Combining severe drought and heat experiences from the Netherlands and New Orleans attempting to create a more climate- resilient delta in the future

MSc Thesis Presentation by:
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Deltares
Enabling Delta Life

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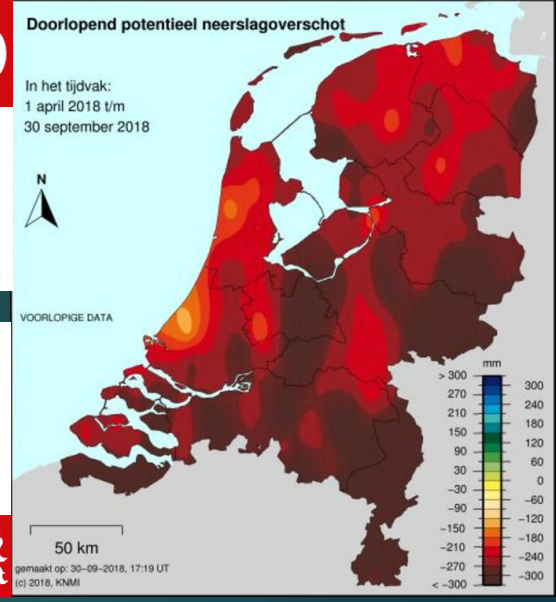
Introduction

- The Netherlands
  - Since 2018 a lot attention for drought and heat impacts
- New Orleans
  - Little attention to drought
  - Little attention for heat impacts.
  - Recently, there has been a heat warning (2019, July 7)
  - Large land subsidence project (Deltares)
- Can we learn from each other's drought and heat experiences

Code oranje vanwege gevaarlijk tropisch weer: pas goed op

Het KNMI heeft vanmiddag code oranje afgegeven vanwege de aanhoudende tropische temperaturen en droogte in Nederland. Er is ook de komende dagen nog sprake van extreme hitte, die gevaarlijke situaties op kan leveren.

Maarten van Ast 24-07-18, 17:06 Laatste update: 20:05



Opnieuw scheuren in huizen door droogte: 'Ik woon hier met minder plezier'

ZEVENAAR - Huizen in met name de Betuwe en Achterhoek scheurden vorig jaar door de extreem droge zomer. Nu de droogte terug is, beginnen de scheuren weer te komen. ,,Ik woon hier met minder plezier.''

Niek Opten 03-07-19, 08:00 Laatste update: 08:12

« Back | Heat Advisory

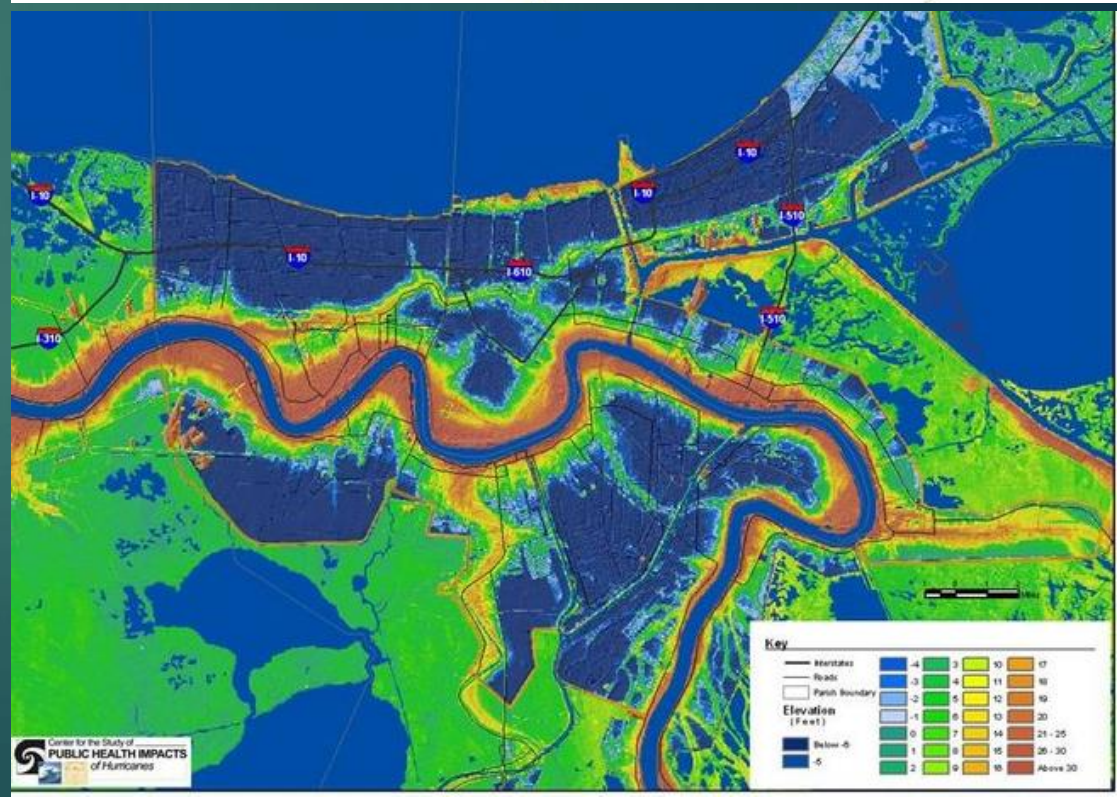
2019-07-07 16:48:26 CEST

Heat advisory in NOLA today noon - 7p. "Feels like" temps 106 to 111. Stay hydrated, stay cool & check on the elderly. ready.nola.gov/heat

Introduction (research area)

Similarities:

- Delta (Mississippi & Rhine river delta plain)
- Below sea level
- Clay (peat) soils
- Subsidence
- Vulnerable for climate change



Introduction (research areas)

<u>Differences:</u>

- Climate
  - Temperate maretime VS Subtropical
  - Double precipitation rates
    - 800 millimeter (NL) & 1500 millimeter (NO)
  - Higher temperatures
    - Average summer temperature 17,5 °C (NL) & 27,7 °C (NO)

- Drought and heat are limited studied in New Orleans

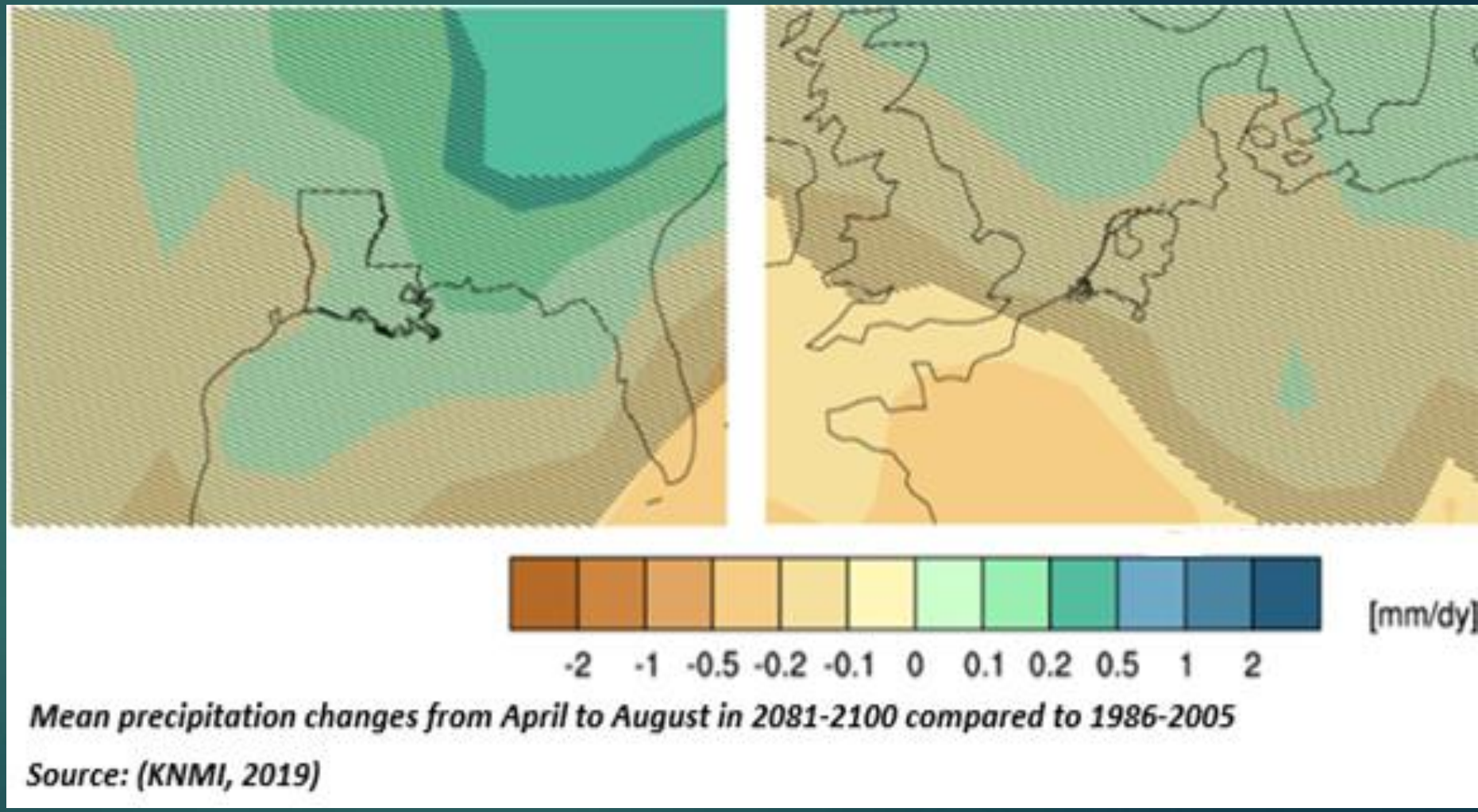
Introduction (future climate)

