

# Addressing the Climate Adaptation Deficit in Water Management and Infrastructure

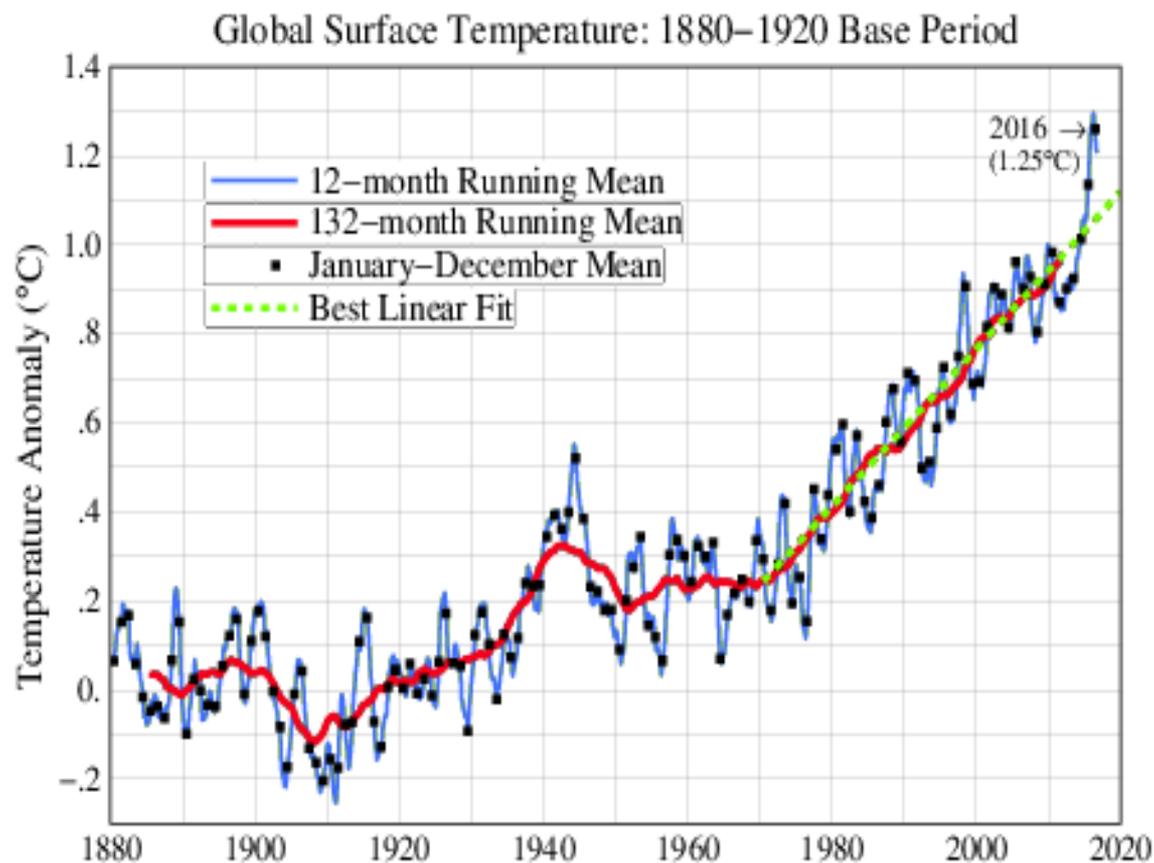
keynote at the  
Pan European Symposium on  
Water, Sanitation, Safety Planning,  
and Extreme Weather Events.

April 6, 2017  
Bilthoven, The Netherlands

by  
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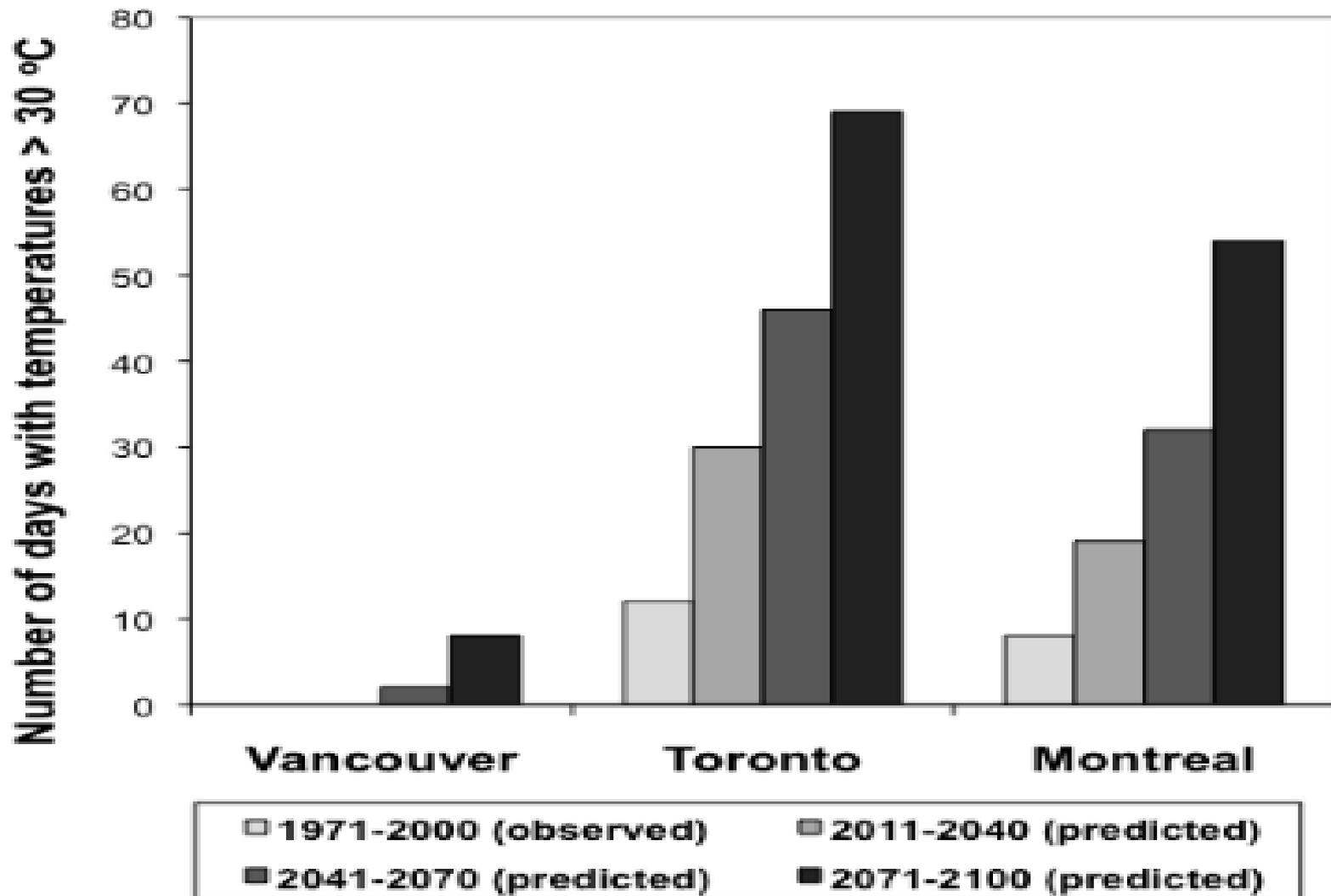


1. The world is warming up. A one and a half to two degrees global average warming will come with major changes in local temperature, precipitation, wind patterns and sea level;
2. There is a growing gap between present systems of the built environment, water management, agriculture on the one hand and historic levels of robustness to weather extremes;
3. Information on future climate is usually presented as long term, geographically large scale with a range of uncertainties attached. Research shows that this type of information is not fit for purpose when it comes to awareness raising and decision making on adaptation at urban level.
4. Examples will be shown of how this can be improved;



This [global temperature chart](#) is updated at Columbia University by [Dr. Makiko Sato](#). Data is based on GISTEMP analysis (mostly NOAA data sources) as described by [Hansen, Ruedy, Sato & Lo \(2010\)](#).

The 1880-1920 average is used as best available base for pre-industrial global average temperatures. See "[A better graph](#)" by Hansen and Sato (2016) for background info.



*Projected increase in the number of days above 30°C –  
Based on data from the Canadian Climate Change  
Scenarios Network, 2010. Source: Toronto Public Health*

# Average number of heat wave days in Northern Africa

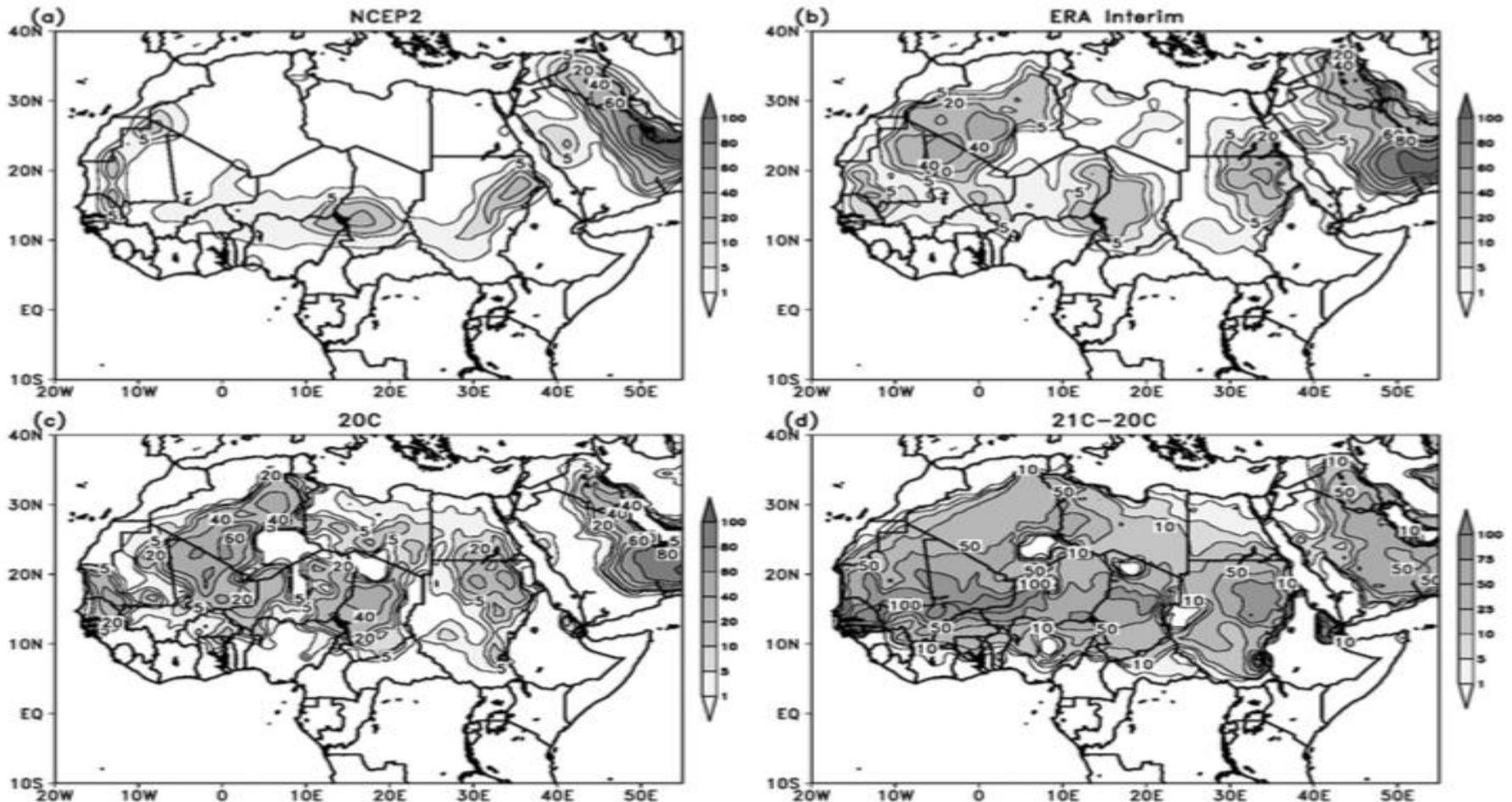
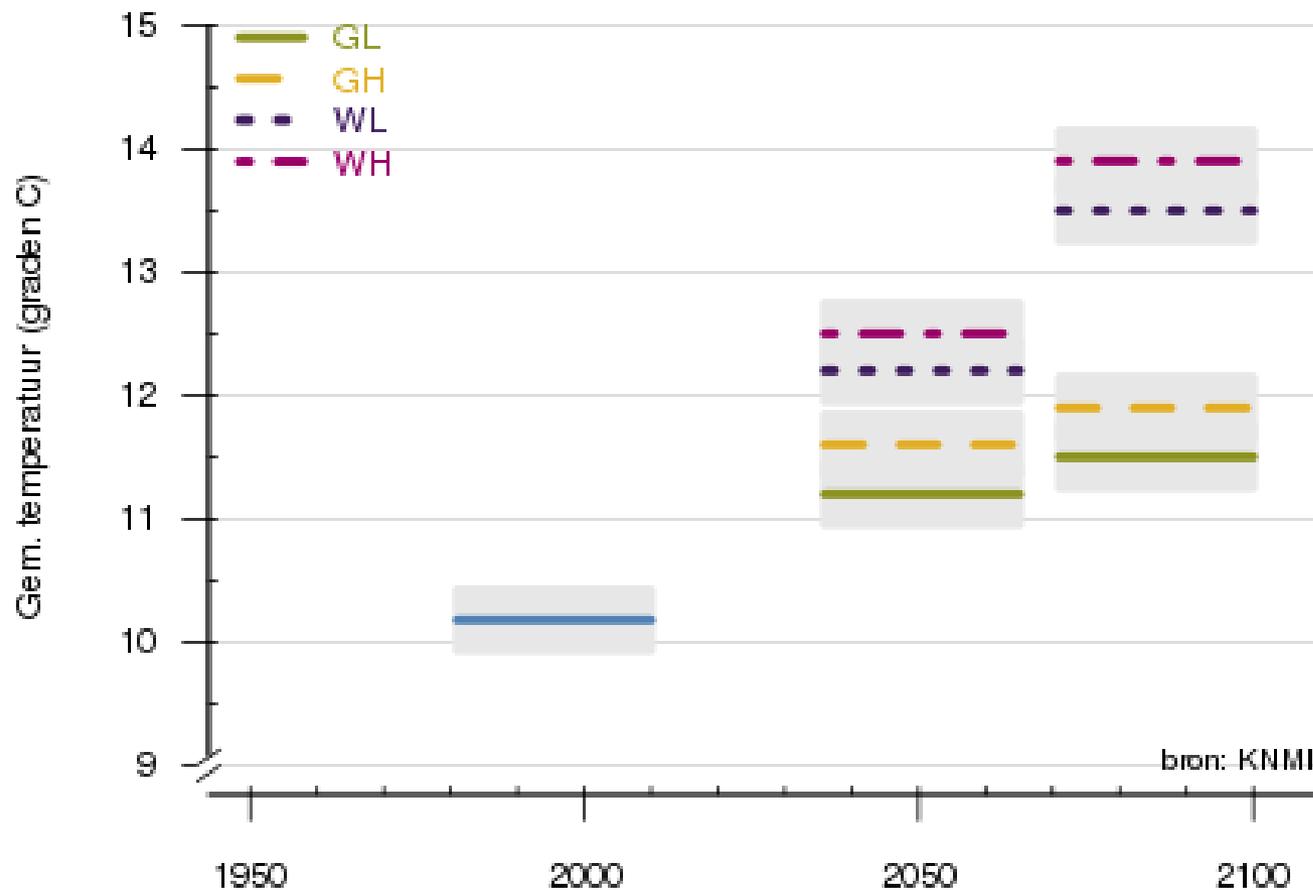


FIG. 5. Average number of heat wave days per year from the (a) NCEP2 reanalysis (1989–2009 average), (b) ERA-Interim reanalysis (1989–2009 average), and (c) 20C ensemble (six-member average). (d) 21C minus 20C difference in the average number of heat wave days per year.

