

# Climate Change and Adaptive Engineering

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# Climate adaptation : ecosystem based engineering solutions

- The total costs for climate adaptation will be small compared to the total expected damage
- Integration of adaptation measures in new or redevelopment programmes today is needed to reduce additional cost in the future
- Use **ecosystem based engineering solutions**
- This requires a holistic, integrated approach to water management



# Overview

- Stakeholder involvement at various levels (HighNoon)
- Adaptation to climate in urban slums (HiAware)
- Adaptation engineering for flood protection using ecosystem strength(Ecobas)
- Adaptation engineering combatting salinity (Balance Island)
- Integrating objectives: Water – Energy Nexus

# 1. Stakeholder involvement at various levels (HighNoon)

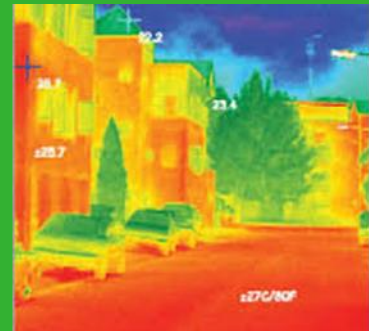
- **Stakeholders** report increases in temperatures across the Ganges basin, nights becoming warmer, winters being shorter, greater variability in rainfall, and extreme events, mostly related to drought, becoming more frequent.
- Within the same state, stakeholder discussions showed commonality concerning **perceived vulnerability** across state, district, and community levels.
- Source: Moors & Siderius, 2012, Bhadwal et al, 2013;  
<http://www.eu-highnoon.org/>

# 1. Stakeholder involvement at various levels (HighNoon)

- In upstream regions, where stakeholders expect climate change to increase flood risk, **adaptation measures** to prevent flood damage are highly prioritized. In mid and downstream regions of the Ganges basin, stakeholders anticipate droughts and lowering of the water table, leading them to prioritize measures to maintain groundwater levels, and to develop water harvesting and water use efficiency.
- Source: Moors and Siderius, 2012; Bhadwal et al, 2013
- <http://www.eu-highnoon.org/>
  - Note: Nested approach
  - No single solution will work for all!

## 2. Adaptation to climate in urban slums (HiAware)

- Helping poor communities to adapt
- Heat stress in urban slums
- More information at <https://www.wageningenur.nl/en/project/The-Himalayan-Adaptation-Water-and-Resilience-HIAWARE.htm>  
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### 3. Adaptation engineering for flood protection using ecosystem strength (Building with Nature; Ecobas)

- Oyster reefs - mangrove forests help to prevent coastal erosion and flooding.
- At the same time, the reefs and mangroves attract fish and crab, creating a source of food for the local human population.
- This is demonstrated by an international eco-engineering project
- Example of 'Building with Nature'



# Soil sealing → Sealed = lost

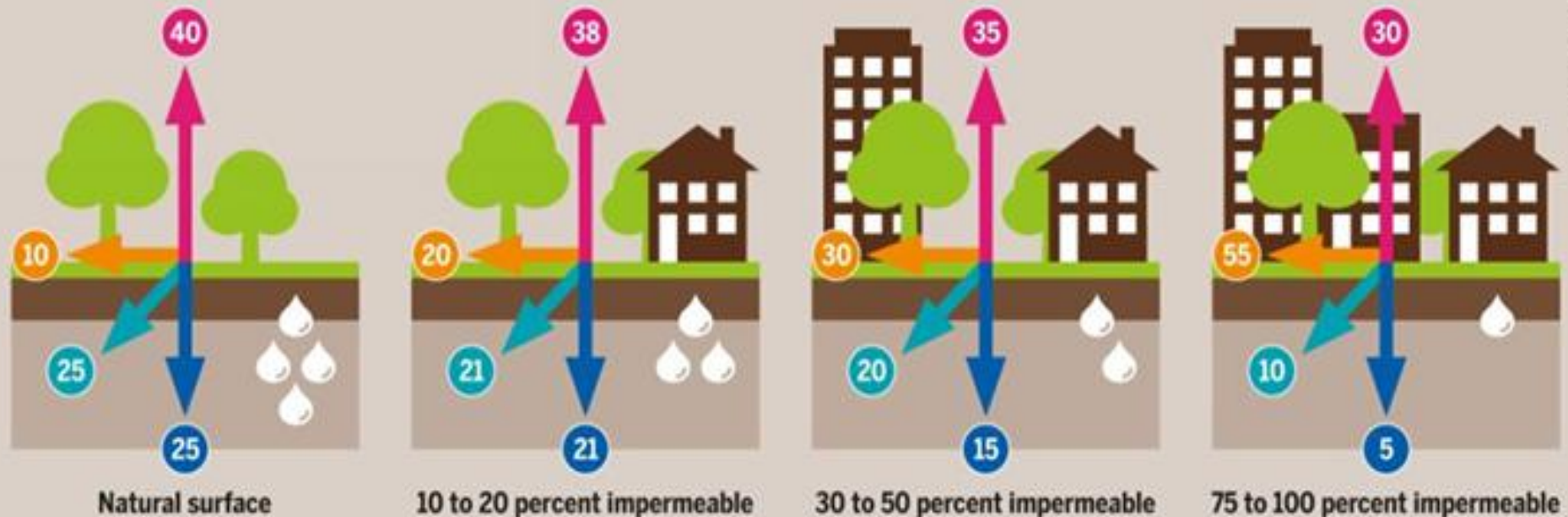
- 46% urban surface NL sealed
- Soil is the natural basis for human, animal and plant life