<u>The Netherlands</u>

- Less precipitation (April to August)

<u>New Orleans</u>

- Slightly more precipitation (April to August)
- Still getting dryer
  - Intensity up
  - Shorter duration

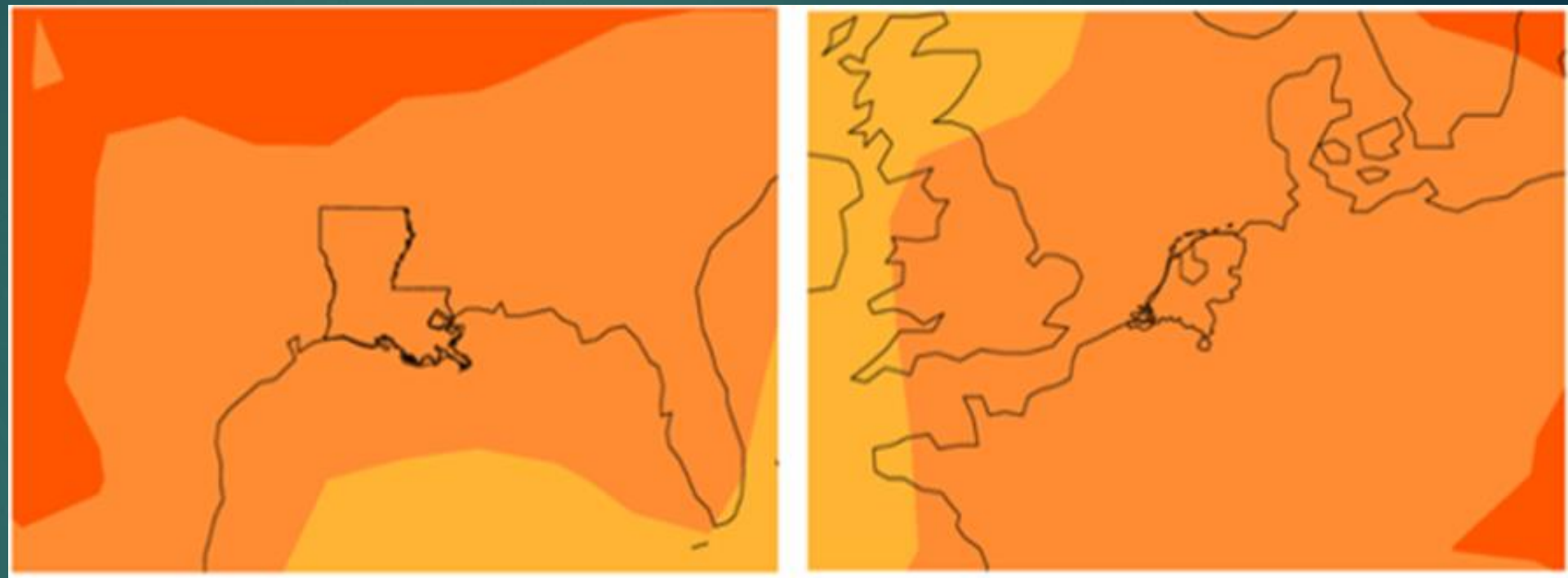


Mean precipitation changes from April to August in 2081-2100 compared to 1986-2005

Source: (KNMI, 2019)

Introduction (future climate)

- More heat
- Similar temperature increase
- +2 or +3 °C

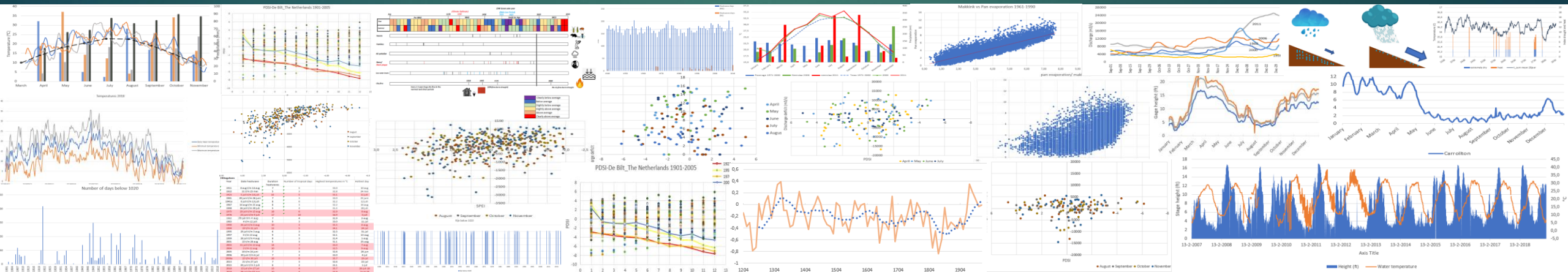


The mean annual temperature changes 2081-2100 compared to 1986-2005
Source: (KNMI, 2019)

Research (Objective)

Research question:

What are the socio-economic impacts of drought and heat events in the Netherlands and in New Orleans, what are the differences and similarities of the occurrence and impacts of drought and heat between the two areas and what are the tools for drought mitigation?



Research (Implementation)