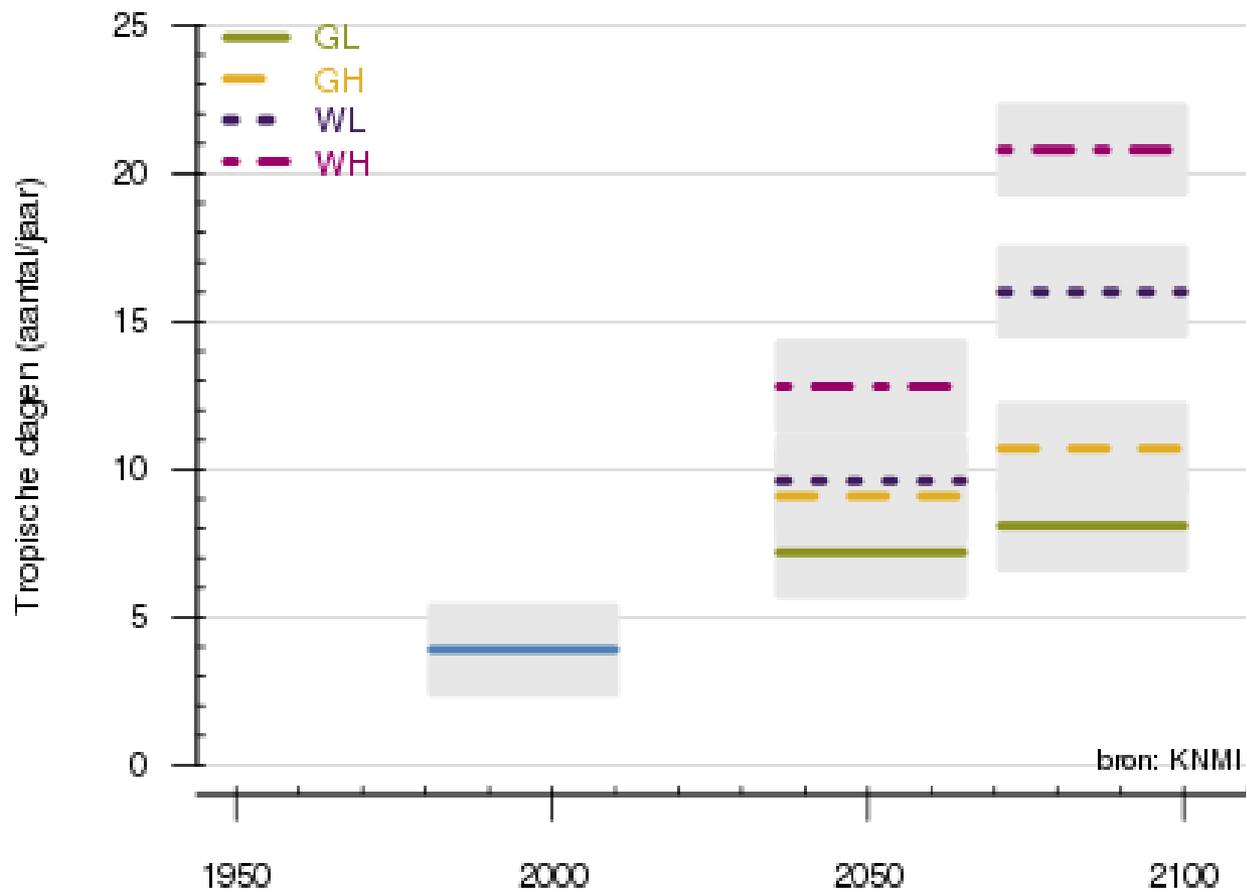
# Scenario's temperatuurstijging

Langjarig gemiddelde jaartemperatuur voor De Bilt in het verleden (blauw) en voor de KNMI 14 scenario's met natuurlijke variabiliteit tussen 30-jaar perioden (grijs)



# Scenario's tropische dagen

Langjarig gemiddeld aantal tropische dagen per jaar (maximumtemperatuur min. 30 graden C) voor De Bilt in het verleden (blauw) en voor de KNMI 14 scenario's met natuurlijke variabiliteit tussen 30-jaar perioden (grijs)





# Changes in daily rainfall in northern Africa

5756

JOURNAL OF CLIMATE

VOLUME 25

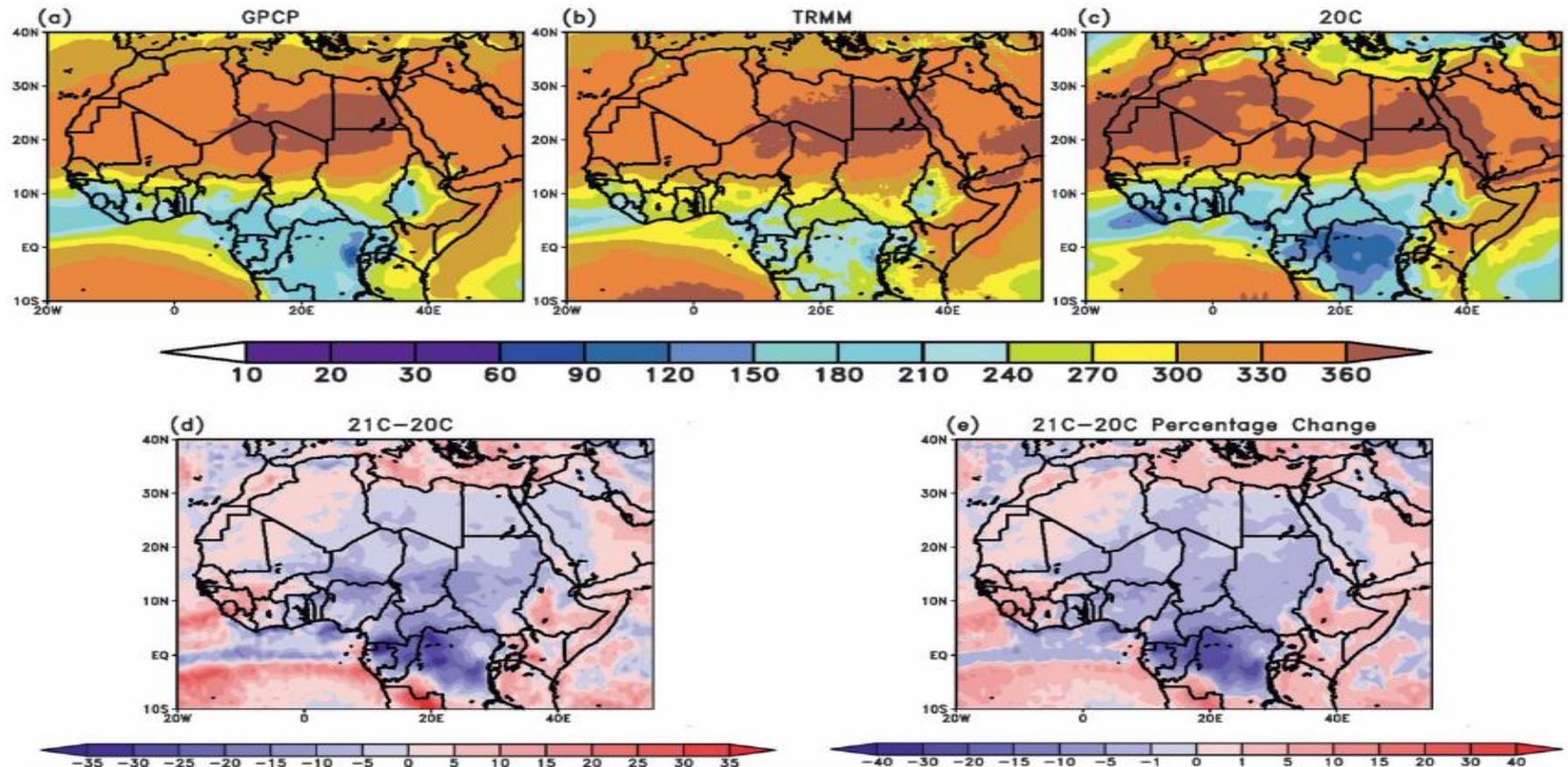
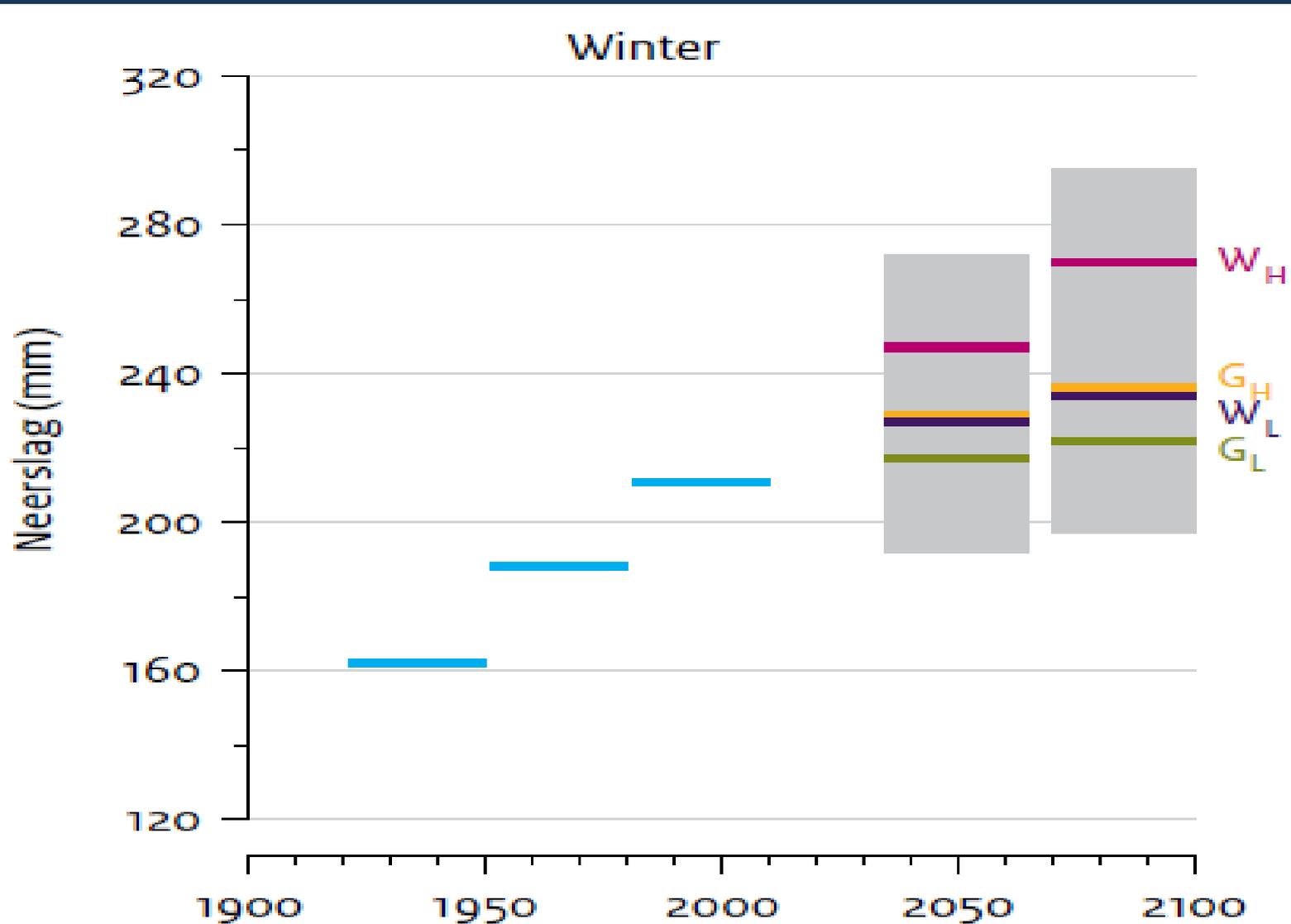


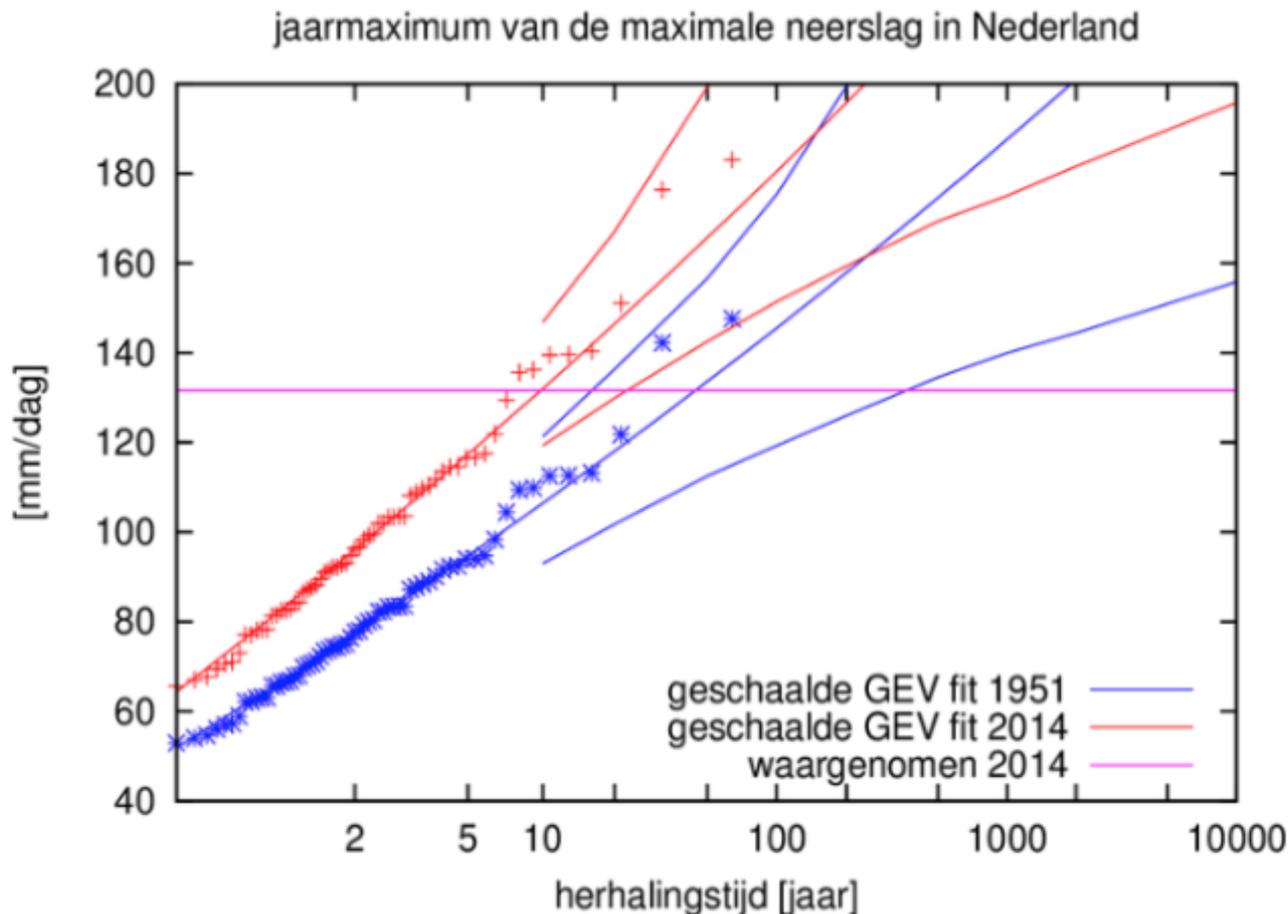
FIG. 6. Average number of days per year when the daily rainfall is less than  $1 \text{ mm day}^{-1}$  in the (a) 1997–2008 GPCP  $1^\circ$  daily precipitation climatology, (b) 1998–2010 TRMM climatology, and (c) 20C ensemble (six-member average). The (d) difference for 21C minus 20C in the number of days per year when the daily rainfall is less than  $1 \text{ mm day}^{-1}$  and the (e) 21C minus 20C percent change difference.