## RAINFALL AND SEALED SOIL SURFACES

Model of water drainage in settlements, in percent

■ Shallow infiltration ■ Deep infiltration ■ Evapotranspiration ■ Runoff





# Green cities: How can we increase the 'sponge' capacity of our cities?

- Green design
- Use of natural processes
- Increase infiltration capacity
- Visualize water system
- Reuse of rainwater

Green+

## The Green City Guidelines

*Techniques for a healthy liveable city*

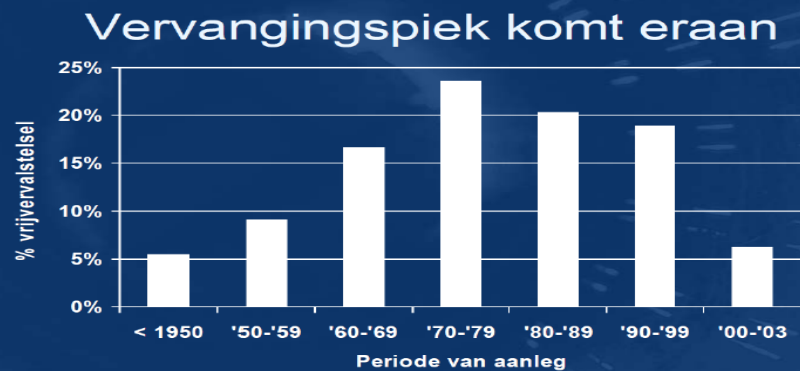
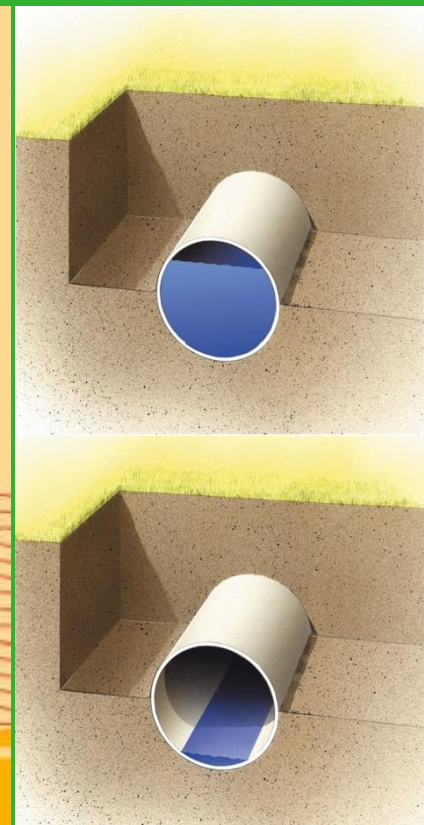
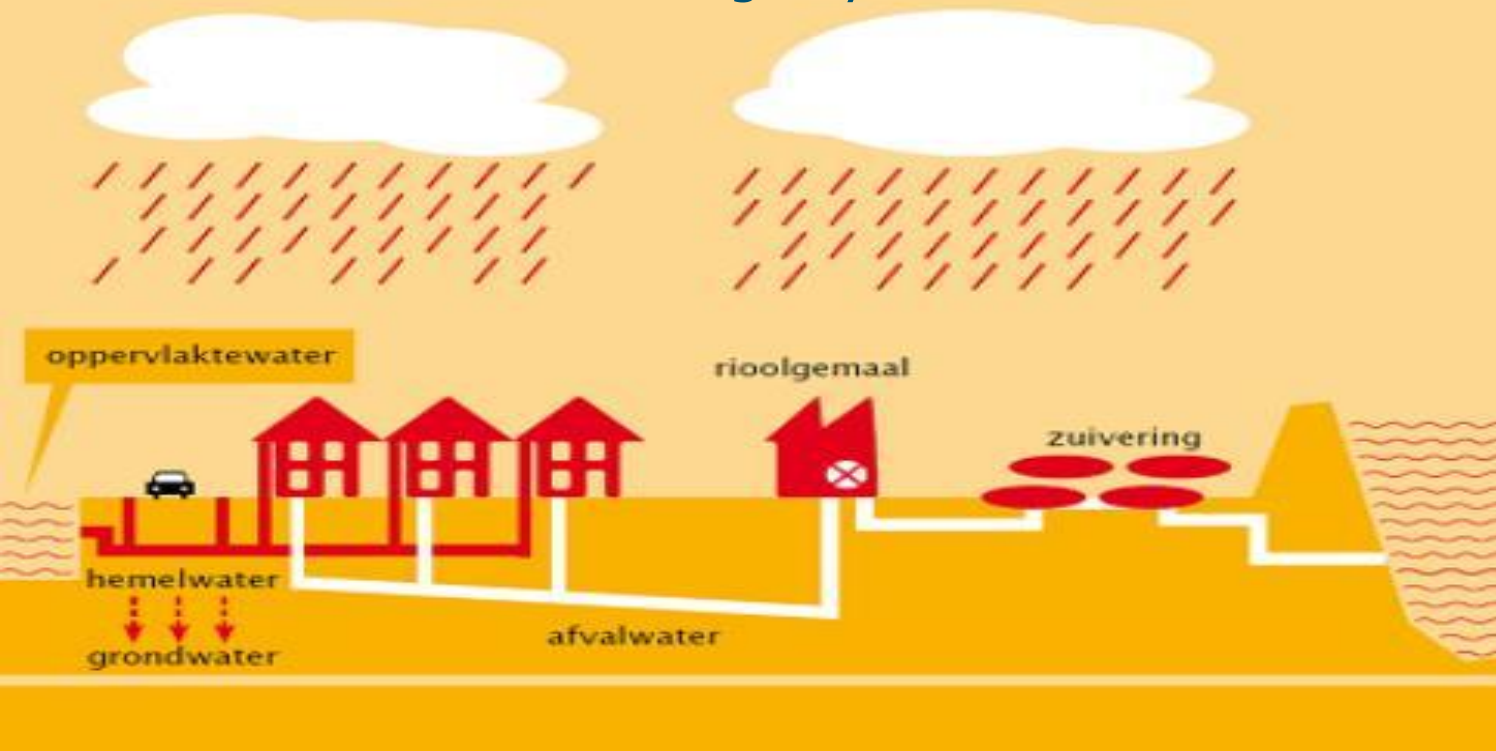
Michelle de Roo | landscape and urban designer



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# NL: € 9 billion investments in the next 10 years