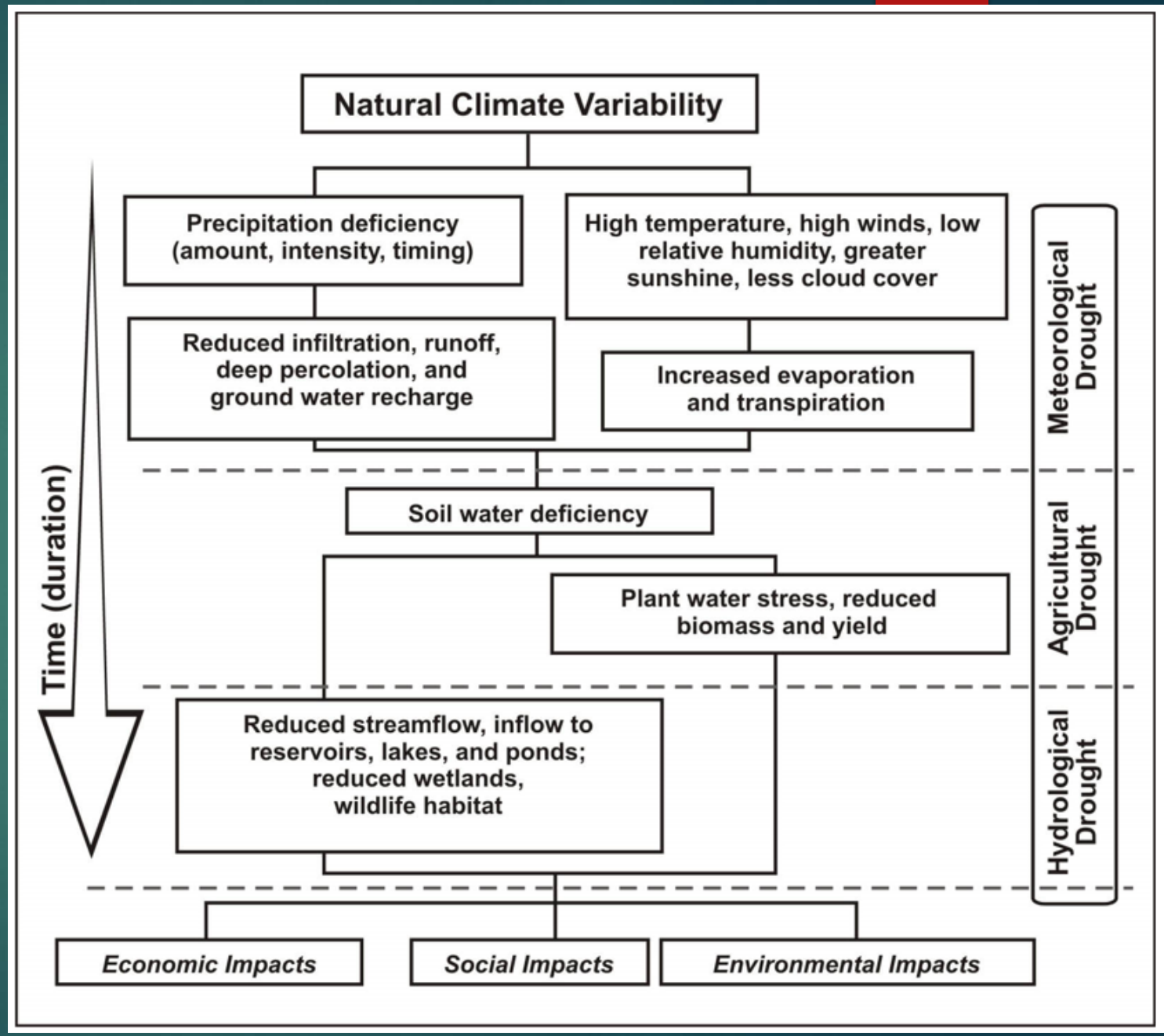
1. Drought and heat of the past 1000 years
   - Literature ''Thousand years weather, wind & water in the Low lands'' (6 books; Buisman)
2. Drought and heat events of the past 100 years in the Netherlands and New Orleans
   - Meteorological data
3. Indicating all drought and heat related impacts of the Netherlands and New Orleans
   - Literature (Researches, newspapers & weather institutions)
   - Fieldwork in New Orleans (2 weeks in April, taking interviews and observation)
4. Similarities/ differences of mitigation option between the Netherlands and New Orleans
   - What can we Learn form each other?

Background

Definition:
Intergovernmental Panel on Climate Change (IPCC):

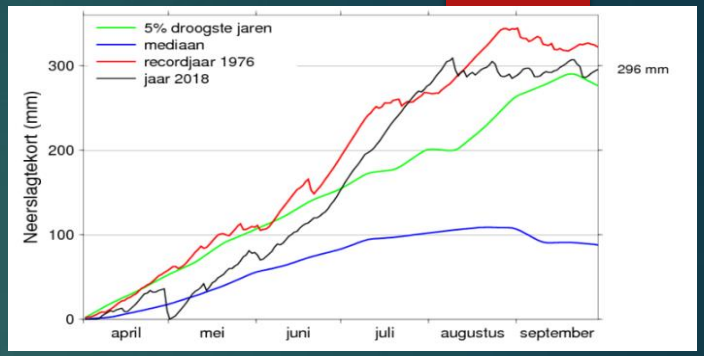
"A period of abnormally dry weather long enough to cause a serious hydrological imbalance"

Urban drought is different and often human induced!! Not included in current definitions



Background (drought index)

- Precipitation deficit (NL)
  - The difference between the amount of precipitation and the calculated reference crop evaporation for the period of April 1 to September 30.



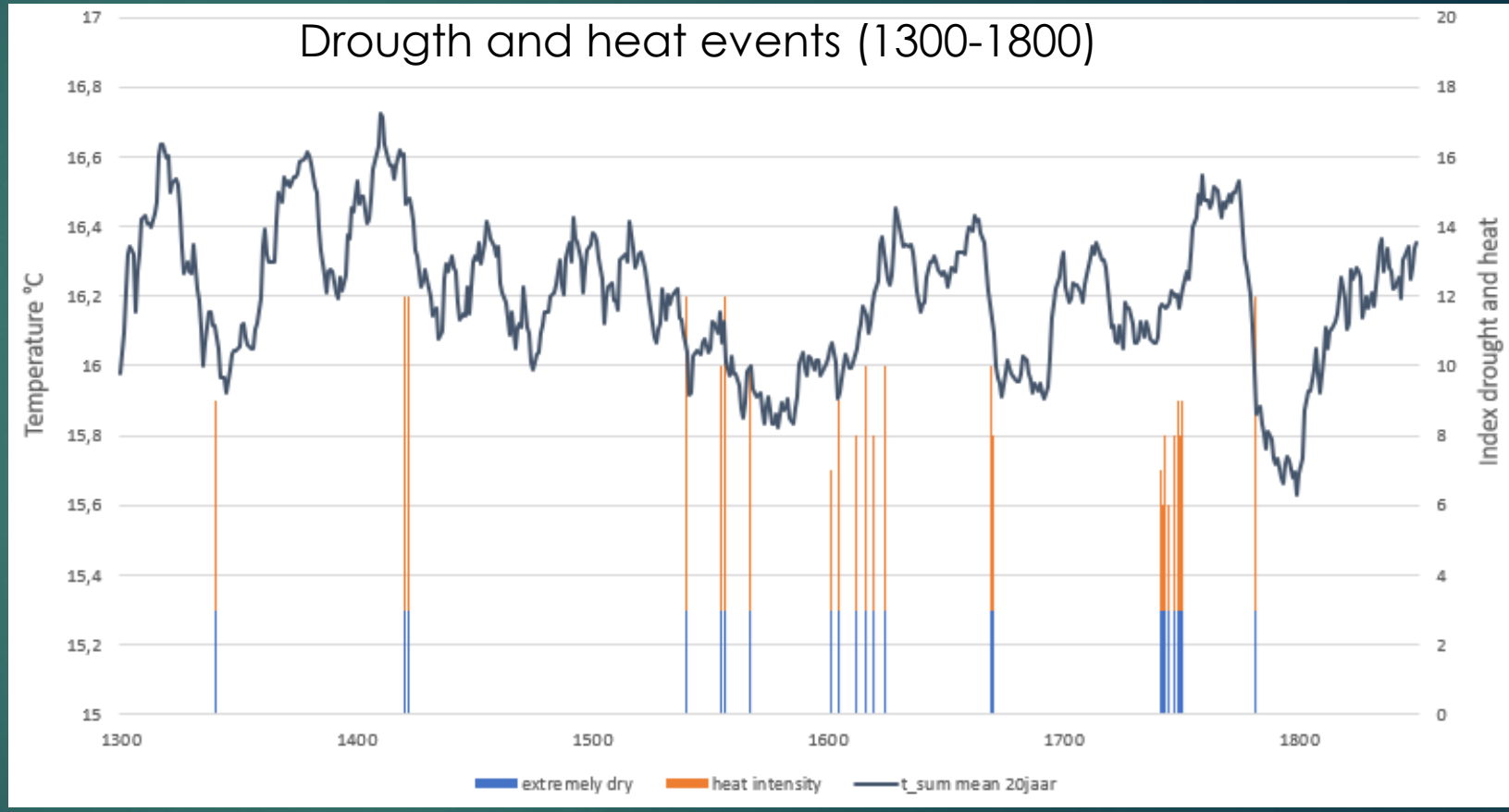
- Palmer drought severity index (PDSI; USA)
  - Long term drought (several months to years)
  - Temperature and precipitation data
  - Supply- and- demand model of soil moisture
  - -10 (extremely dry) and +10 (extremely wet)

Description	Palmer Drought
Normal	0
Moderate drought	-2
Severe drought	-3
Extreme drought	-4
Exceptional drought	-5.0 or less

- Heatwaves
  - Maximum temperature for five consecutive days ≥ 25 °C, of which three days are ≥ 30 °C (the Netherlands).
  - Extreme heat: period (2 to 3 days) of high heat and humidity with temperatures above 32 °C (USA).