# Scenario's winter precipitation, The Netherlands (KNMI)



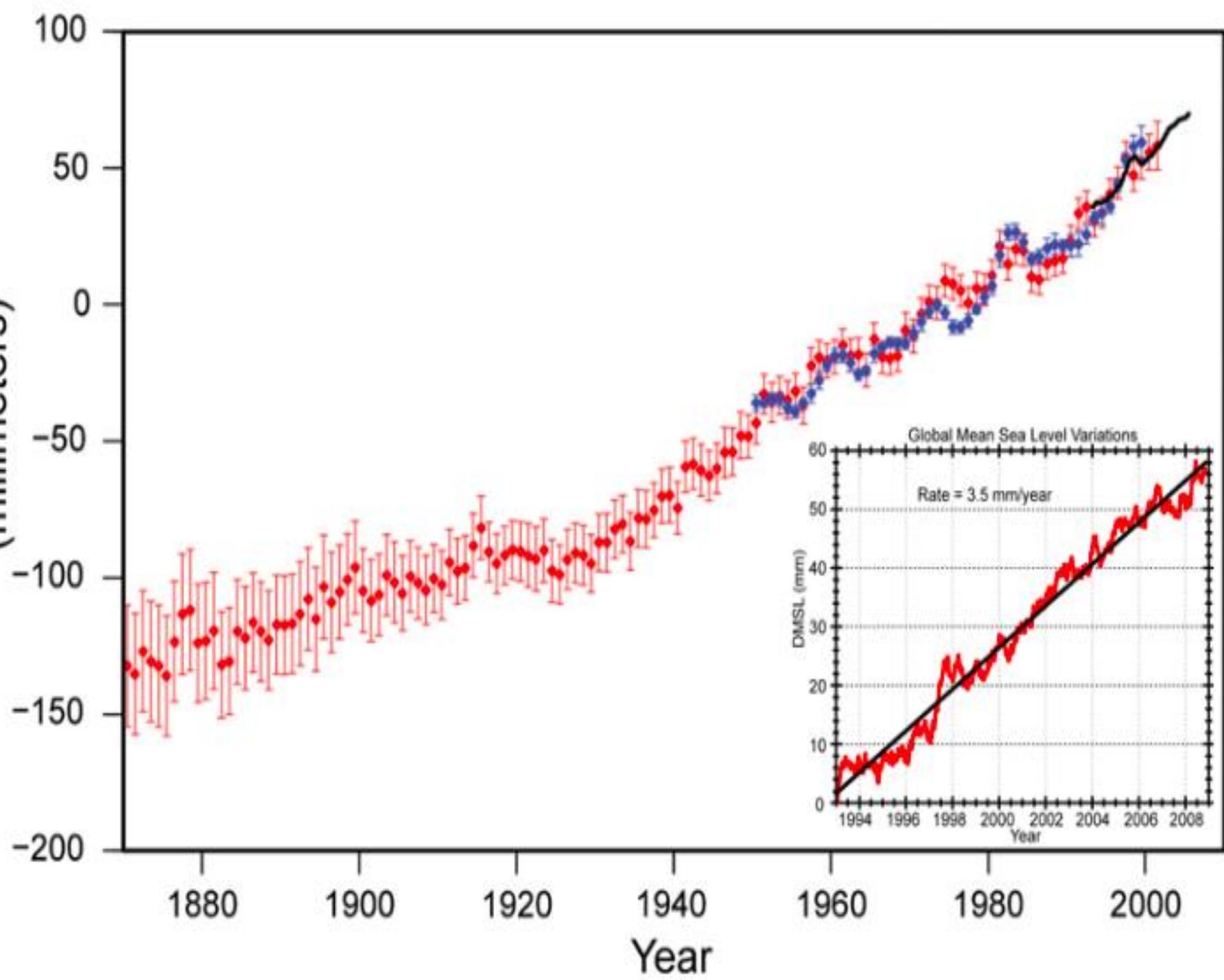


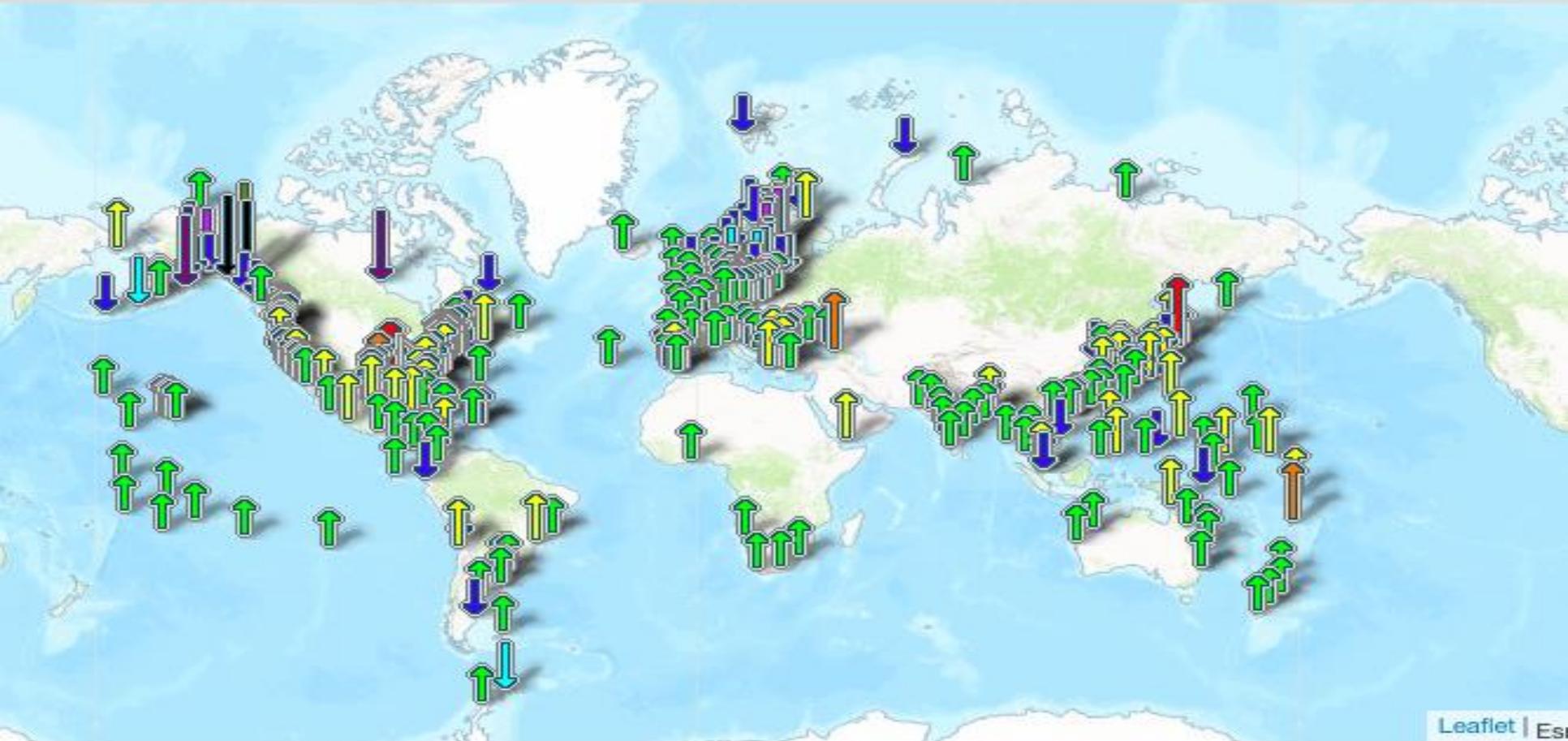
# The 1:100 year extreme rainfall event in 1900-1980 time frame has become the 1:30 year rainfall event in 2014.



Figuur 3. Aanpassing van de per jaar hoogste neerslag in Nederland gemeten op één van de 8-8 neerslagstations (64 waarden) aan een GEV verdeling die schaal met de wereldgemiddelde temperatuur. De waarde van 131,6 mm voor 28 juli 2014 (horizontale lijn) i

Sea-level deviation  
(millimeters)





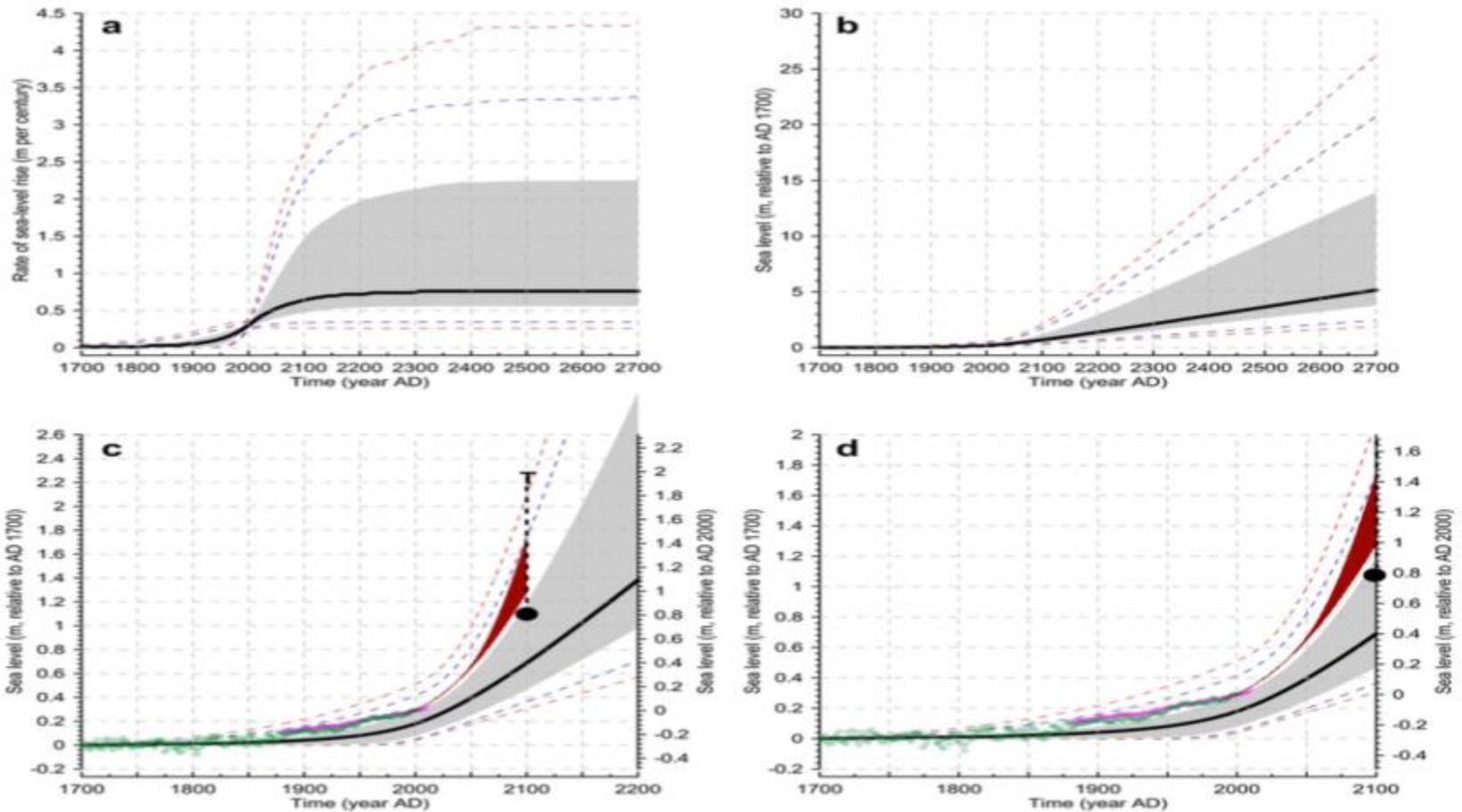
Leaflet | Esri

Illustrates regional trends in sea level, with arrows representing the direction and magnitude of change. Click on an arrow for more information about that station.

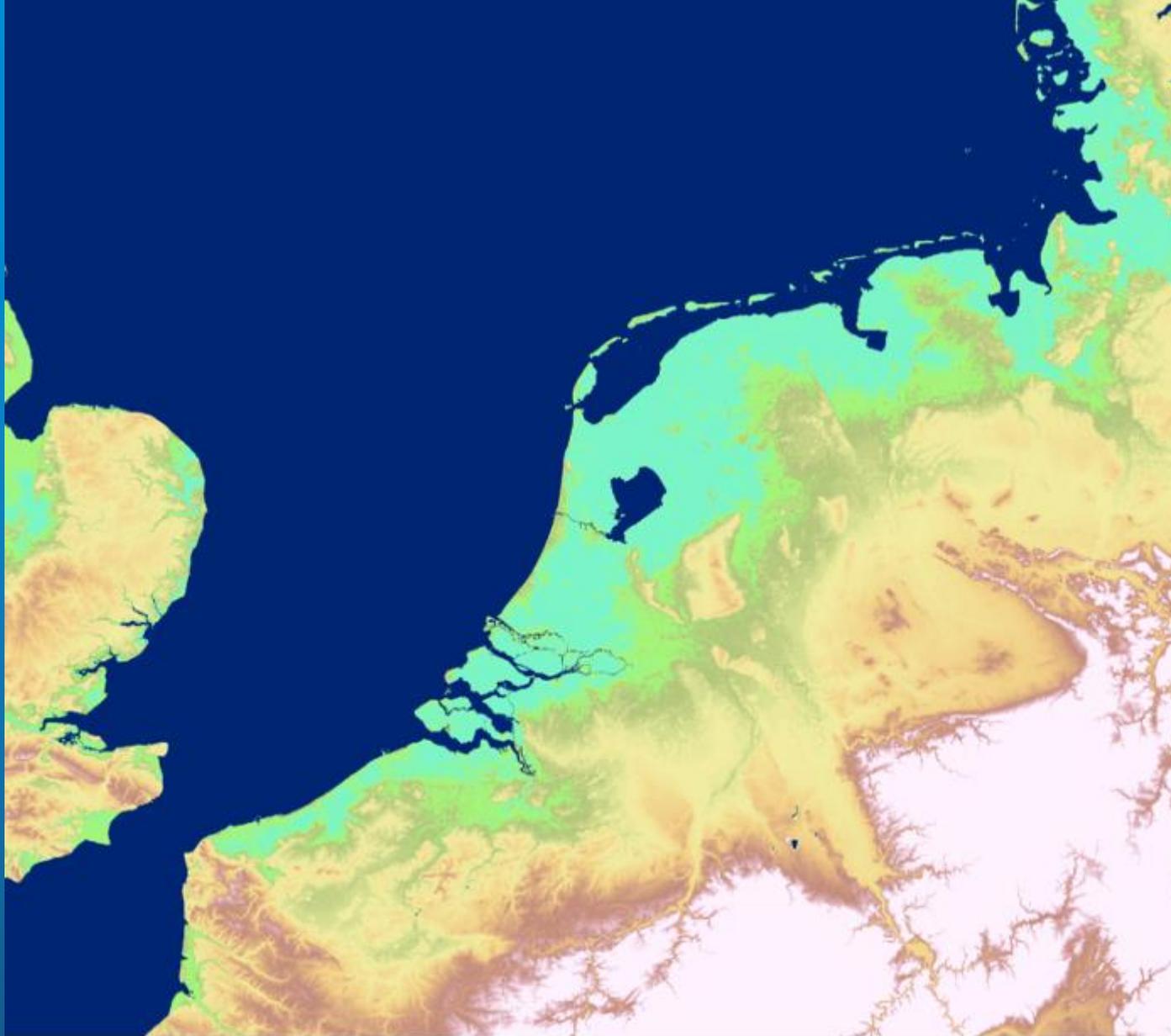
### Sea Level Trends mm/yr (feet/century)

