Climate vulnerability assessment for urban area in the Netherlands

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Research objectives:

- How vulnerable are Dutch villages and cities for CC?
- How to reduce this vulnerability by adaptation measures? When to implement these? Who?
Conclusions (1)

Vulnerability

- Most urban areas in NL are vulnerable for flooding, drought and heat stress
- Vulnerability is not only result of exposure; also damage sensitivity (susceptibility) and adaptability
- Only *relative* vulnerability per theme was assessable
- Vulnerability varies largely per theme, region and town section
- No relation found between vulnerability and urban typology
Conclusions (2)

Adaptation

- Through synergy with urban reconstruction 88% of our urban areas could be climate resilient by 2060
- Many low-cost, low-regret adaptation options. Low-cost climate adaptation seems feasible!
- Adaptation measures depend on local conditions and preferences
- Effectiveness of measures is location-specific and hard to quantify; research is needed!
- Climate adaptation is to be part of urban development policy at all levels. Legislation is to be considered
Climate change leads to more exposure of urban areas

- Sea level rise
- More and more heavy rainfall
- More severe droughts
- River flood peaks
- Higher temperatures, more evaporation / water demand

Dutch cities are vulnerable because:

- Site conditions (low, no gradient, soft soil)
- Built centuries ago, with design criteria used in these days
- Reconstruction only once per 50 – 100 year
Vulnerability is result of:

- **Exposure** - frequency and degree of
- **Damage sensitivity** (susceptibility)
- **Adaptability**

**Exposure:**
- Indicative assessment, using **data mining**

**Damage sensitivity**
- Poorly known

**Adaptability**
- Aging of buildings and infrastructure indicative (?)
Coastal and fluvial flooding
- Pluvial and groundwater flooding
- Drought
- Heat stress

For municipalities > 25,000 inhabitants
Coastal and fluvial flooding

Hazard

Exposure

Damage

Victims
Hazards from:
- Sea
- Rivers, lakes, main canals
- Secondary drainage system

Exposure and susceptibility
- Depth, duration and size of inundations increase
- 30% of housing areas exposed
- Most floodprone houses are post WWII;
- Cultural heritage flood risk free
- Victims and direct economic damage are assessed; indirect damage hardly known

Flood risk
- Exposure does not increase ....
- .... but hazard and damage sensitivity does!
Pluvial flooding

Predicted runoff distributions for a 54mm precipitation event for the Rotterdam region

Flow accumulations for Delft

% flood-affected buildings and infrastructure for 77 mm storm
Hazard from
- More intensive rain storms

Exposure and susceptibility
- NL is flat; no ‘flash floods’ and limited inundation depths
- Low-lying urban areas at risk
- Mostly small damage incidents (e.g. flooded basement, flooded road)
- No relation with urban typology, except in center zones.

Adaptation options
- Increase retention and storage capacity, in particular in low areas.
Indicative change in drainage dependency of urban areas (above: current situation; below: situation in the W+ scenario)

Groundwater flooding

Age and vulnerability of buildings to groundwater nuisance
Groundwater flooding

Hazards from:
- Increase in rainfall and river discharges

Exposure and susceptibility
- Groundwater flooding occurs across NL (high - low, sand – clay – peat soils)
- Lowlands – with their high groundwater table and subsurface drainage system - and parks are the most vulnerable
- More urban development in lowlands after WW II
- Land subsidence aggravates the problem.

Adaptation options
- Plenty no-regret options available.
Drought

Hazard from
- Less rainfall in summer

Exposure and susceptibility
- Low grw level => low soil moisture & enhanced land subsidence
- Damage to wooden pile foundations 1/3 of pre-’60 buildings!
- Tree roots adapt to gradual increase of drought
- Increased impact of salinization and water temperature on water quality

Risk
- Hard to quantify because of lack of data
- Damage can increase substantially.

Adaptation options
- Water supply required!

Planbureau voor de Leefomgeving
Heat stress

Hazard from
- Temperature increase + UHI

Exposure ans susceptibility
- Urban Heat Island effects can increase exponentially with urbanisation
- Urban land use dependent. Industrial zones and business districts perform poorly.
- Blue and green buffer the UHI effect
- Elderly are particularly vulneranble
- Air conditioning becomes the standard; fossile energy consumption will increase
- Outdoor activities less attractive

Risk
- Related to density of urban fabric.
- Susceptibility not yet quantified.
Total risk due to:
- Coastal and fluvial flooding
- Pluvial and groundwater flooding
- Drought
- Heat stress
- In-addeable

Result:
- Urban areas on higher ground limited effect
- No relation to urban typology
- All cities have their ‘hotspots’
- Young cities relatively vulnerable, because of their low adaptability
Taking adaptability into account:

spatial distribution of the Expected End of Lifespan
• Urban areas transform each 50 – 100 years, on average
• 37% of our urban areas is at its end of economical life span; these areas will need redevelopment in the next 10-20 years
• 88% of our urban areas could be climate resilient by 2060, if synergy with this redevelopment is realised.
• So: Adaptive capacity is large
• Start now, not to miss any opportunities!
Adaptability
- Many measures are no-regret or low-regret
In conclusion

• Adaptive capacity is large (2010-2060)
• Many low-regret/low-cost measures available
• Adaptation partly by public, partly by private parties
So:
• Costs of adaptation are limited!
• We’ll miss opportunities if we don’t start now!