Results (past 1000 years)

- Small ice age (1430-1820)
- Mean summer temperature lower than current (17,5 °C)
- Drought apperars often in colder periods
  - Drougth and heat not always compound events



Results (PDSI)

Description	Palmer Drought
Normal	0
Moderate drought	-2
Severe drought	-3
Extreme drought	-4
Exceptional drought	-5.0 or less

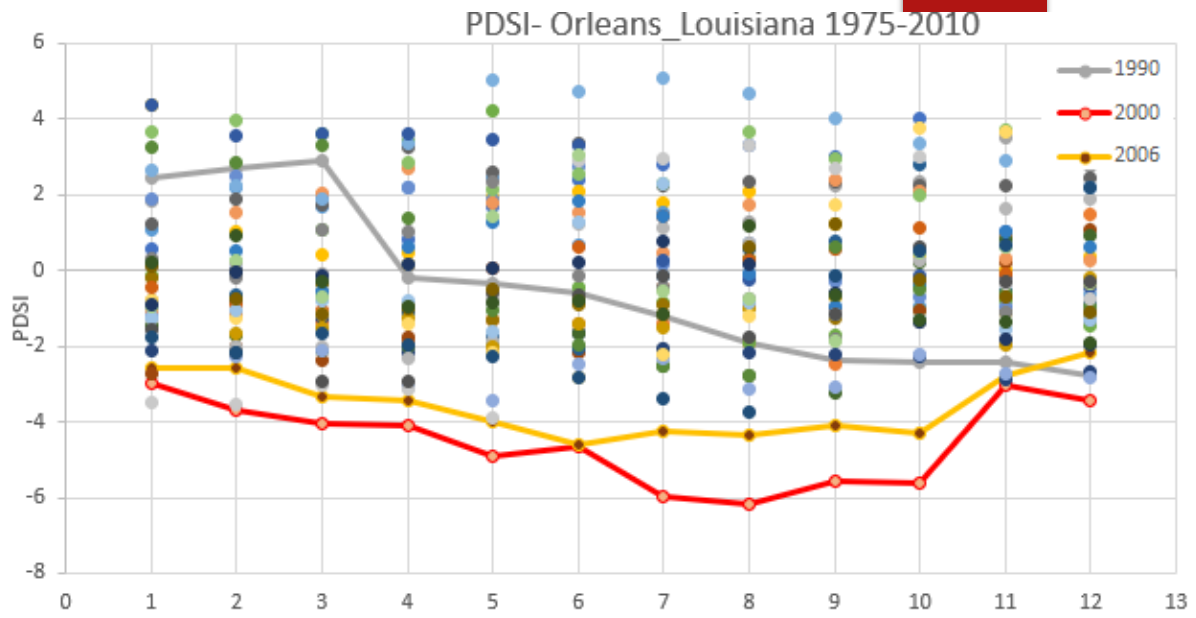
New Orleans

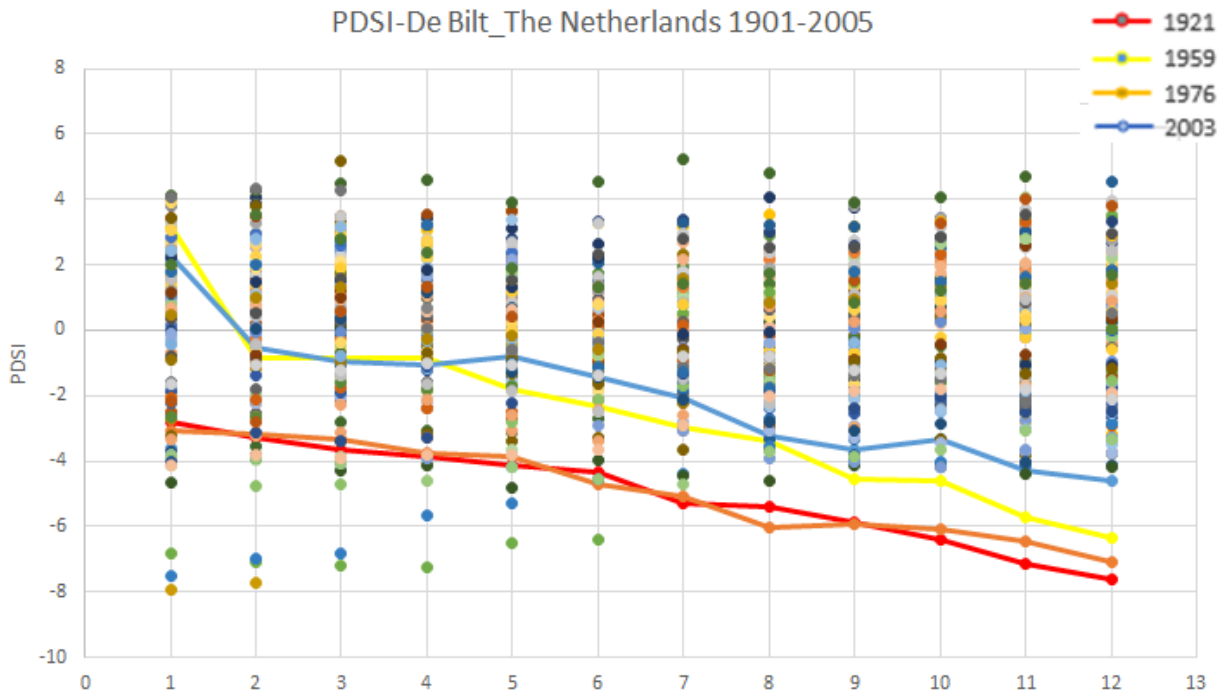
Rank	Year	Month	PDSI
1	2000	August	-6,2
2	2006	July	-4,6
3	2001	May	-3,9
4	2009	August	-3,7
5	1999	May	-3,4

- 1963: driest year (no pdsi values)
- 2011: second driest (no pdsi values)

The Netherlands

Rank	Year	Month	Mean
1	1921	December	-7,6
2	1976	December	-7
3	1959	December	-6,3
4	2003	December	-4,1





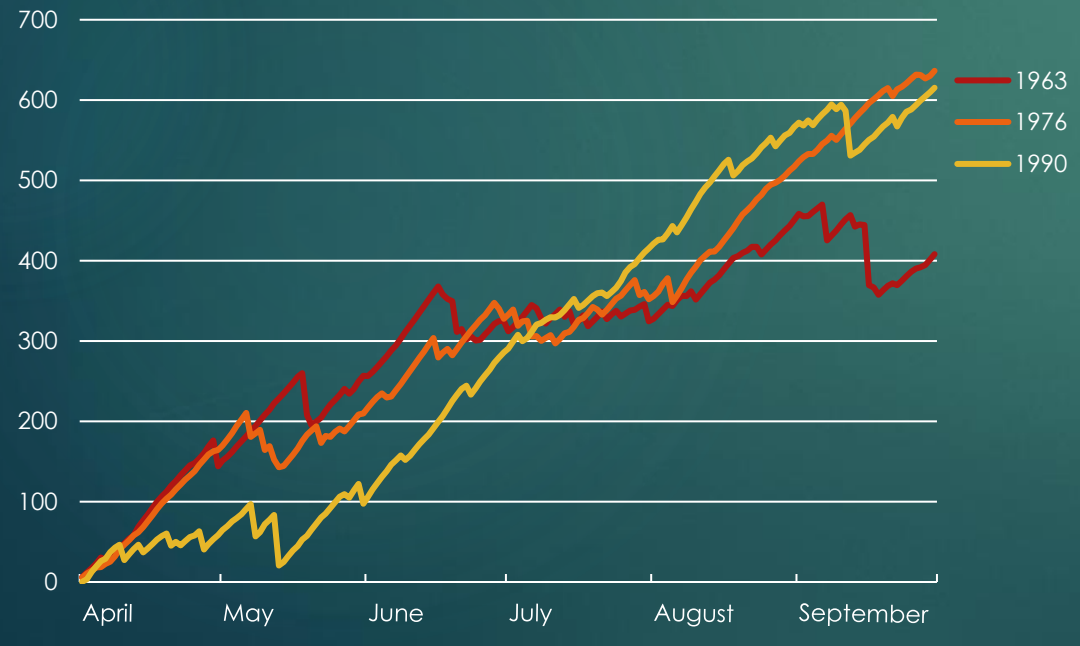
Results (precipitation deficit)