15 to 21 (5 to 7)	6 to 9 (2 to 3)	-3 to 0 (-1 to 0)	-12 to -9 (-4 to -3)
12 to 15 (4 to 5)	3 to 6 (1 to 2)	-6 to -3 (-2 to -1)	-15 to -12 (-5 to -4)
9 to 12 (3 to 4)	0 to 3 (0 to 1)	-9 to -6 (-3 to -2)	-18 to -15 (-6 to -5)

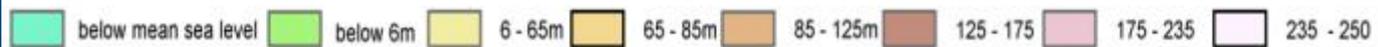
# Sea level rise scenario's (Rohling et al, 2013)



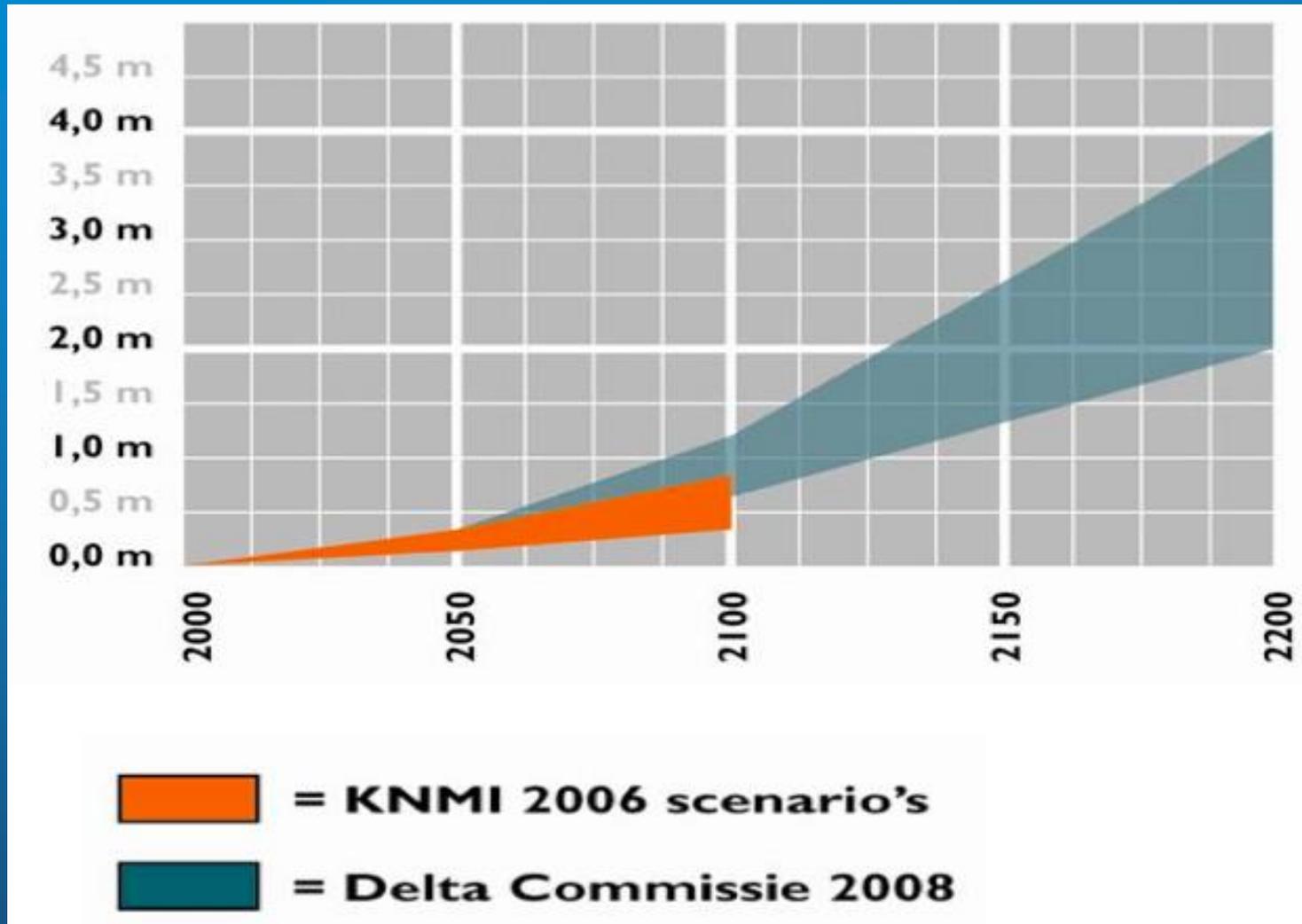
**Figure 3 | Probabilistic assessment of natural sea-level change based on equations 1–3.** The heavy line is the probability maximum (peak of the probability distribution), the grey envelope marks the 68% probability interval, and the dashed blue (red) lines mark the 90% (95%) probability intervals, respectively. (a). Rates of SLR relative to 1700, in  $\text{m cy}^{-1}$  (i.e.,  $100 \times$  result from equation 1). (b). SLR after equation (2). (c). Zoomed-in portion of (b), ending at 2200. The brown wedge is the range of semi-empirical projections by Vermeer and Rahmstorf<sup>7</sup>, the heavy dot outlines the most-likely projection by Pfeffer et al<sup>8</sup>, and the heavy dashed black line represents the full range of SLR estimates of Pfeffer et al<sup>8</sup>. Historical sea-level reconstructions of Jevrejeva et al<sup>11</sup>. (green dots) and Church and White<sup>21</sup> (magenta dots) are also shown. (d). As (c), but zoomed in on 1700–2100.



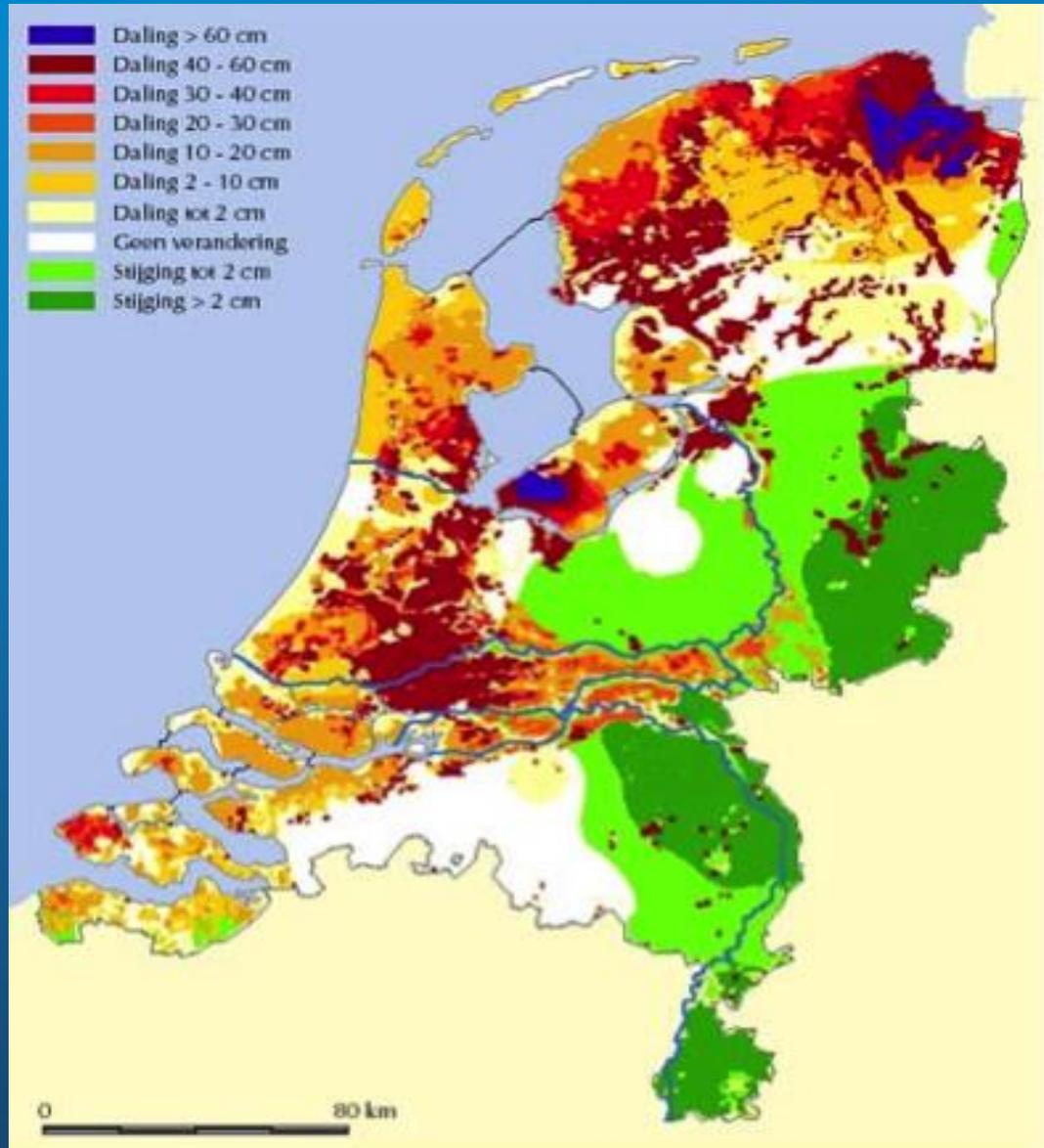
## Legend



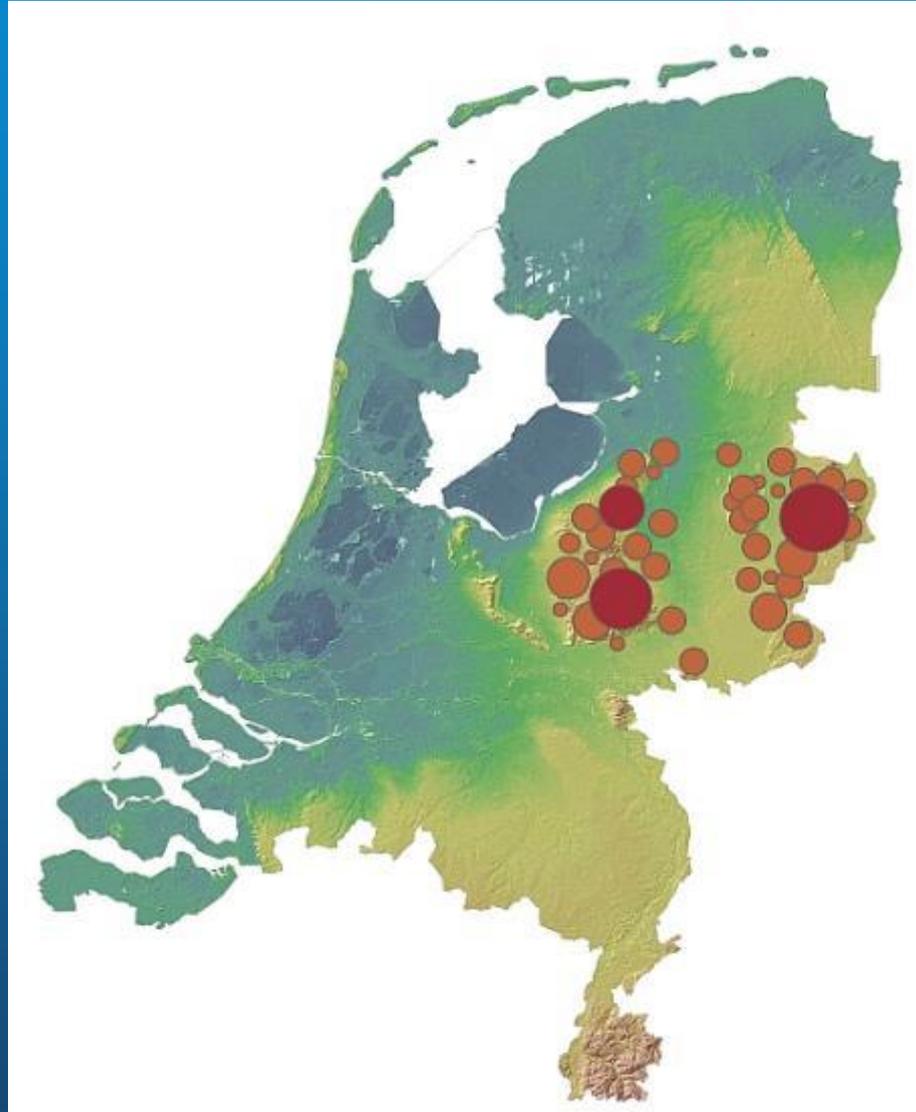
# Sea-level rise projection (m) most likely (KNMI) and upper end scenario



# Subsidence by 2050



# Option 1: retreat to higher grounds



# Option 1: offensive strategy



# Option 2: protecting within existing boundaries, closed version”



# Option 2: protecting within existing boundaries, “open version”



# Nourishment of the coastal sand-river



Images Courtesy RIKZ





waterschap  
Hollands  
Noorderkwartier

# De Hondsbossche zeekering van hard naar zacht



# Examples of existing broad (super) dikes, “unbreakable dikes”



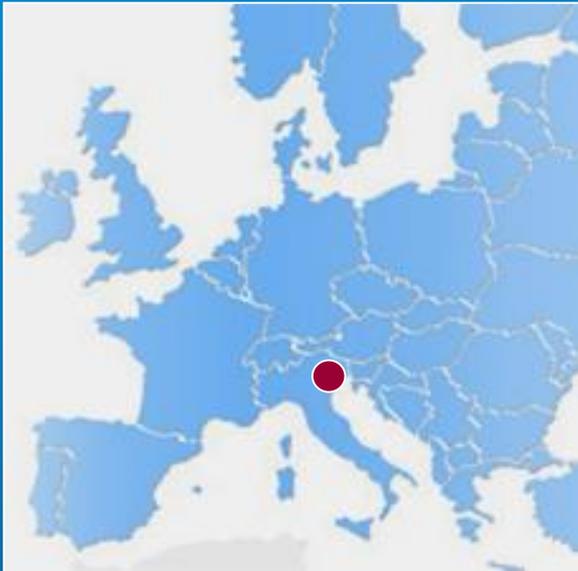
# Multifunctional flood defence in Hamburg, Germany



