Climate Proof Cities

Aims

As dynamic systems where many people live and work, cities are vulnerable to the consequences of climate change. They run an increased risk of flooding, droughts and heat waves. Adaptation of urban patterns, public space and water systems, and construction of houses and buildings is essential to keep cities safe and pleasant to live in over the years. How to make cities climate proof?

Climate Proof Cities (CPC) is one of the themes in the national research programme Knowledge for Climate. CPC aims at strengthening the adaptive capacity and reducing the vulnerability of the urban system against climate change, and to develop strategies for adapting our cities and buildings. The focus of this four-year research programme is on heat in the city due to long periods of high temperatures and on water nuisance caused by more frequent and intense precipitation.

Research questions

Within the consortium researchers from different institutes and diverse backgrounds work together on twenty projects to answer the five main research questions:

- How does the urban climate system function in the Netherlands?
- How vulnerable are Dutch cities to climate change and what will be the impacts of future climate change?
- What measures and strategies are available to improve the adaptive capacity of cities?
- How to implement adaptive measures in urban areas?
- What are the costs and benefits of climate adaptation policies?

Insights

Climate change and cities: what is the problem?

Because of the high density of buildings and the characteristics of urban material, heat is retained in cities and the so-called Urban Heat Island effect (UHI) occurs. The UHI effect occurs in every Dutch city, whether it is large or small. The atmospheric UHI, the difference in air temperature between the city and its surroundings, is strongest after sunset, and the city does not cool down until the end of the night. The UHI effect is stronger during the summer than during the winter. On hot summer days the temperature difference can amount to 9˚C in the evenings. Due to climate change, high temperatures will occur more frequently, especially in cities. Other effects in cities include more frequent heavy precipitation and flooding.

Vulnerability of cities: how big is the problem?

The vulnerability of neighbourhoods to heat depends on the age of the inhabitants, the type and quality of the buildings, and various urban characteristics. Especially people over 75 are sensitive to heat stress. Terraced and semi-detached houses are less often subject to high temperatures and periods of overheating compared to detached houses and houses on a corner or the end of a terrace. Aside from this, specific urban characteristics can make an area more vulnerable to warming. In Amsterdam, for example, we found that the share of paved surfaces in an area is for 70 percent responsible in determining surface temperature.

The vulnerability of urban elements to flooding depends on threshold values: the water levels when damage begins to occur. Traffic disturbances and interruptions in the electricity supply, for example, can already occur at water levels of 30 cm.

Climate proof cities: what needs to be done?

Painting roofs white and planting more greenery leads to a reduction in the outdoor temperature. However, which measure or combination of measures can best be applied is highly dependent on the local conditions, such as orientation, height to breadth ratio of the street, and type of buildings.

Newly built (well-insulated) houses gain the most in lowering indoor temperature from shielding windows and doors from direct sunlight, and creating natural ventilation by opening windows. In older houses, extra insulation can in fact have a significant effect, as can other adjustments to the building envelope (a green roof and increasing the albedo).

To make urban water systems more robust in the face of flooding there have long been methods available to enlarge transport, storage and infiltration capacities. Old and some new measures, such as water squares, have been assessed, among others on the capacity to cope with several heavy rain events within a short period.

Adaptation policy: how to implement these measures

It is unlikely that climate adaptation will become an independent policy area for local authorities. That is why a lot of energy is put into 'mainstreaming' and integrating climate adaptation in existing policy fields. 'Awareness' and continuity in the translation of adaptation into the political and administrative agenda appears essential. Practically, mainstreaming may happen when 'anchoring points' can be found in other policy areas, and goals can be formulated that serve multiple purposes.

Stakeholder cooperation

To enable implementation of research results in practice, the CPC researchers work together with stakeholders from municipalities and water boards in case studies in different Dutch urban areas: Rotterdam, Haaglanden, Amsterdam, Arnhem/Nijmegen, Brabant and Utrecht. The CPC case study areas serve as pilot areas for research and for developing local climate adaptation strategies. Depending on the case, the focus can be on measuring and modelling of the area, design of specific measures, or governance aspects of adaptation.

Case studies

Case Bergpolder Zuid

For the neighbourhood of Bergpolder Zuid in Rotterdam a large-scale renovation is planned. Coupling renovation with climate proofing makes this neighbourhood the ideal case study for CPC. Bergpolder Zuid is a typical 19th century residential area, that is thermally vulnerable, with many unpleasant and uncomfortable public outdoor spaces. Poor housing quality increases the indoor vulnerability for high temperatures. In cooperation with a housing corporation, district council Rotterdam North and the Municipality of Rotterdam, CPC's researchers investigate the effect of several possible climate adaptation measures. Green design principles are being developed for various types of building blocks, highlighting the importance of orientation of the streets and the street profiles. A shadow analysis in the Eudokia block, for example, shows there is almost no shadow in the block in June. Wind affects the west façade and the rooftops, and whirlwinds develop inside the block. By applying green design principles, such as a vegetable garden, a green pergola, a green wall windbreak and a green southeast façade the climatic situation of the Eudokia block would improve. Preliminary model results show that implementing a larger water pond in the Energiehof would lead to 2°C lower temperatures on hot summer days.

Climate Proof Cities

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Working with Hotspots / Stakeholders

- Amsterdam
- Arnhem/Nijmegen
- Brabantstad
- Hotspot Haaglanden region
- Hotspot Rotterdam region
- Utrecht
- Waternet
- STOWA (Foundation for Applied Water Research)

Consortium partners

KWR Watercycle Research Institute
UNESCO-IHE Institute for Water Education
TU Delft
TNO
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International research partners
The University of Manchester, United Kingdom
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Knowledge for Climate

To develop the scientific and applied knowledge required for climate proofing the Netherlands and to create a sustainable knowledge infrastructure for managing climate change

Knowledge for Climate is a research programme (2008-2014) that develops knowledge and services needed to make the Netherlands climate proof. Governmental organisations (national government, provinces, municipalities and water boards) and businesses actively participate in the research programme. Knowledge for Climate focuses on eight areas, called hotspots: Mainport Schiphol, Haaglanden Region, Rotterdam Region, Major Rivers, South-West Netherlands Delta, Shallow waters and Peat Meadow Areas, Dry Rural Areas and the Wadden Sea Region. The scientific research is carried out in eight themes by consortia.

- Climate Proof Flood Risk Management
- Climate Proof Fresh Water Supply
- Climate Adaptation for Rural Areas
- Climate Proof Cities
- Infrastructure and Networks
- High-quality Climate Projections
- Governance of Adaptation
- Decision Support Tools

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