Audubon Park Oak Tree - New Orleans

- The experience of high Precipitation deficits are different between the Netherlands and New Orleans
  - Example: Large trees survive high precipitation deficits in New Orleans

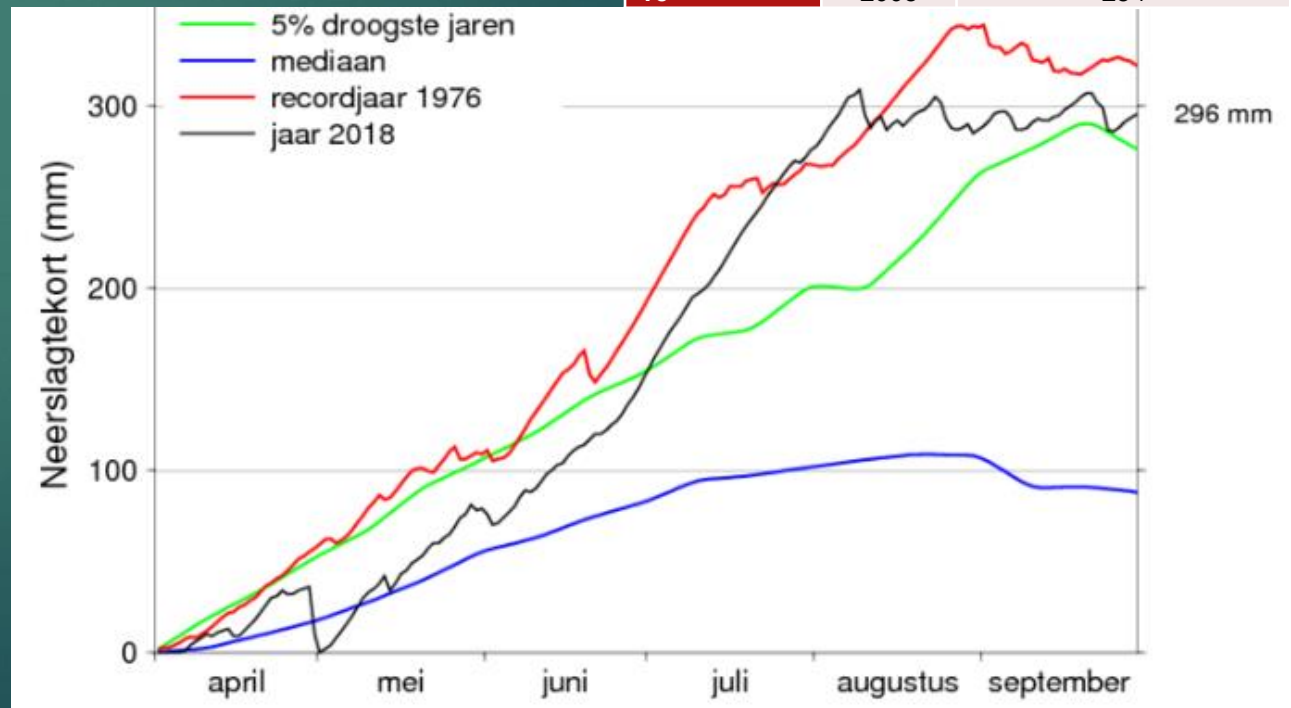
- New Orleans (1960-1990)

Rank	Year	Precipitation deficit (mm)
1	1976	636
2	1990	615
9	1963	470



- The Netherlands

Rank	Year	Precipitation deficit (mm)
1	1976	361
2	1959	352
3	1911	328
4	1921	321
5	2018	309
10	2003	234

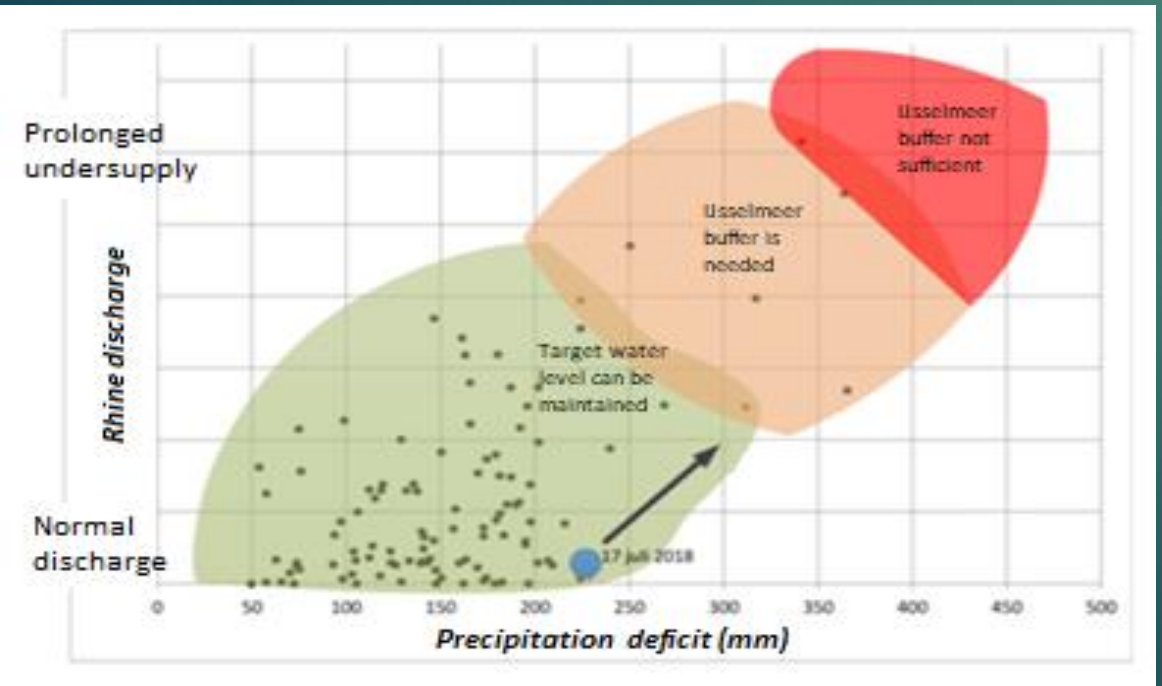


Results (River discharge/ drought)

- Inspired by Deltares
- River important to keep water level high in polders during summer
  - Prevent subsidence