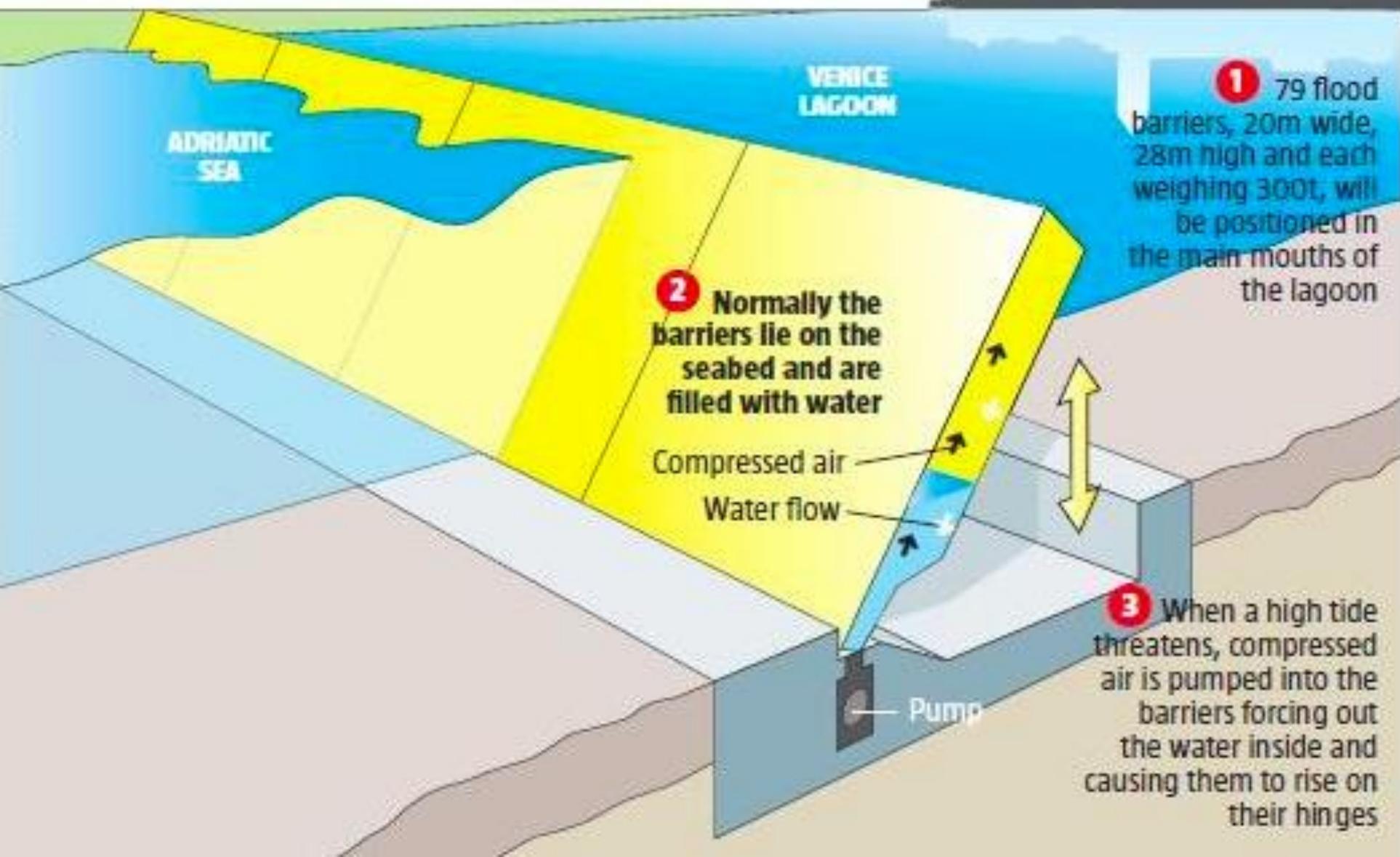


# Venetië

## De werken om overstroming te beperken



## MOSE: HOW IT WILL WORK



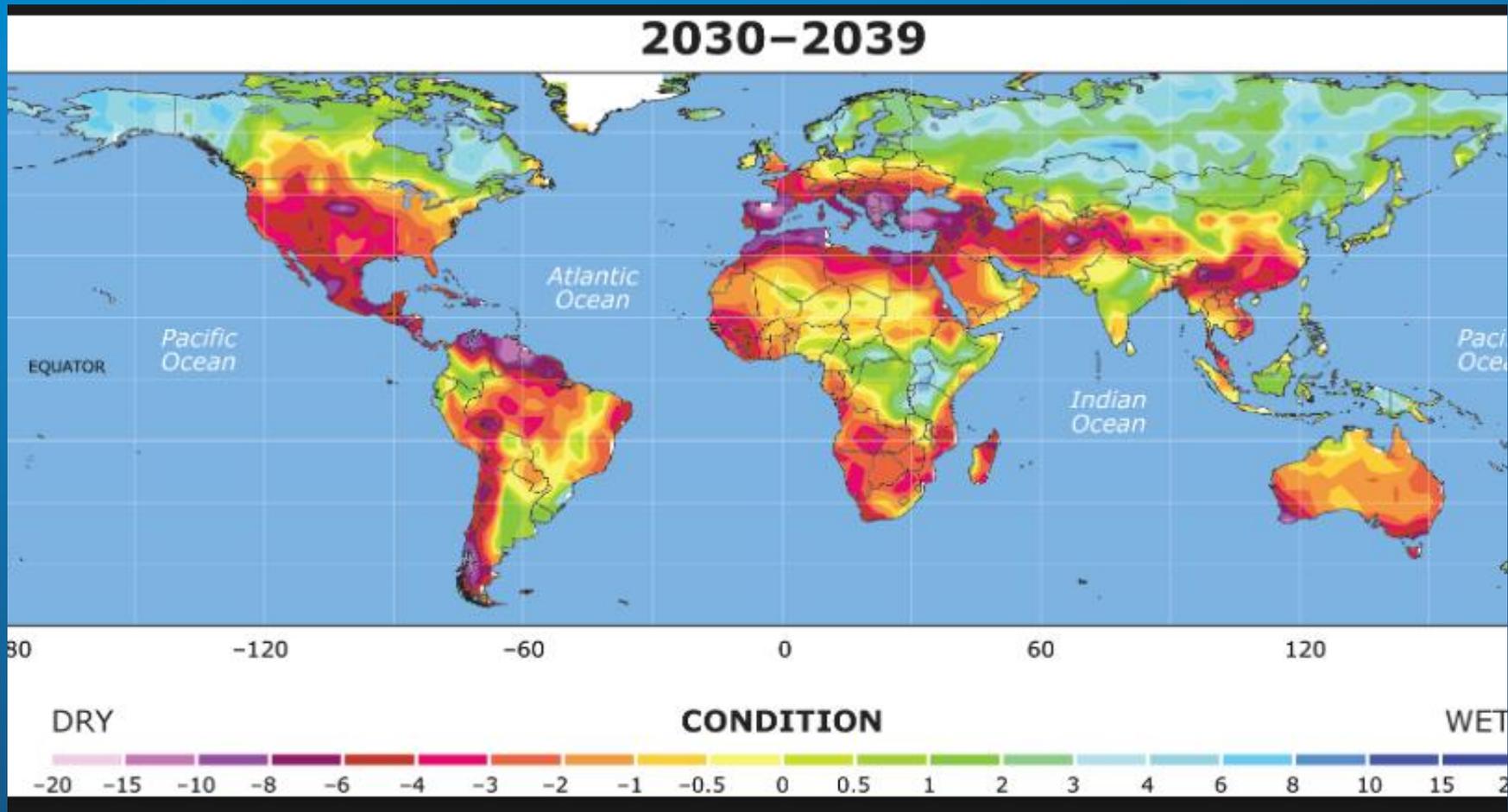


# Hydro-meteorological effects of Climate Change

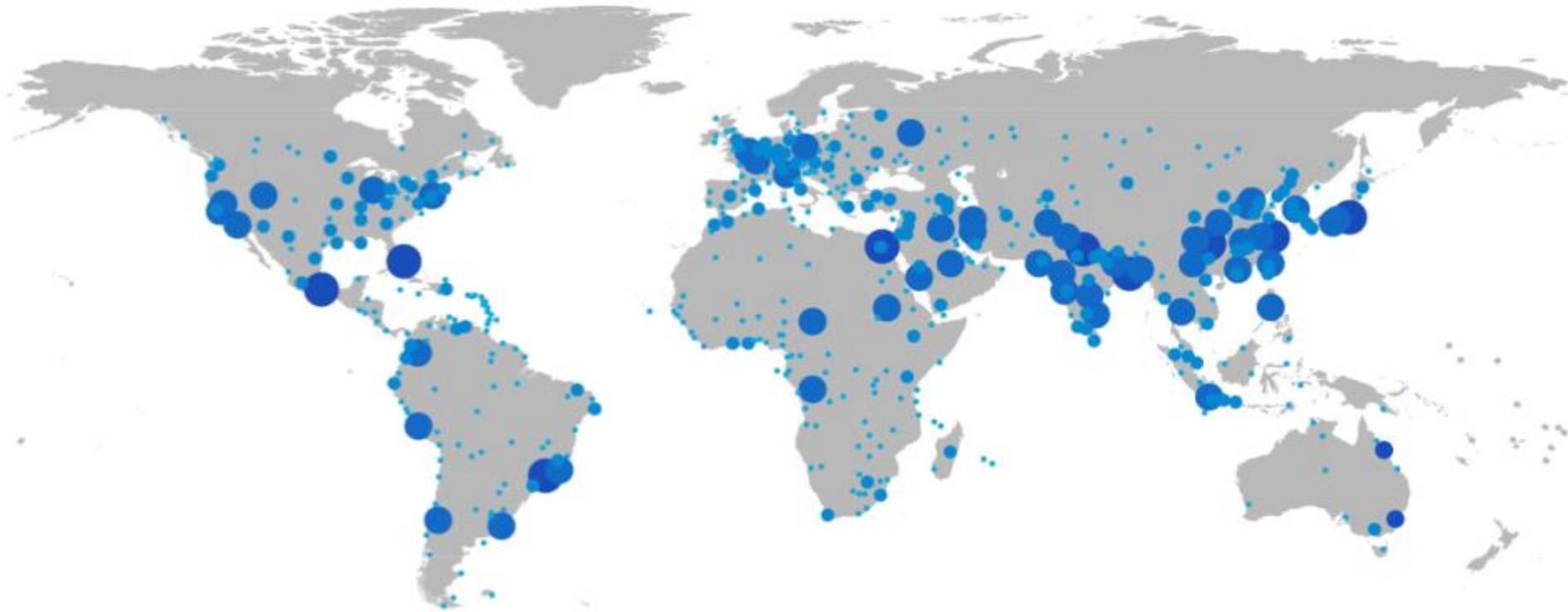
- Sealevel rise and higher peak flows in rivers;
- Temperature rise in cities: year average plus 2 to 6 degrees Celsius;
- More frequent and more intense heat waves;
- More frequent prolonged drought;
- More frequent and more intense peak rainfall;

# Drought areas as projected for the period 2030-2039

## National Centre for Atmospheric Research



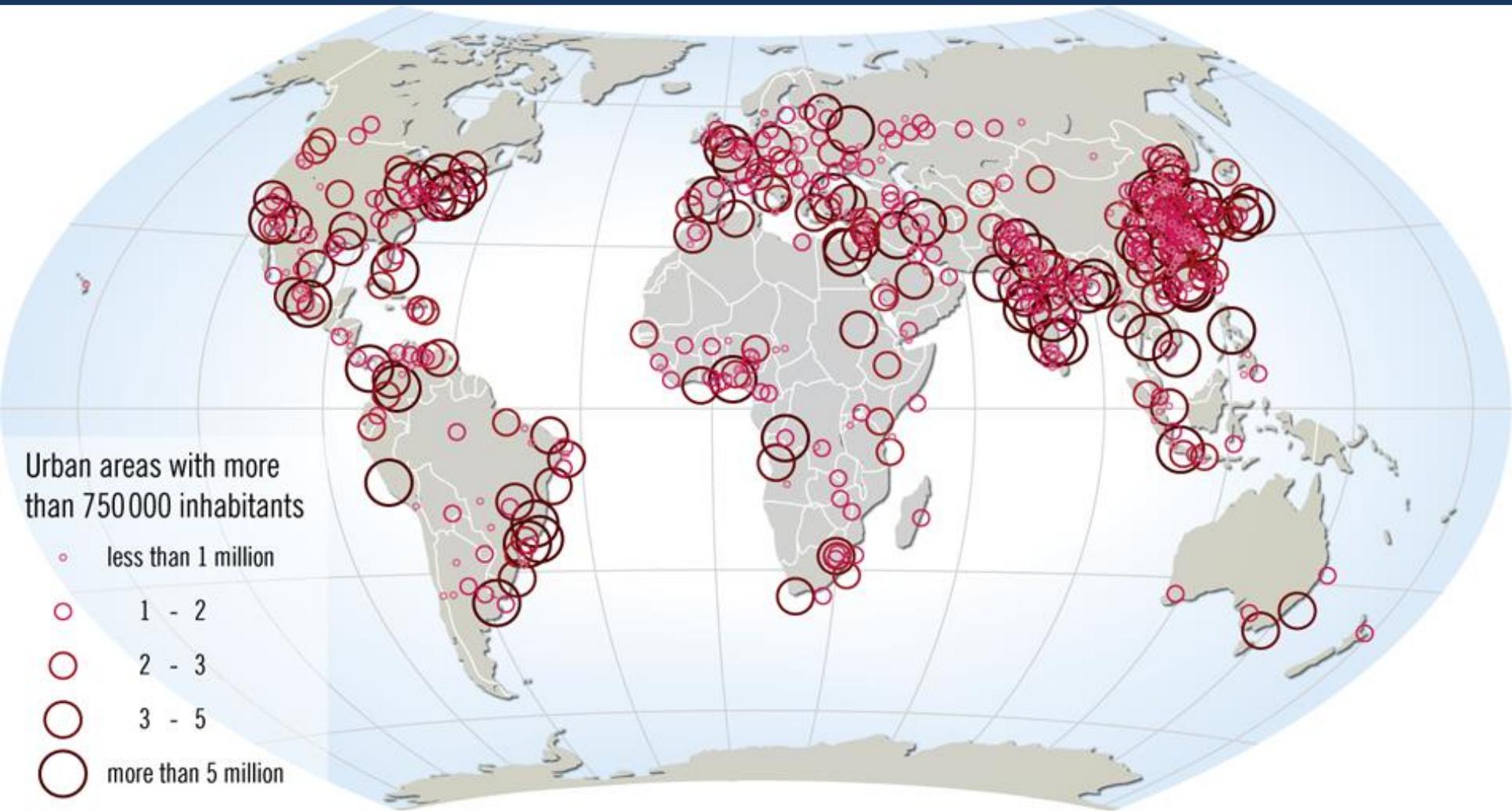
# Flood exposure is everywhere!