Disconnect rain from sewage system





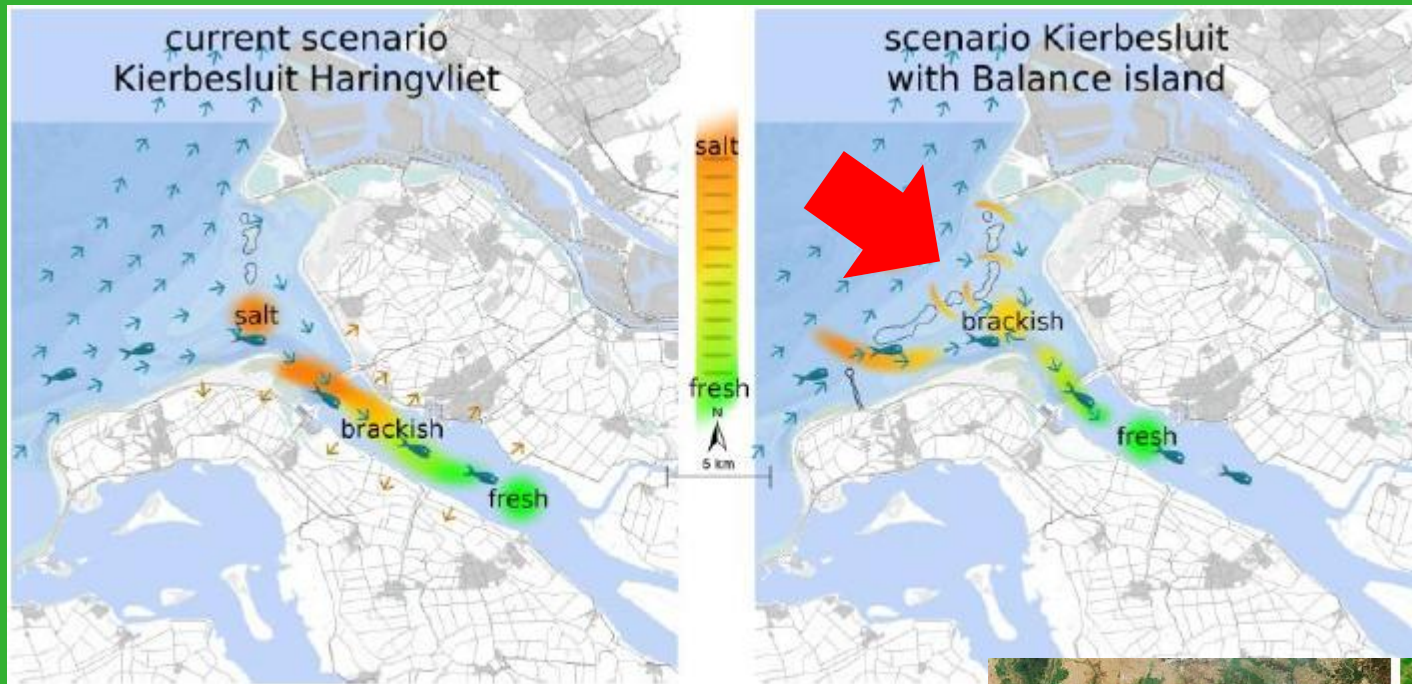
# 4. Adaptation engineering combatting salinity (Balance Island: NL-Vietnam-BGD)



IMARES  
WAGeningenUR



water architect  
van buuren



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# 5. Integrating objectives: Water – Energy Nexus

- How can we reduce energy use by the water sector?
- How can we best use water to store and generate energy?
- Some examples from the Netherlands.



# Water related energy use in California

In 2013 +/- 7% of total electricity use used by agriculture and pumping (ECDMS)

	Electricity (GWh)	Natural Gas (Million Therms)	Diesel (Million Gallons)
<b>Water Supply and Treatment</b>			
Urban	7,554	19	?
Agricultural	3,188		
<b>End Uses</b>			
Agricultural	7,372	18	88
Residential	27,887	4,220	?
Commercial			
Industrial			
Wastewater Treatment	2,012	27	?
<b>Total Water Related Energy Use</b>	<b>48,012</b>	<b>4,284</b>	<b>88</b>
<b>Total California Energy Use</b>	<b>250,494</b>	<b>13,571</b>	<b>?</b>
<b>Percent</b>	<b>19%</b>	<b>32%</b>	<b>?</b>