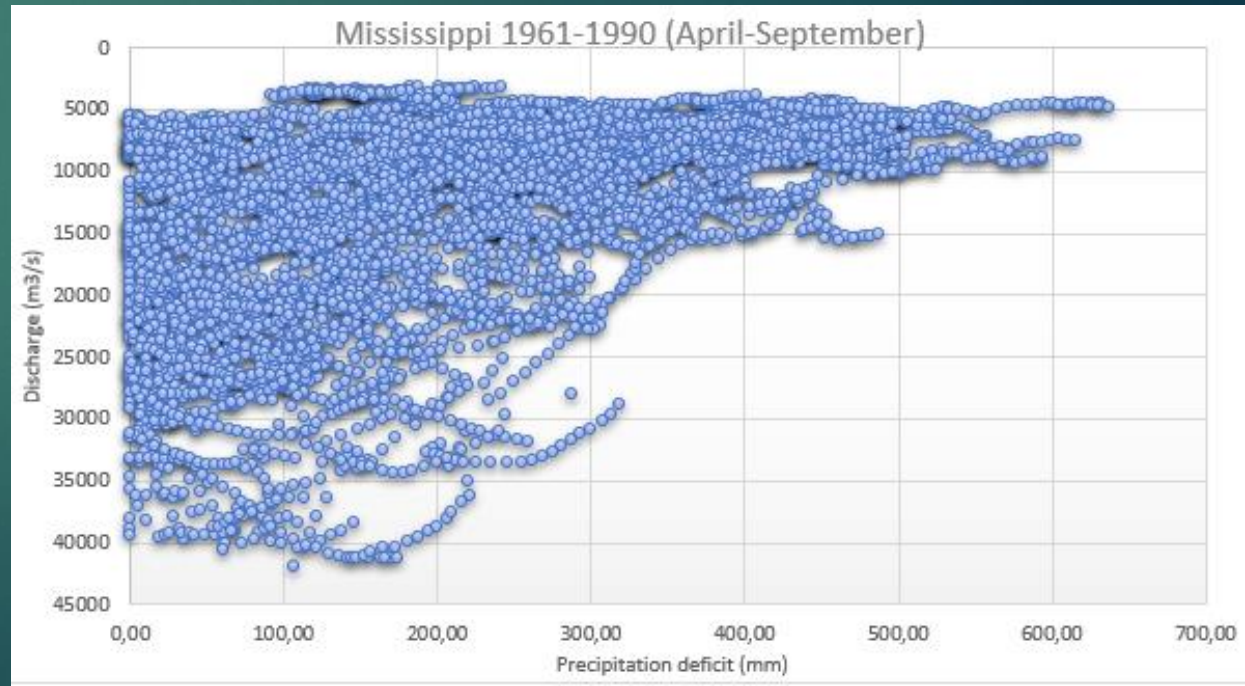
Rhine

- Water is used to maintain polder levels
- Correlation: low Rhine discharges with a high precipitation deficit



Mississippi

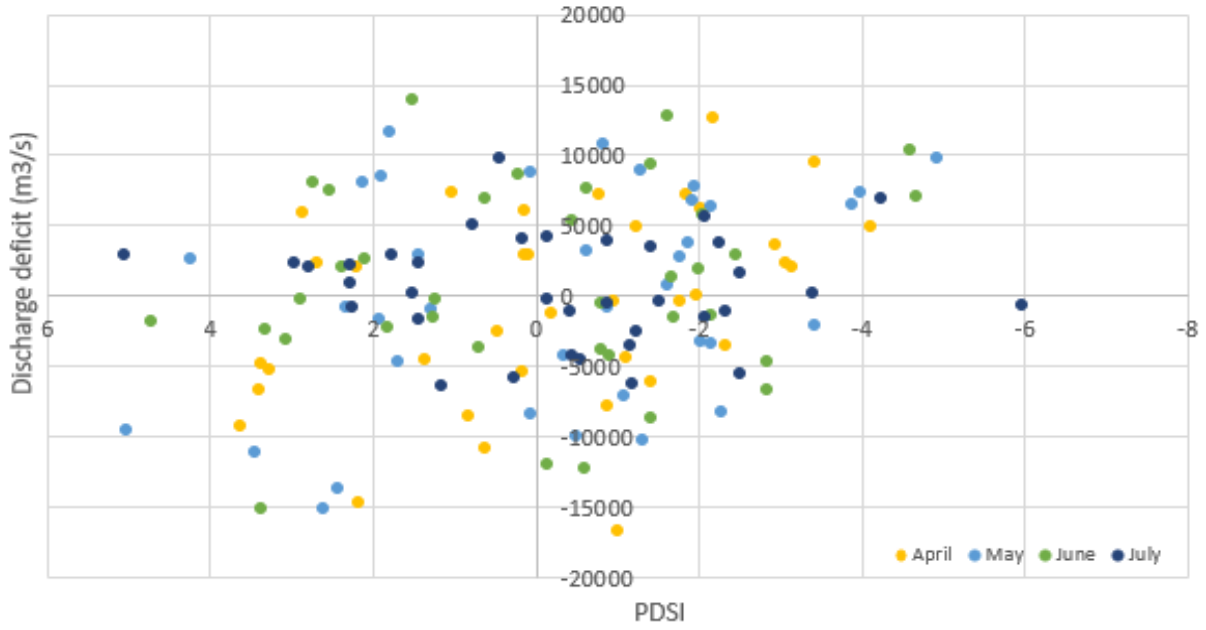
- Daily discharge and daily precipitation deficit (dutch method)
- Correlation



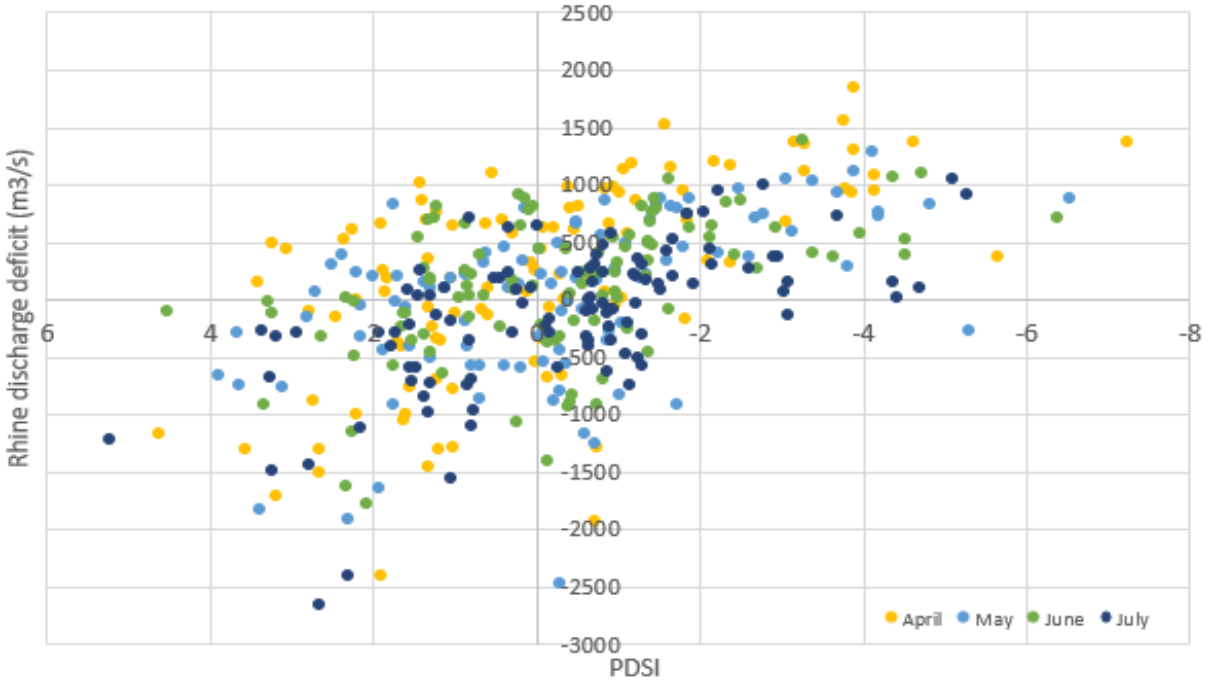
Results (River discharge/ pdsi)

- Mississippi
  - 1975-2010
  - Little correlation
- Rhine
  - 1901-2005
  - correlation

Mean Mississippi discharge and PDSI number of April to July (1975-2010)