Exposure is growing, especially in high hazardous areas close to rivers and coastlines

Urban areas with more than 750 000 inhabitants

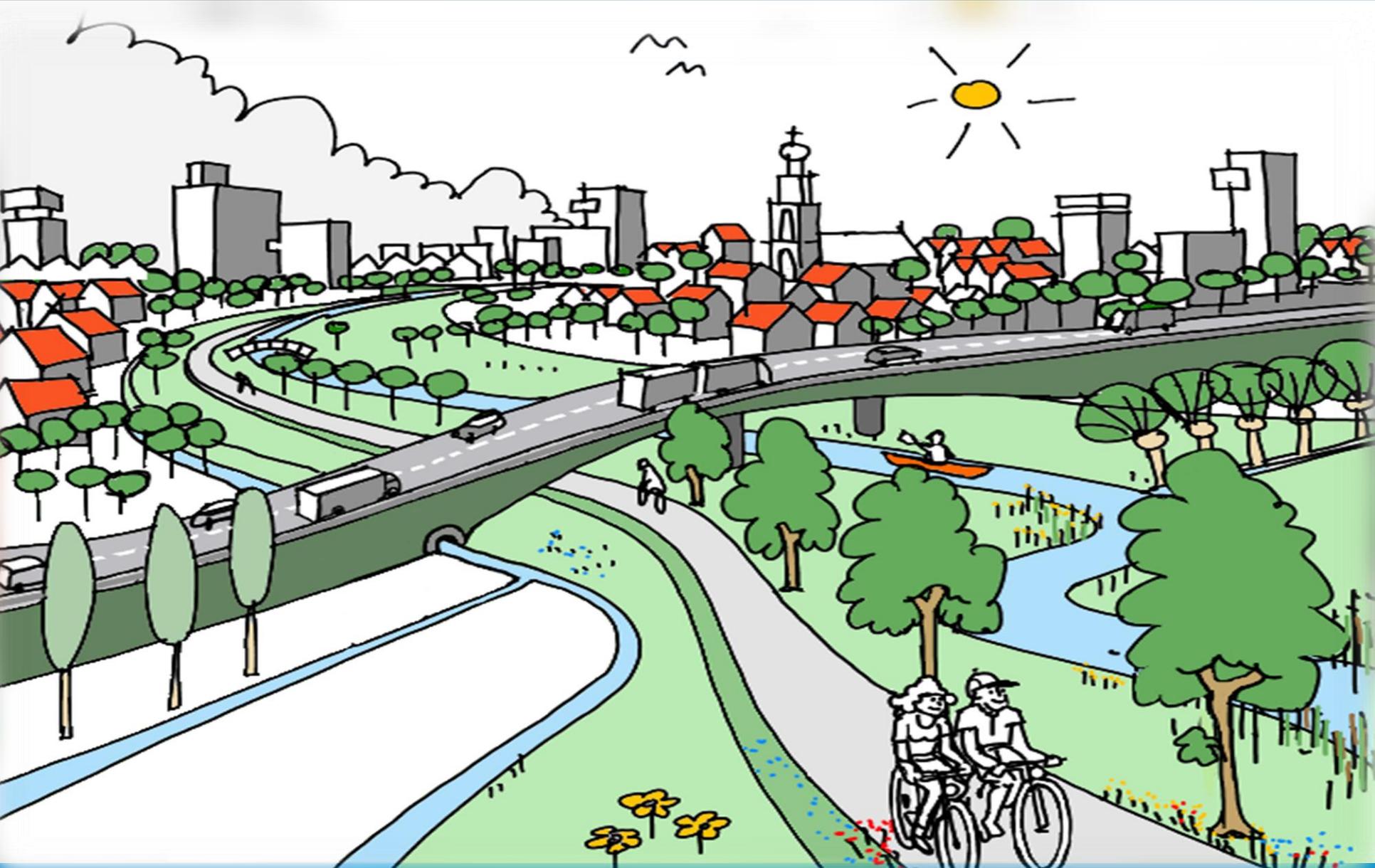
- less than 1 million
- 1 - 2
- 2 - 3
- 3 - 5
- more than 5 million



# Urban adaptation to climate change: a range of measures:

- More insulation and shade from heat: adjustments of buildings; aircondition (renewable energy) ;
- More green in the cities including green rooftops;
- More water buffering to overcome long periods of drought at all scales: garden, neighbourhood park, suburb and city;
- Better drainage and protection from rain- and riverwater flooding at the scale of: buildings, neighbourhood, suburb and city;

# Adaptation to Climate Change













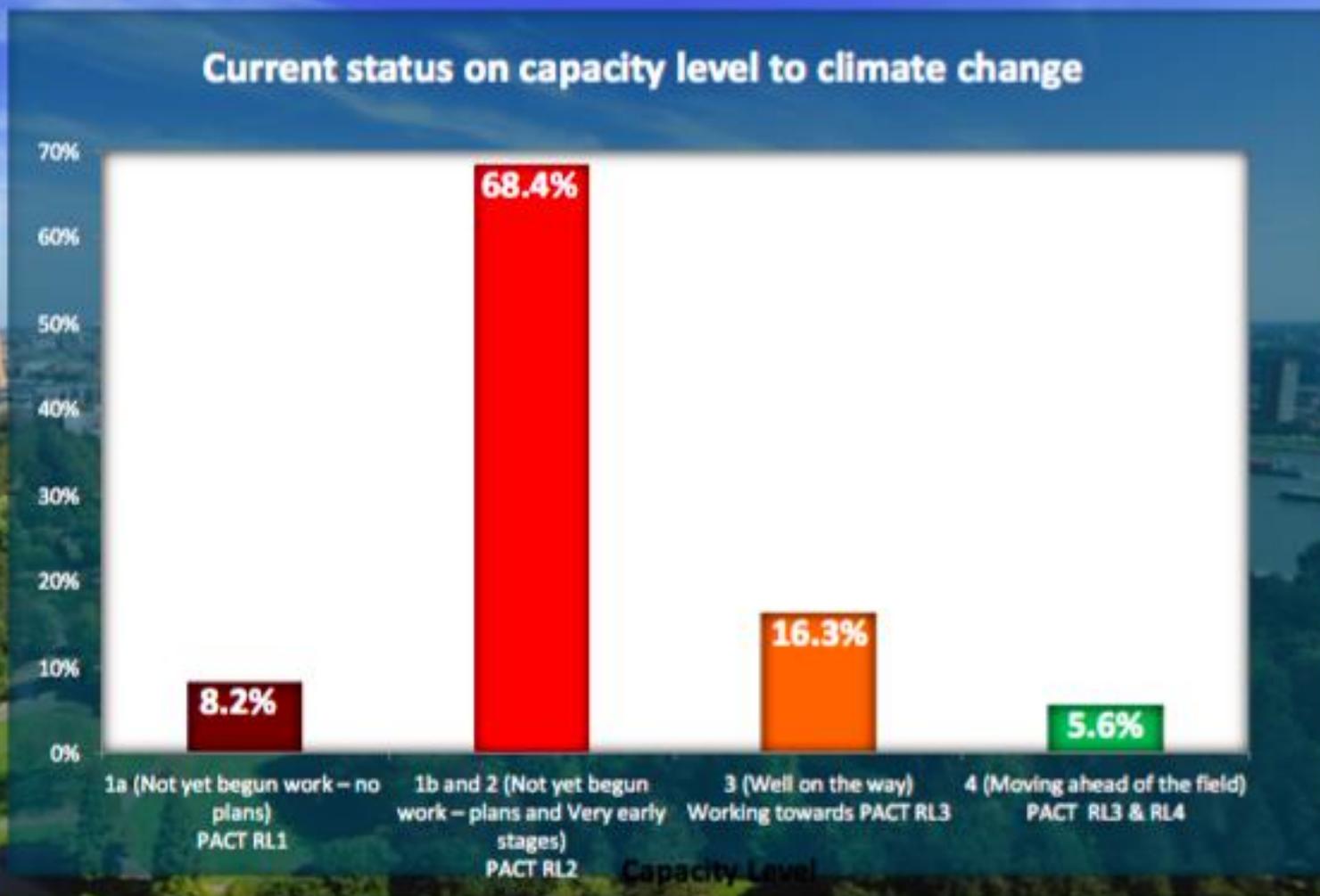








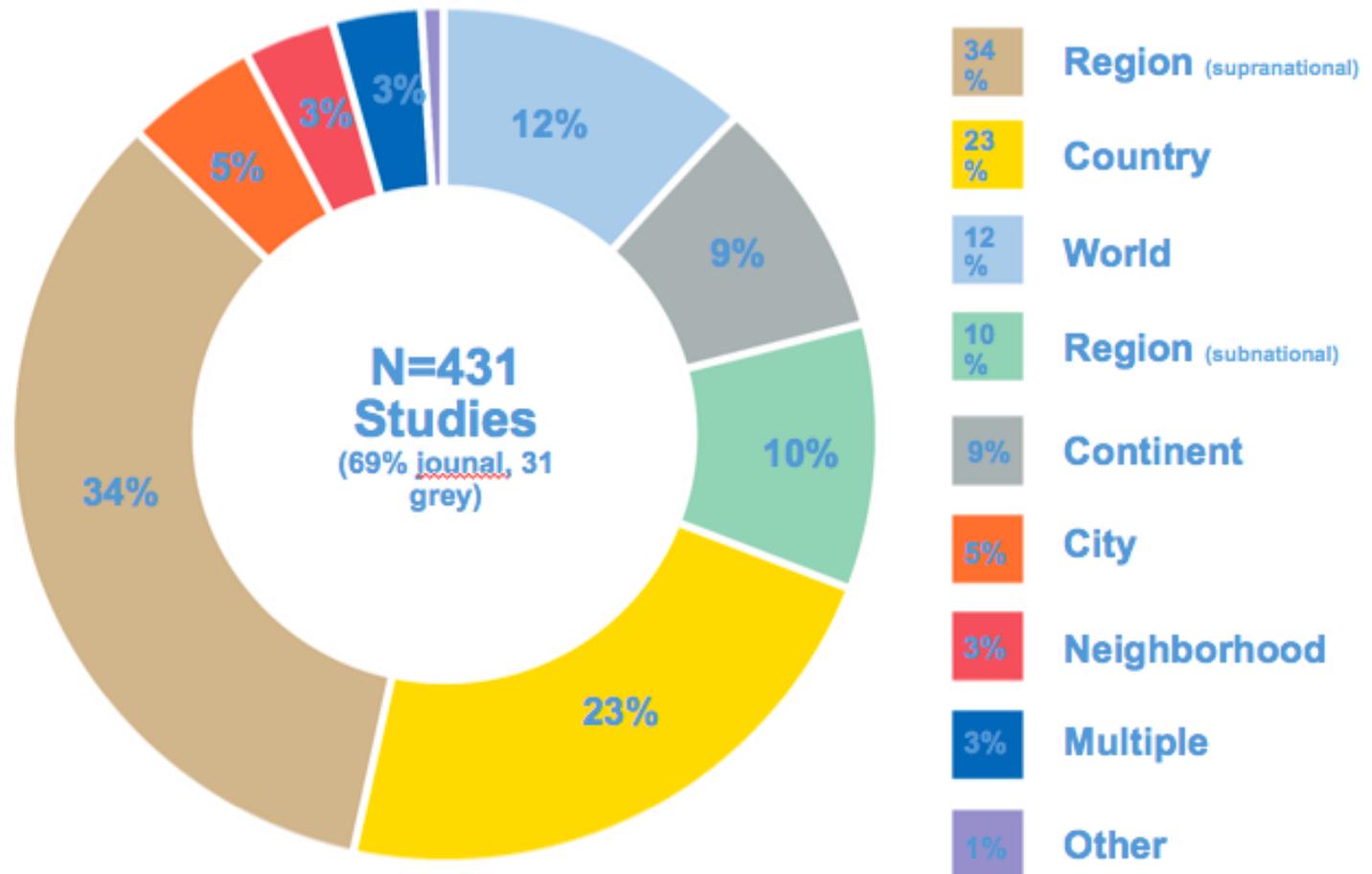
# Capabilities in European cities



196 cities were asked to select the option that best describes their **current status on adaptation**

Results confirmed by detailed questions and by in-depth review of 21 cities using the **PACT framework**

# Vulnerability assessments (maps)



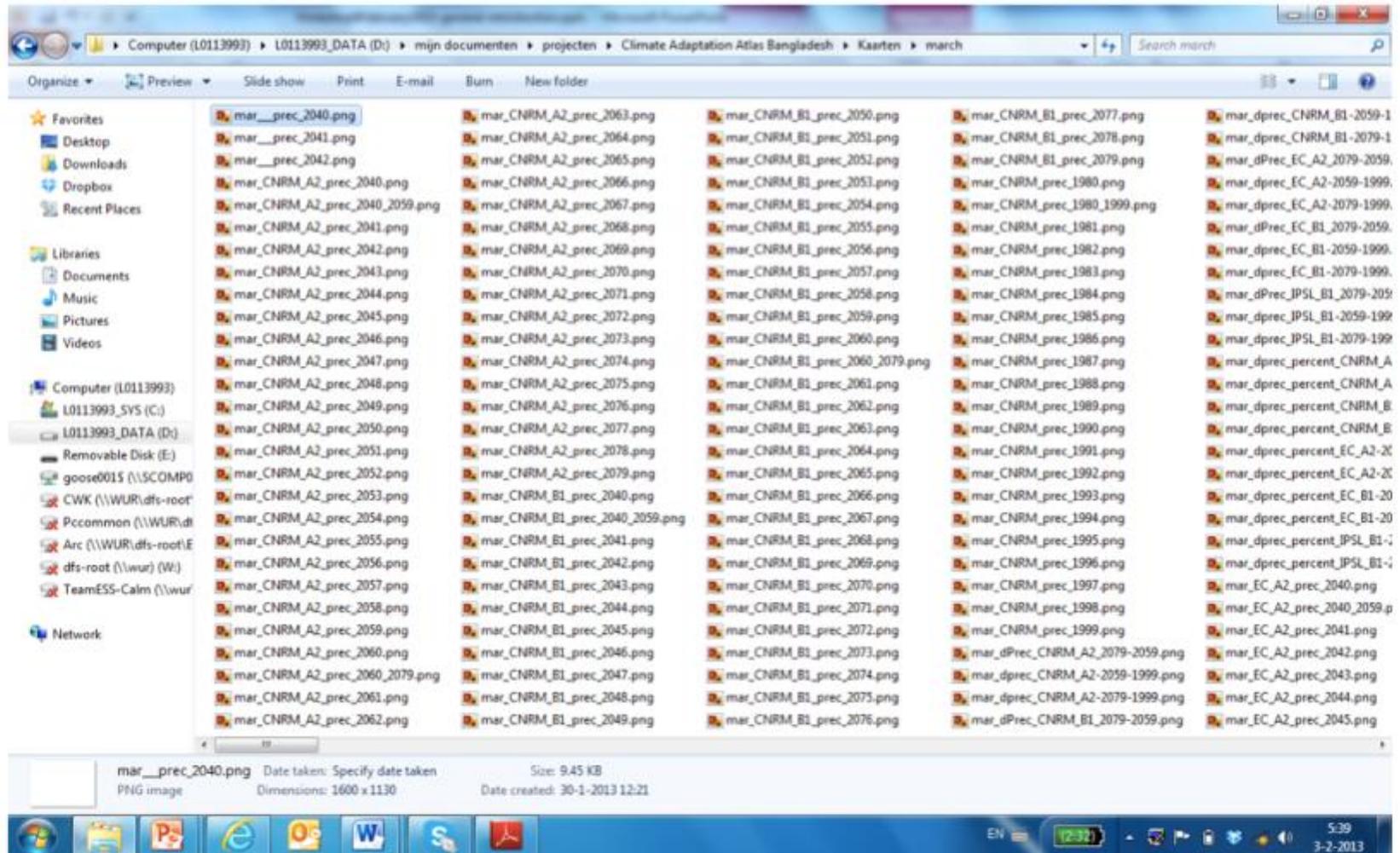
# User needs: 'Heat map city of Gent'