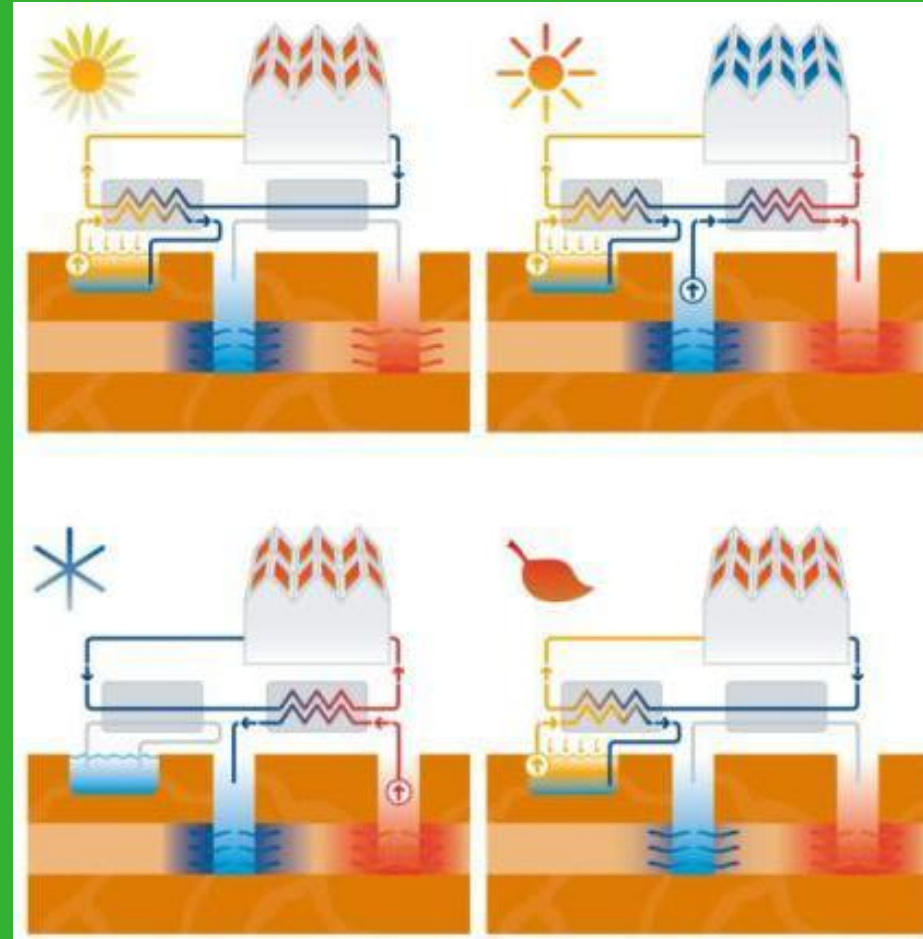
CEC 2007



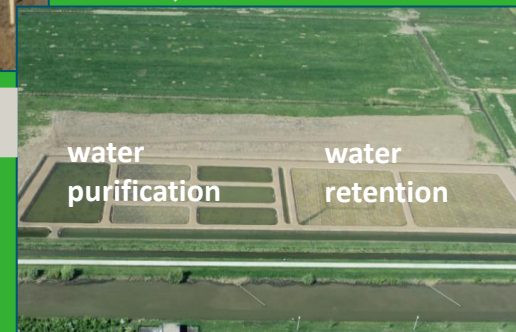
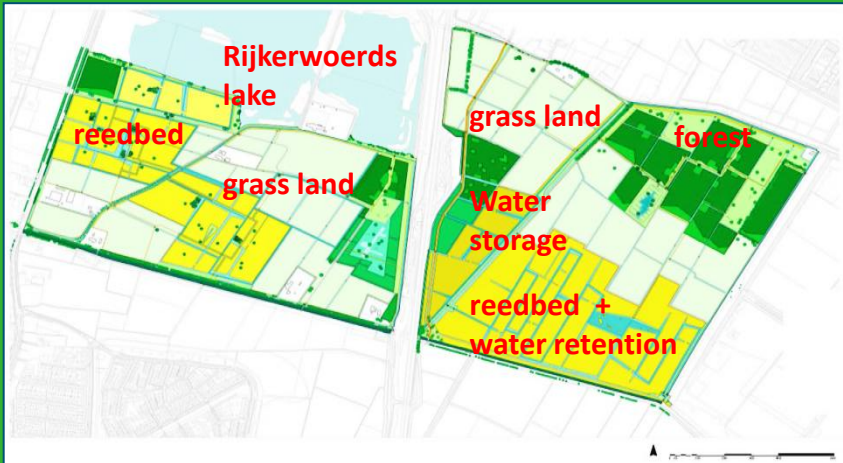


# Cool water for energy and ecosystems

- Reducing CO<sub>2</sub> emissions by storing summer heat in the soil to use in winter.
- Using heat from surface water has positive effects on water quality.
- Cooling surface water inhibits development of algae and botulism.



# Rich Water World: Combining water storage, retention & purification



# Benefits of green infrastructure

- Green solutions for storm water management are often equal (33%) or even cheaper (44%) than conventional solutions
- Reduce damage by preventing floods
- Moderating air temperatures and improving air quality
- Enhance biodiversity
- 5 – 30% higher property value
- Improved quality of life





# Conclusion

Technical solutions  
are needed

Stakeholder  
involvement is  
essential

Increasing benefit of  
ecosystem based  
engineering

Explore payment for  
ecosystem services

Investment now to  
avoid higher costs in  
future



Thank you

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