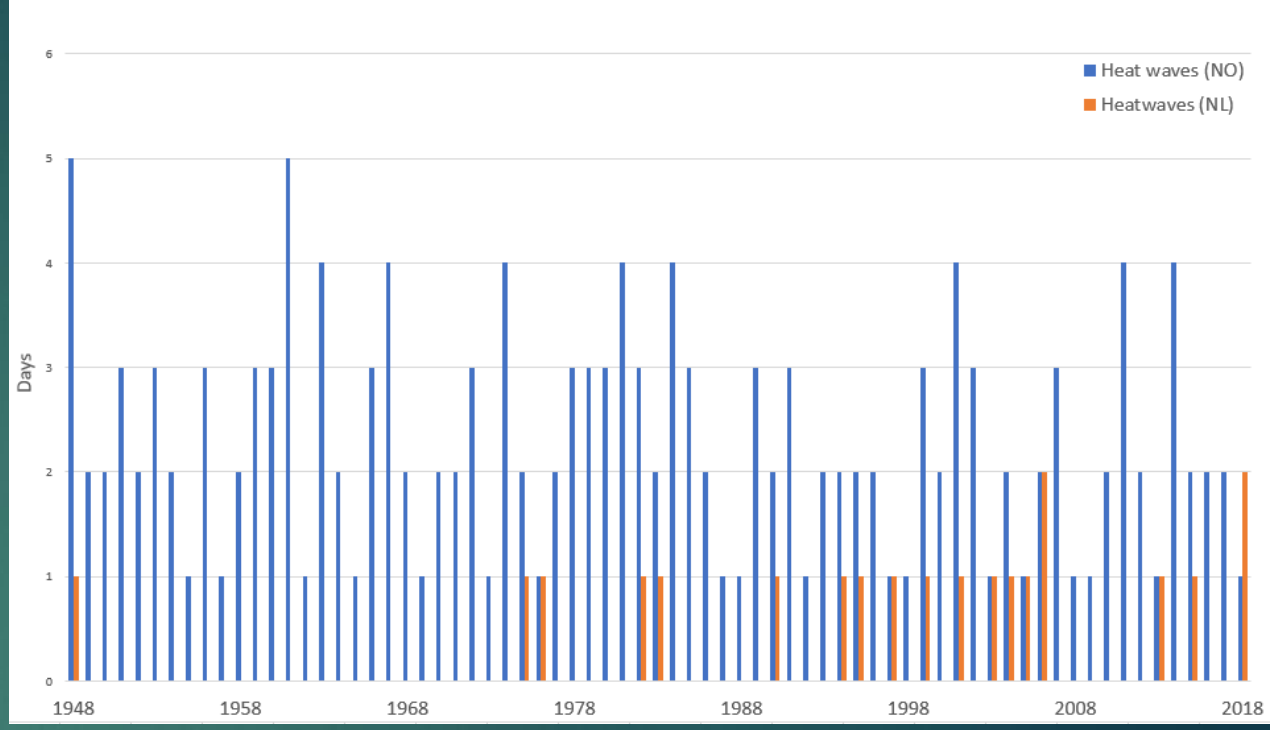


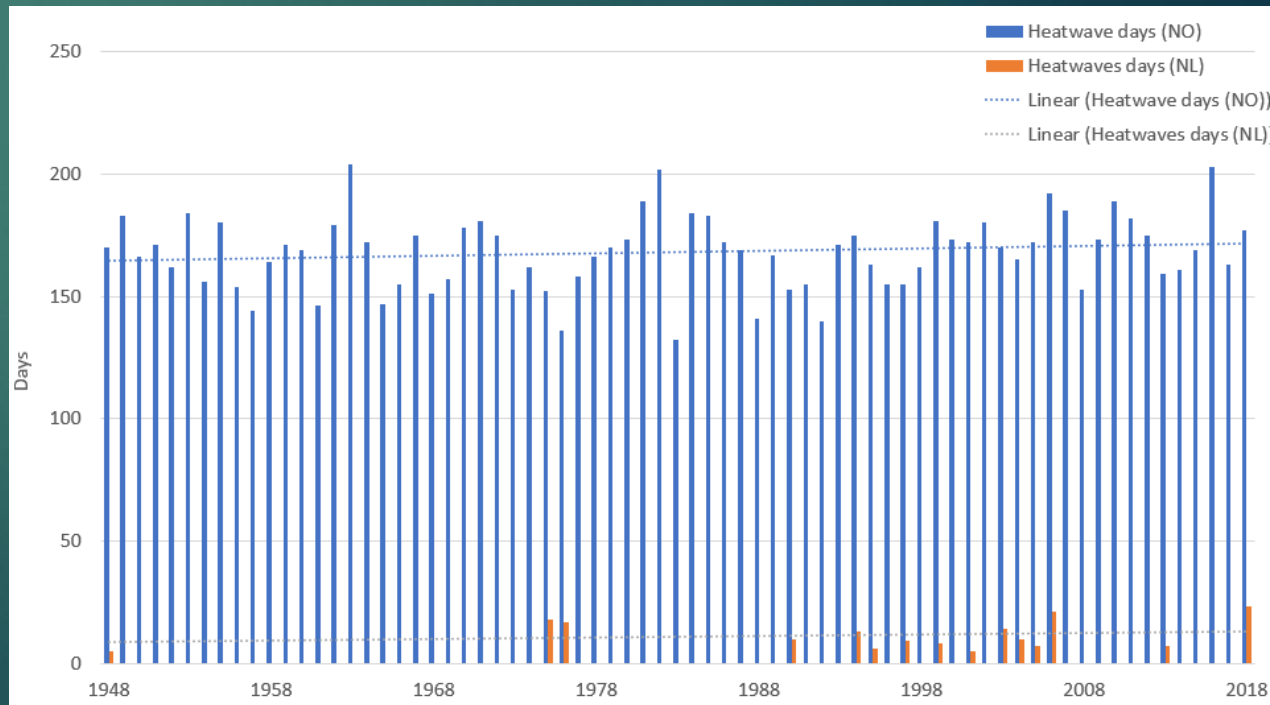
Mean Rhine discharge and PDSI number of April to July (1901-2005)



Results (Heatwaves)

- New Orleans
  - Every year one or more heatwaves
  - Duration heatwaves +150 days
- The Netherlands
  - Not every year a heatwave
  - Duration heatwaves < 25 days





Results (drought impacts)

Infrastructure

Road sides

Underground infrastructure

Buildings

Levees

Surface water

Vegetation

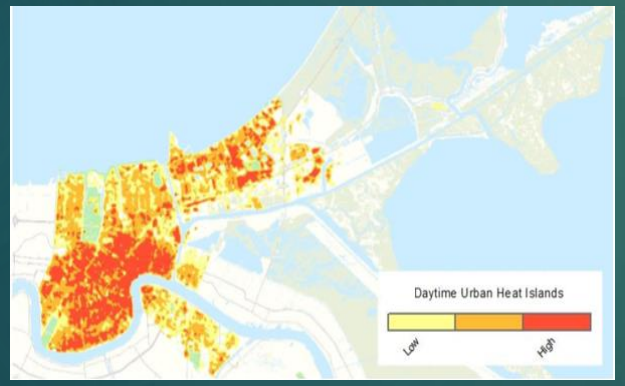
Animals

Results (heat impacts)

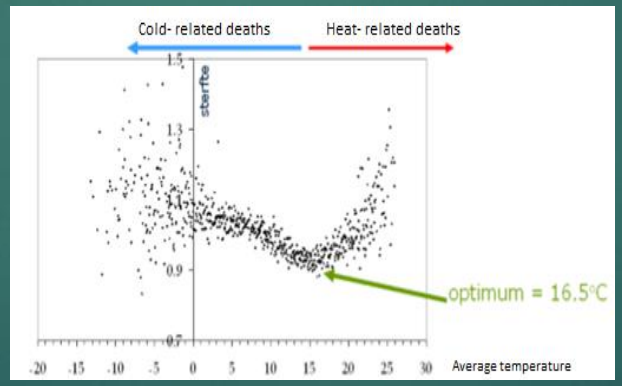
Railway

Roads

Surface water



Heat stress



Human Health

Animals

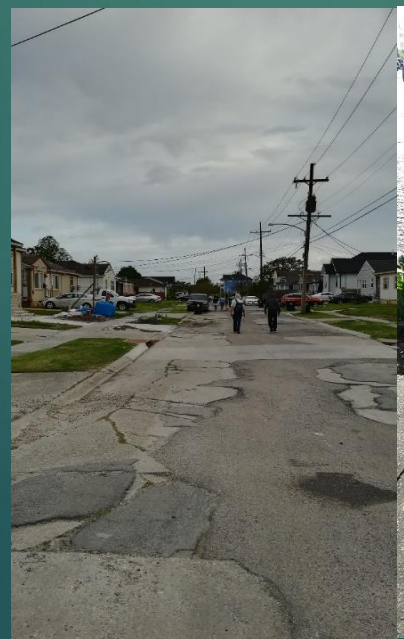
Results (New Orleans)

Interviews

- Almost no indication of drought and heat impacts

Drought impacts

- Houses
- Roads
- Sewage pipes
- Drinking water supply



Heat impacts

- Human Health
  - Heat stress
  - Mosquitos

Results (New Orleans key findings)