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# Climate Impacts on rainfall extremes in Bangladesh



# Disclosing climate impact information

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## Regionaler klimaatlas (German Climate Portal)

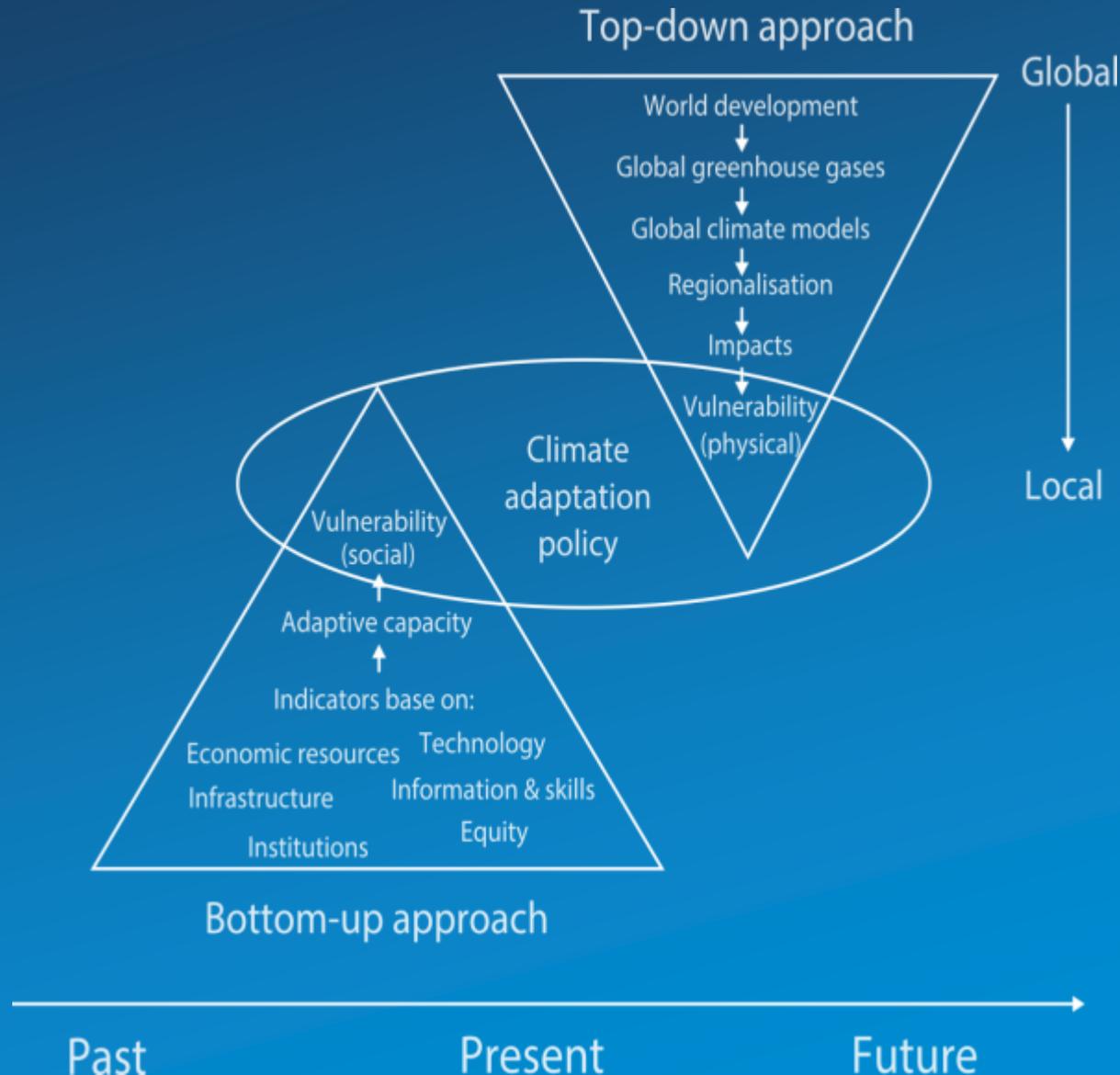
15 scenarios and model combinations

13 time steps

4 seasons and yearly average

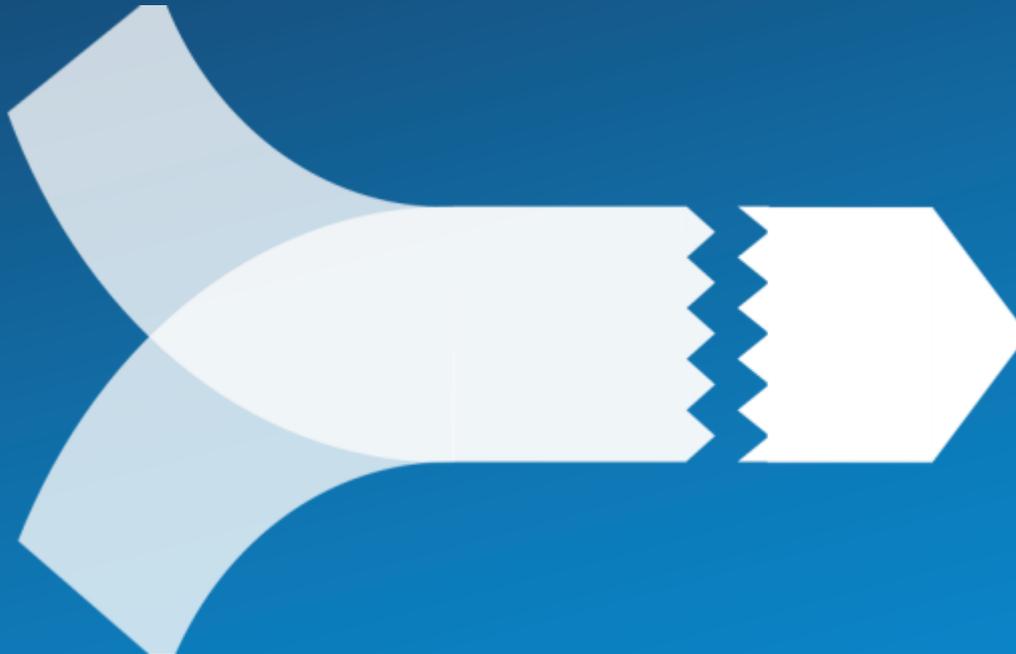
975 maps per climate indicator

# Approaches to adaptation (Dessai and Hulme 2004)



# The 'last mile'

Top-down  
adaptation



Municipal  
adaptation

Bottom-up  
adaptation

# Municipal challenges; climate is just no priority



Aging  
population



Environmental  
pollution



Social  
issues



Population  
decline



Climate change

And many more...



# Municipalities and climate change

- Adaptation is one of many issues
- Mitigation has priority
- Limited resources
- If addressed; then often top-down sectoral and ad-hoc

# Solution:

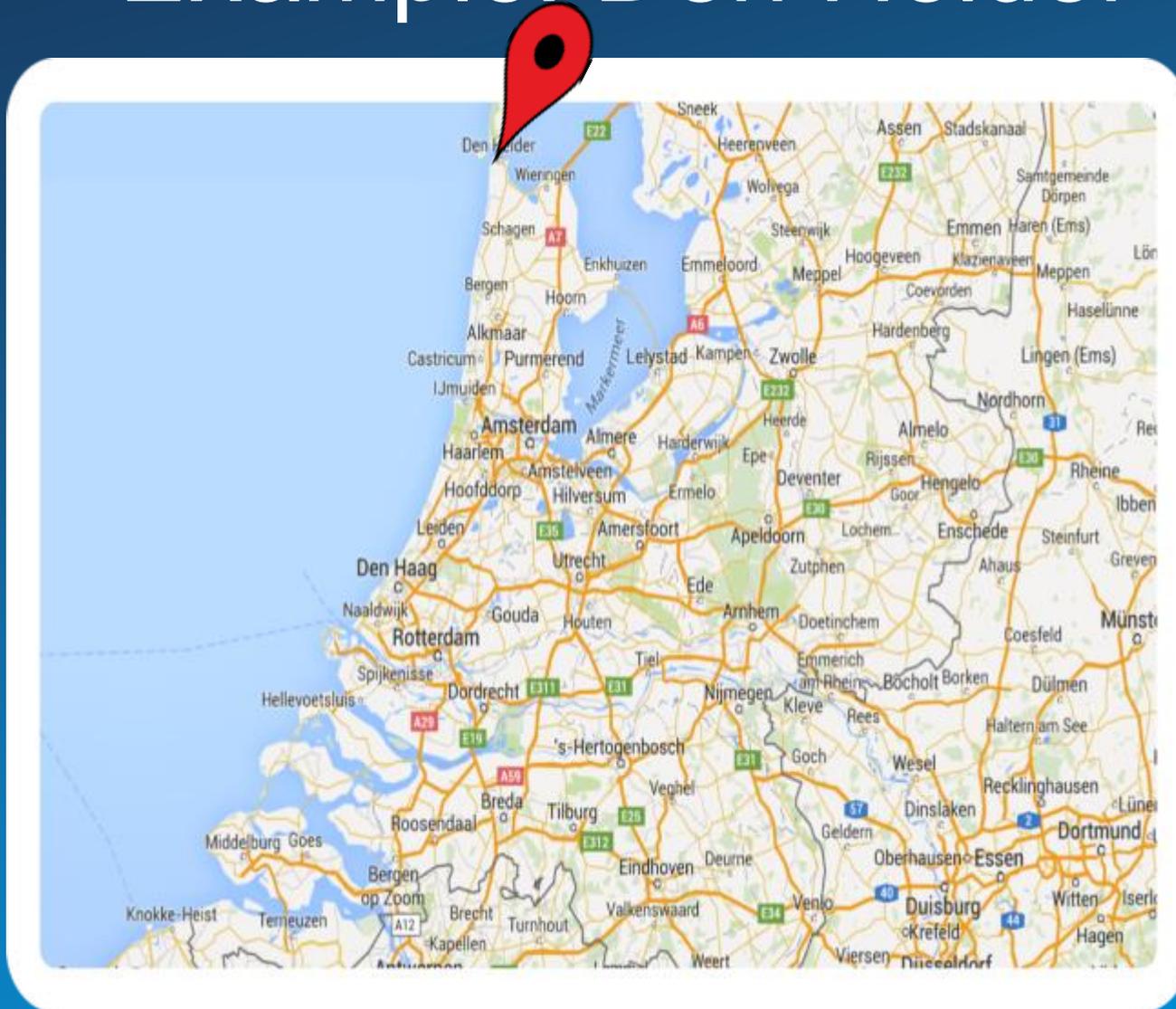
“ adaptation-as-you-go “

Focus on existing urban problems, ambitions and plans, and introduce climate resilient solutions / alternatives

# Adaptation-as-you-go in three steps

1. Inquire about major plans urban plans, issues and investments;
2. Develop simple, easy accessible and relevant climate information;
3. Organise a participatory and multidisciplinary process to discuss options for making the plan more climate robust.

# Example: Den Helder



# Den Helder

Low income housing, many social issues

Central question:  
How to restructure this neighbourhood?



# Example: Rheden



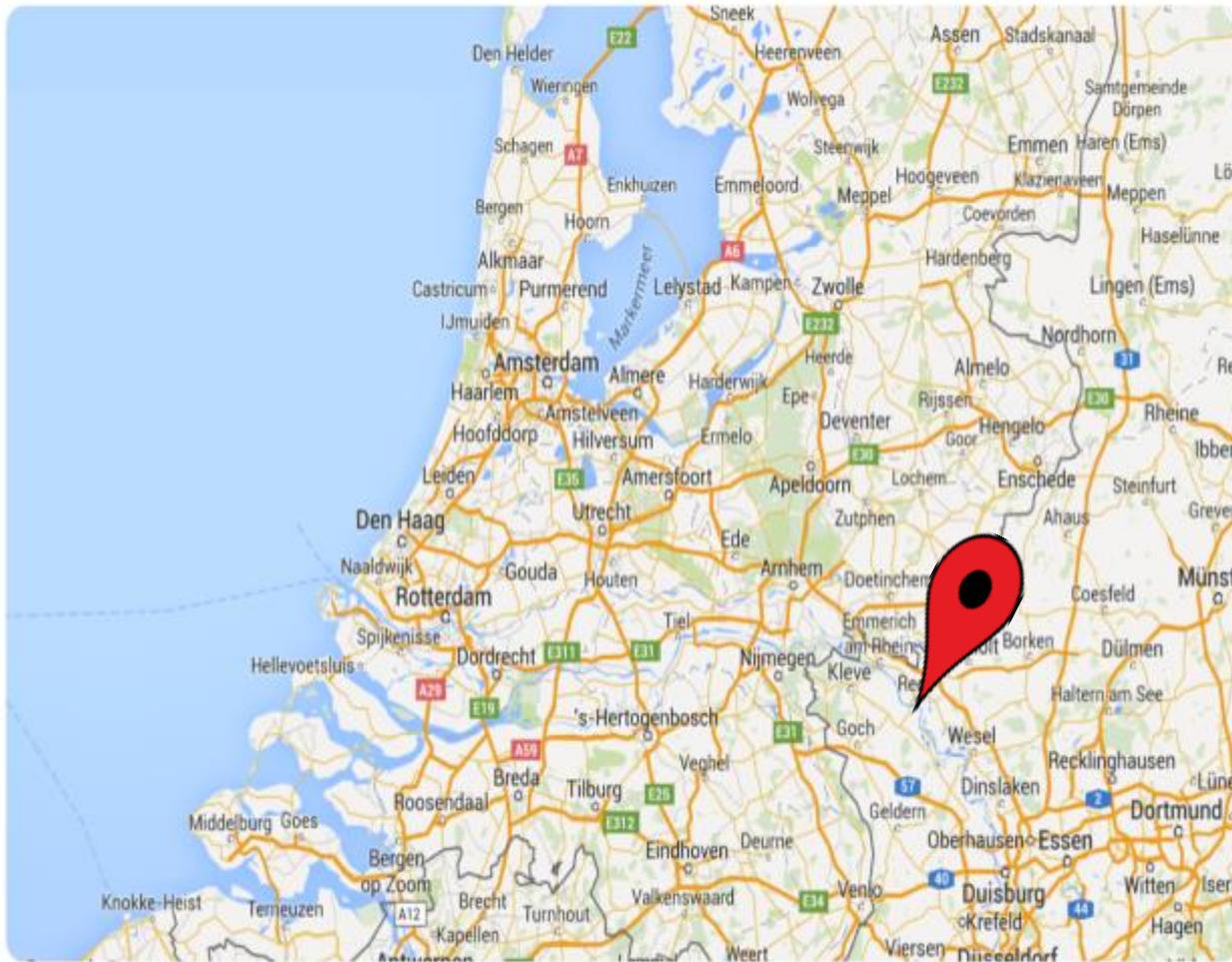
# Rheden (Netherlands)

- City shrinkage
- Demographic change



Central question:  
How to keep the city attractive?

# Example: Menzelen



# Menzelen (Germany)

- City shrinkage
- Soil subsidence (Salt mining)

How to maintain water safety with soil subsidence and fluctuating river discharge and extreme precipitation?



