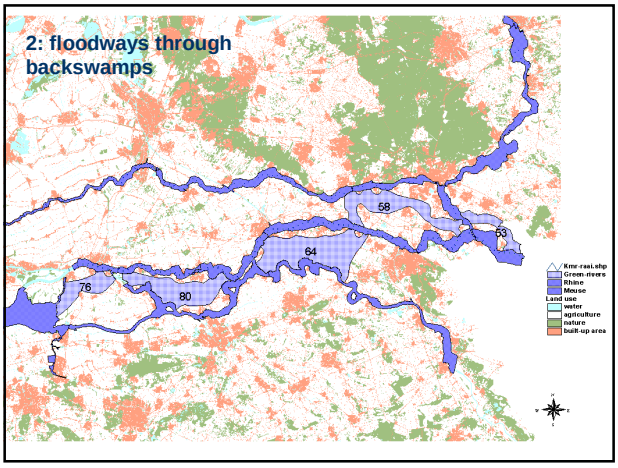
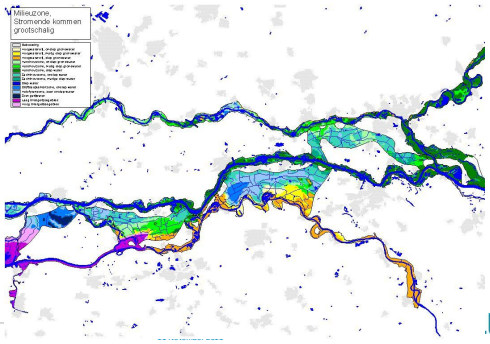
2: floodways through backswamps

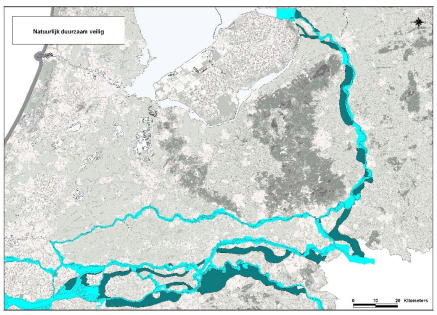


Eco-series



tares

Contours of a long-term vision (Alterra & WL): a bit of both



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Compartmentalisation =
also limit damage potential through 'green rivers'

Dike ring		Compartment	Surface area		Maximum damage		Index
			ha	%	billions €	%	E*1000/ ha
Rijn & IJssel	48	green river	2400	8	0.2	1	96
		remainder	26309	92	19.3	99	734
Betuwe	43	green river	7350	12	0.9	3	116
		remainder	55222	88	31.9	97	577
Land van Maas en Waal	41	green river	11275	40	1.3	5	116
		remainder	16627	60	26.4	95	1589
Bommelerwaard	38	green river	7225	67	1.2	20	167
		remainder	3621	33	4.7	80	1298
Land van Altena	24	green river	3800	23	0.3	5	81
		remainder	12629	77	6.1	95	480

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Evaluation of strategies
monetary

Strategy	Costs*	Damage*
Current policy	0.9	0.5
Compartments a	1.0	0.6
Compartments b	1.6	0.3
Green River spontaneous	8.0	0.0
Green River ecological	8.0	0.0
Green River multifunctional	3.0	0.1
River and Land	25.0	0.0

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Evaluation of strategies
other/ intangibles

Strategy	Flexibility	Economy	Ecology	Scenic
Current policy	4.1	5	3.5	4.4
Compartments a	6.9	5.3	4.0	5.2
Compartments b	6.7	4.7	4.1	5.3
Green River spontaneous	4.8	3.3	7.7	6.6
Green River ecological	4.8	3.4	8	6.6
Green River multifunctional	4.7	5.7	6.7	6.7
River and Land	3.8	2.6	8.7	6.4

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Conclusions

No 'overall best solution'/ resilience strategies more sustainable

Preferences remain important:

- cost-effectiveness short term: conventional
- maximum flexibility: compartments for detention
- nature and scenery: 'green rivers'

Resilience strategies? Invest now, revenues in future

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Is this change of strategy likely to happen?

Room for Rivers (since 1996)

purposeful inundations (detention basins and calamity polders 2002)
= beginning of differentiation of safety standards
has been rejected by Parliament

compartmentalisation again under discussion since 2002;
recent study (by us) shows when cost-effective; in latest Water Plan (2008)

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