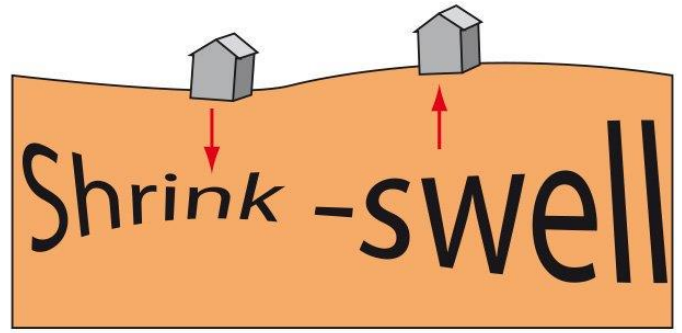
- Not only meteorological drought
  - Extreme rainfall events
- Human induced drought
  - 24 large stormwater drainage pump stations
    - Pumps every raindrop directly to the canals
  - Broken sewage systems

- Many drought related damages are caused by shrink and swell due to varying groundwater levels

New Orleans (Pump station 6)

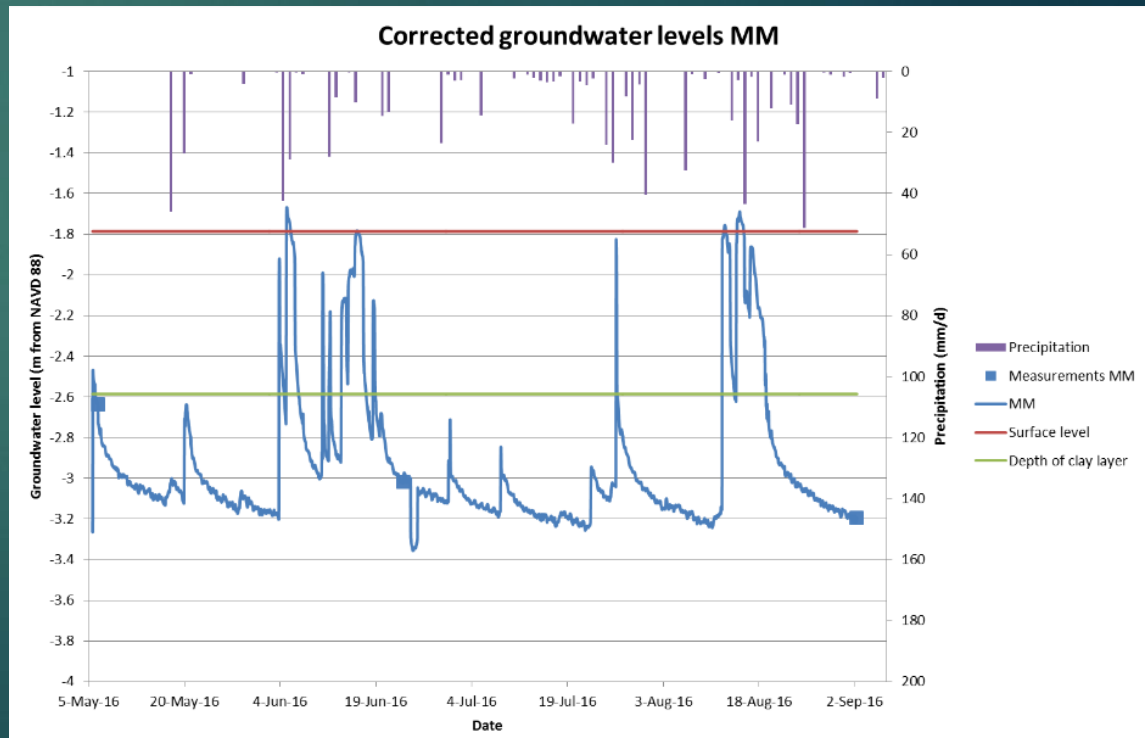
Shrink and Swell

- Normally groundwater levels are at the same level as drainagesystem



- Groundwater level drops (below clay layers)
  - dry periods
  - pumping
  - broken sewage systems
    - Clay layers contracts (shrink)

- Groundwater levels are rising:
  - wet periods
  - leakage of drink water pipes (55% = 1mm/day)
    - Clay layer swells



Mitigation options

Drougth

- Repair underground infrastructure
- Maintain groundwater levels at a certain elevation in urban areas
- Store water during wet periods (green & blue infrastructure)
- Using drought resistent vegetation
- Using cisterns for irrigation instead of drinking water

Heat

- Double amount of trees
- Better insulation of houses
- Information & warning systems

Discussion

New Orleans

- Meteorological data is inconsistent
- There is not much awareness of drought and heat related impacts
- Measures have not only positive outcomes (Airco, Trees & repairing underground infrastructure)
- Extreme precipitation and flooding are major issues which should be in mind while constructing drought measures

The Netherlands

- Long continuous meteorological data sets
- Enough available information to indicate drought and heat related impacts

Conclusions

- Drought and heat events are from all times and will appear more often in the future

New Orleans

- Drought events are short
- Low Mississippi discharges do not always correlate with dry periods

- Drought is underexposed
- Heat events are extreme and affecting mostly human health

- Shrink and swell processes are causing most drought related damages

- Using Dutch expertise to maintain groundwater levels at a high elevation preventing drought damages.

The Netherlands

- Drought events are long and noticeable
- Low Rhine river discharges correlate to dry periods

- Much attention for drought and heat events and related damages

- Long duration of low water levels causing most damages

- The Netherlands can learn from extreme heat events in New Orleans

Infrastructure

Drought + heat

Drinking water pipe
Gas pipe
Storm water drain
Sewage system
Sand
Clay

Tree
grou ndwater level drop
-> expansion root system
.uplift tiles & asphalt
-> water shortage
.prematur leaf fall
.drought stress
- Possible drowning in wet periods or rising grou nd water due climate change or autonomous developments (renovation draining infrastructure)

Isolated Footing (no piles)
Shrink/Swell
-cracks fou ndation&walls
-differential subsidence house
-subsidence damage stairs

Airconditioning
- noice
- produce heat + water
- HFC greenhouse gas
- increase electricity demand
- humidity up, cooling effect down

Wooden Pile fou ndation
-Shrink&Swell
-> Pole rot & negative adhesion -> differential subsidence
-> cracks in walls

Bridge
- steal expansion
. not able to close or open

Railway
- subsidence embankment
- electronic failures
- expansion rails
. rail buckling

Broken Pipes & Catch basins
Subsidence (Shrink/Swell)
-> subsidence
. leakage sewerage
. u ndisered drainage
. dead water storage (insects)
. street flooding
. pollution & bacteria enter water system
-> risk human health

Driveway/garage con nection
- subsidence

Sidewalk & bicycle path
- loose tiles
- susidence
-> u nsafe

Roads
Subsidence shrink/swell
-> local subsidence
. cracks
. bumpy
- Heat
. Melting
. Track formation

. Fire

House conection
(Sewer + gas + drinking water)
-> shrink/swell ->
leakage in crawl space
. water nuisance
. odor nuisance
. gas explosion risk
*drainage

Drainage
- clogging
. iron oxidation
. vegetation growth

Urban Green

Drought + heat

Urban trees/ Park
=>Soil dehydration
- drought cracks
- withered grass
- assimilation limit
- premature leave & fruit fall
- tree bark release
=> more vulnerable to diseases and pests
=> less attractive for recreation
- drinking water scaraty animals
- increase oak processional caterpillar / harvest bugs => human health risk

Stagnant water
- increase bacterial activity
- algal bloom % duckweed
-> drop oxygen levels
-> fish mortality
- odour nuisance
- blue algae
- mosquitos
-> risk human health

Sand
Clay
Fresh water
Salt water

Levee
- drought cracks
- dry/burnt grass
- local subsidence
-> Instability
- water level variation
-> instability

River
extremely low water
- saltwater intrusion
high concentration
pollutants & medicines
- transport stagnation

Swamp
- peat fires
- salinization
-> disappearance swamps

Heat + Moisture
-> longer growing season (vegetation)
. more maintenance
. hay fever

Fire

Evaporation
water demand
(gw, sw)

Lake
- salinization

Increasing inland subsidence
-> increased hydraulic head difference

Hydrochemical
-> bank -> erosion
(collapsing clay minerals due to high salinity)

Abstract Grou nd water
-> saline
. Fe.rich(consuming oxygen)
. subsidence


Any questions??????