# Climate workshops; design



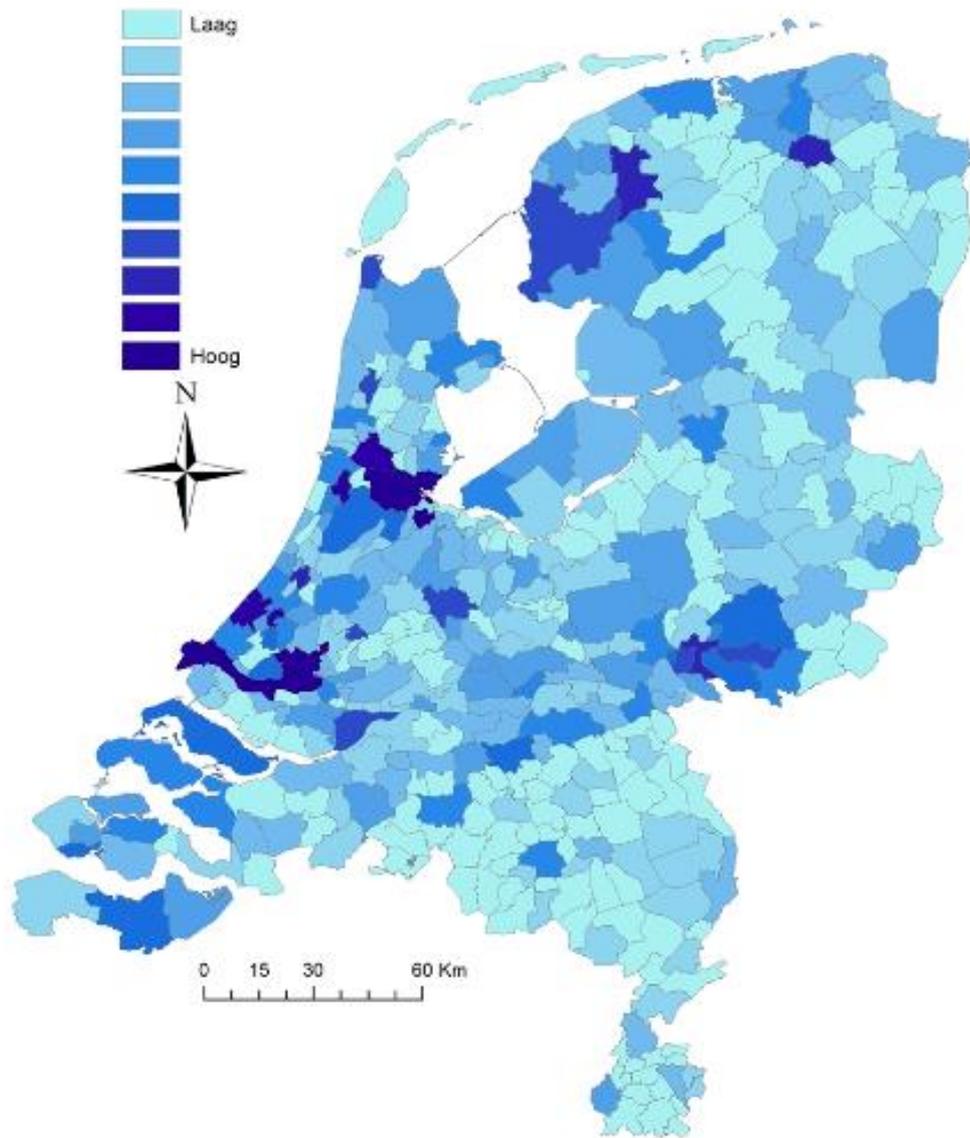
# Climate scenarios, data and visualisation examples

- The Hague, heat stress in 2050, analysis for different climate and city development scenario's;
- Amsterdam climate effects atlas; heat and flooding;
- Bangladesh climate effect atlas; data as called for by the users managers and planners;
- Future land use scenario's combined with future climate schenario's .
- Examples from Climate Adaptation Services web site:  
<http://www.climateadaptationservices.com>

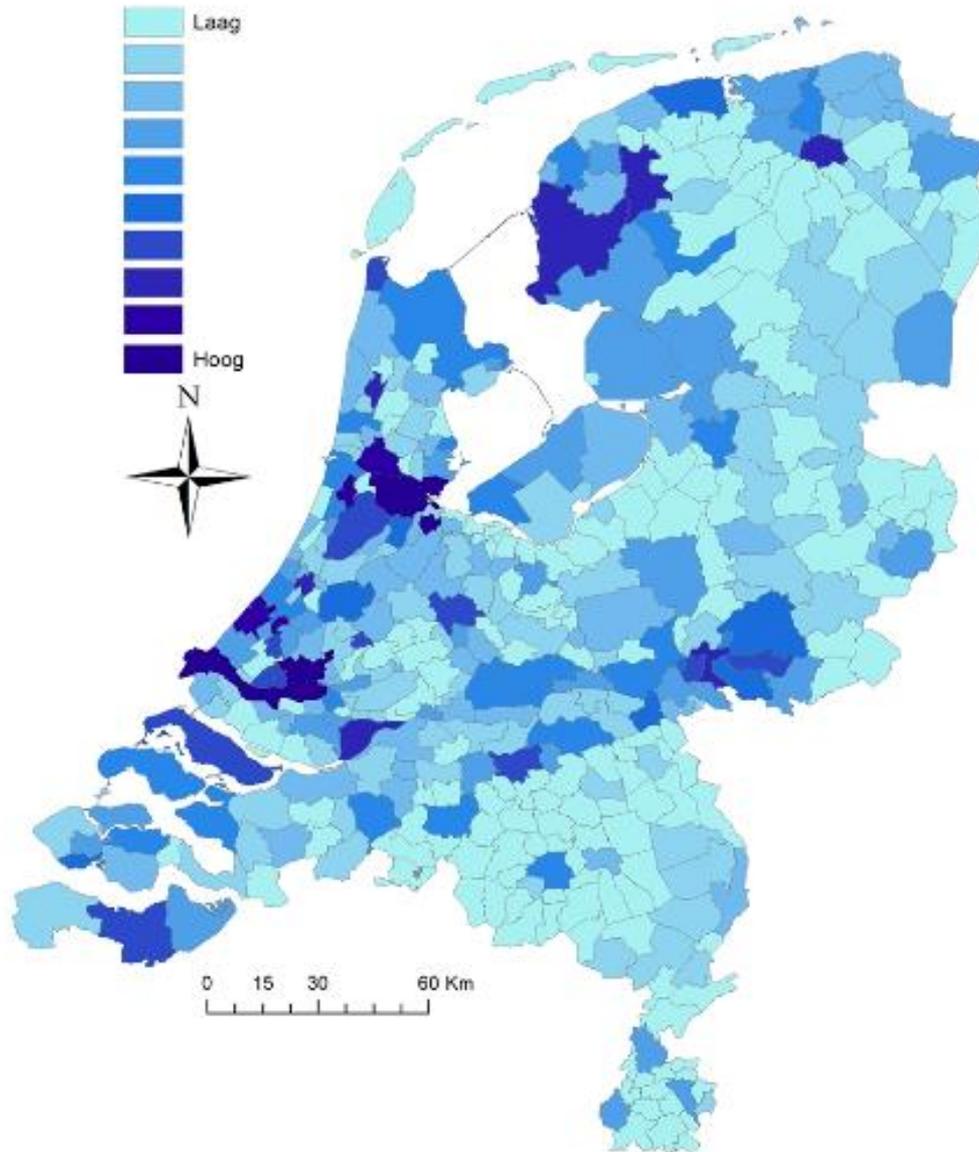
Adaptation deficit  
in aggregated monetary value

preliminary calculations per  
municipality / county / city

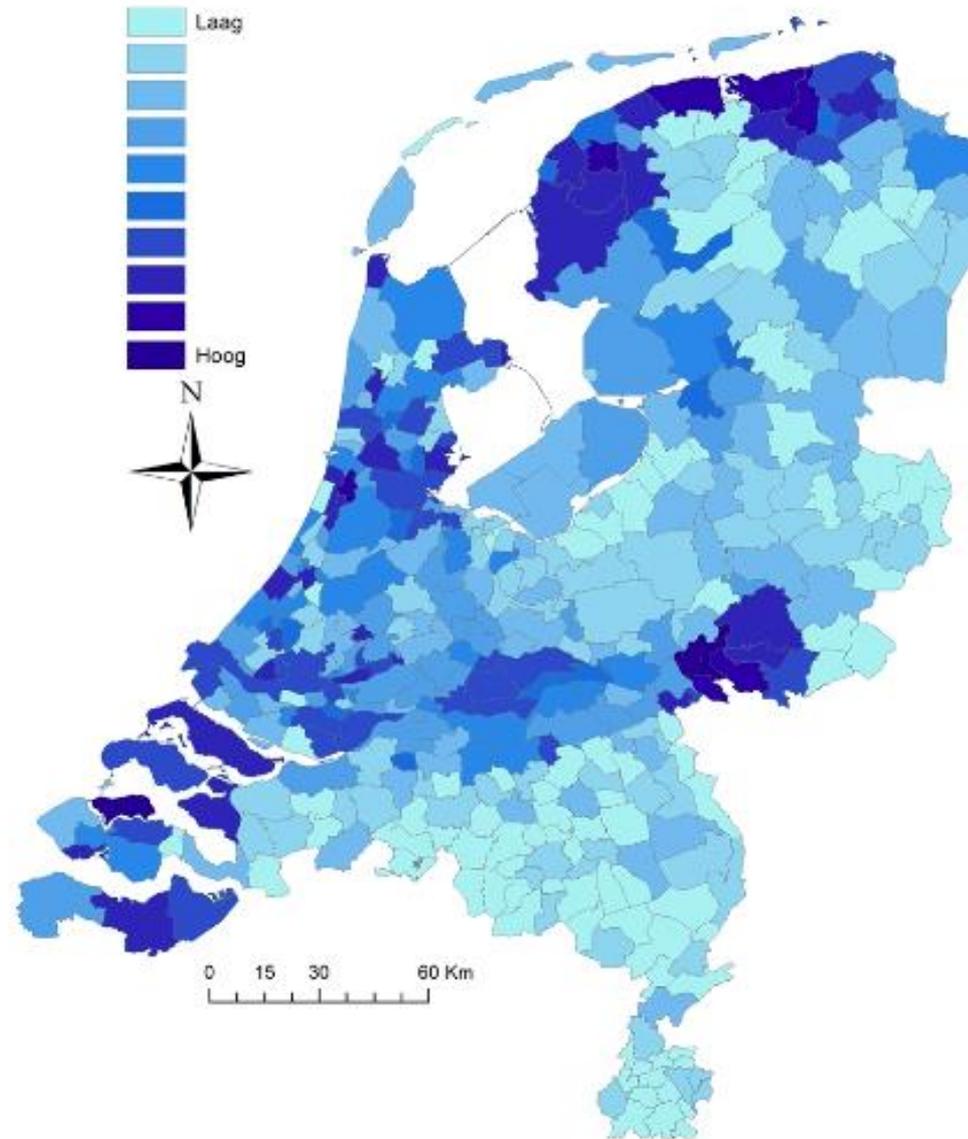
# Kosten klimaateffecten (Laag)



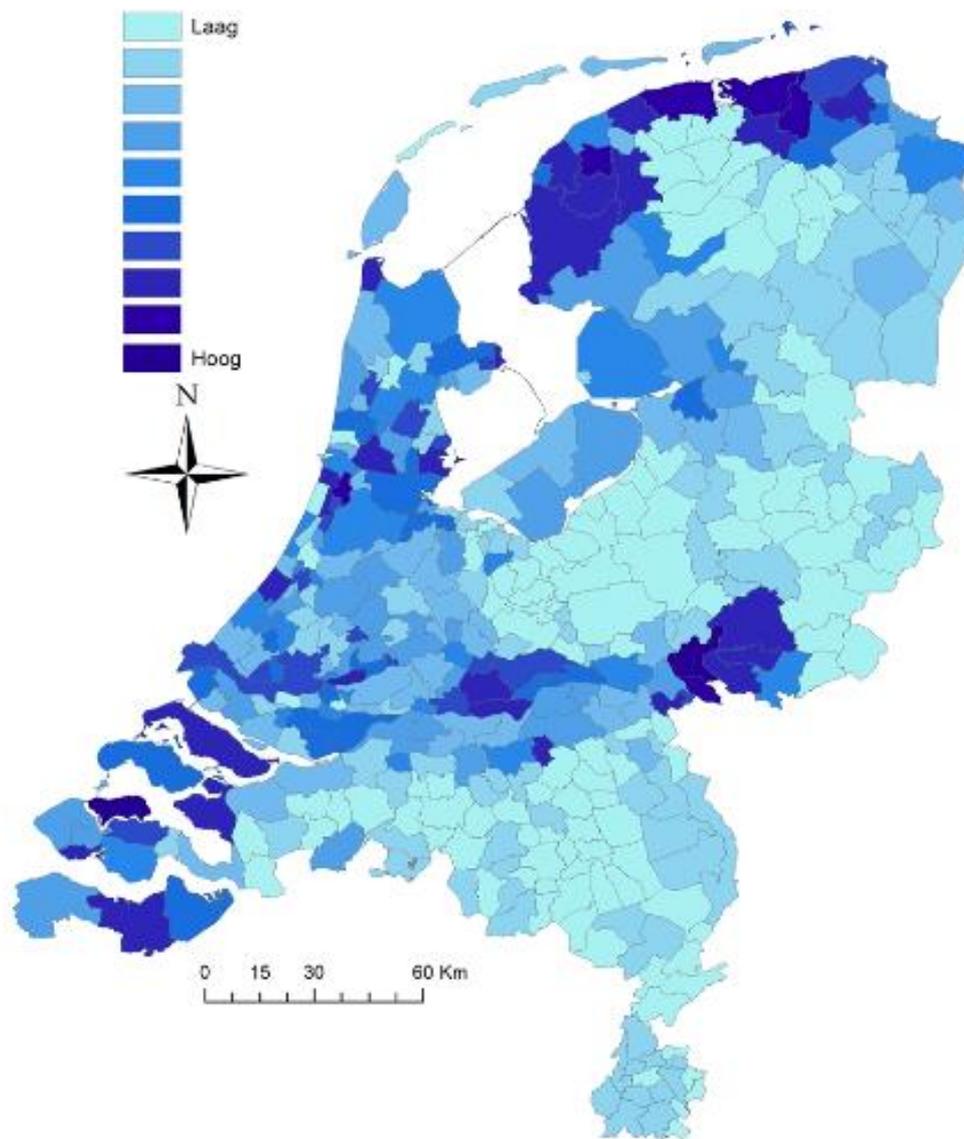
# Kosten Klimaat effecten (Hoog)



## Kosten Klimateffecten per inwoner (Laag)



## Kosten Klimateffecten per inwoner (Hoog)



# Nexus issues / synergies (1)

- Increasing the organic carbon content of soils reduces the CO<sub>2</sub> atmospheric concentrations and helps to buffer extreme rainfall and;
- Shifting to more organic food diets reduces CH<sub>4</sub> emissions and reduces the water needs and thus climate vulnerability in agriculture;

# Nexus issues / synergies (2)

- Planting trees reduces the atmospheric concentrations of CO-2 and helps to store/buffer water and lower the temperature;
- Water is a good medium to store/buffer heat/energy and as such an excellent medium for use in heat pump systems for electrifying heating systems in homes and offices;

# Final recommendations

- Make sure that climate information is presented in a simple way;
- When in consultation with stakeholders on adaptation: start with analysis of and solutions for other issues or plans and identify alternative, or additional climate robust solutions;
- Transitions towards a climate neutral society are generally considered more urgent than adaptation; thus in efforts for adaptation start from plans and investments aimed at emission reduction and present adaptation as an additional sustainability issue;

Thank you for your attention