Sustainable buildings and street

Case workplan Climate Proof Cities – March 2012

SUMMARY

The Case “Sustainable Buildings and Streets” focuses on climate adaptation at the micro-scale level including the outdoor environment (streets) and the indoor environment of buildings, with specific attention to outdoor and indoor heat stress. The projects in this case include the development of a classification of buildings and streets, measurements, numerical simulations and governance issues. It is the explicit intention in this case to develop and investigate different case studies for the different hotspots and other partners. The classification of buildings and streets will allow generalizing research results and will ensure applicability to similar situations at other locations. Measurements will only be performed at a few specific locations and they will be used to validate the numerical simulation models. These models can subsequently be employed for the other cases at the other locations. The goal is to address cases with a range of different building and street typologies and different building use (e.g., apartments, schools, offices). Three case studies have been identified in close collaboration with the hotspots and other stakeholders:

1) Bergpolder Zuid in Rotterdam
2) J.P. van Muijlwijkstraat in Arnhem
3) Temporary non-insulated school buildings in Tilburg.

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ADDITIONAL INFORMATION

In the framework of this case, collaboration has been established with the heat stress project carried out by the GGD in Arnhem (Peter van den Hazel, Joris van Loenhout, Moniek Zuurbier - Hulpverlening Gelderland Midden (GGD)). This collaboration is further outlined below.

Work plan

I. MEASUREMENTS

ARNHEM/NIJMEGEN

The measurements will be conducted in the J.P. van Muijlwijkstraat in Arnhem. The J.P. van Muijlwijkstraat is a street with a quite regular profile in terms of street with and building geometry and typology. It is therefore considered as a suitable case for the on-site measurements, which will only be performed at a few selected positions, and for the use of these measurement data for the validation of the numerical simulations. The measurements should start in May. The numerical simulations are currently ongoing.

Photograph of J.P. van Muijlwijkstraat in Arnhem

Photograph of J.P. van Muijlwijkstraat in Arnhem

The measurement campaign in the J.P. van Muijlwijkstraat in Arnhem is conducted as part of the cooperation between the projects “Future Cities” and “Climate Proof Cities”. The measurements consist of the following components:

1) Outdoor reference measurements on the roof of a building (by WUR-MAQ & WUR-Alterra) (project 1.1):

a) air temperature
b) relative humidity
c) wind speed and wind direction on a 10 m mast on top of the roof
d) precipitation
e) radiative components

2) Indoor measurements at 5 positions in at least two buildings (by TU/e) (project 2.1):

a) temperature
b) relative humidity
c) CO_2 concentration

3) Outdoor fixed and mobile measurements at street level (by WUR) (project 1.3 and 3.1)

Fixed measurements at street level for project 1.3 and outdoor mobile “Bakfiets” measurements at street level.

4) Outdoor perception research (by WUR) (project 3.1)

Interviews (questionnaires) in combination with outdoor mobile “Bakfiets” measurements at street level.

5) Implementation of adaptation measures (project 1.3, 3.1, 3.5 and 3.8)

Measurements need to be performed before and after implementation of climate adaptation measures in the street and for a few buildings. The choice of adaptation measures to be implemented during the measurement campaign is limited by budget constraints. However, note that the performance and effectiveness of a wide range of adaptation measures will be evaluated using validated numerical simulation models. Concerning the measurements, “mobile” green features will be installed, primarily to support the outdoor perception research. This will include

green features at street level as well as at the building facades. Other adaptation options can still be included, pending acquisition of additional funding.

ROTTERDAM – BERGPOLDER ZUID

[Main items to be discussed in April 10 and April 19 meetings]

1) Outdoor reference measurements on the roof of a building (by WUR-MAQ & WUR-Alterra):
a) air temperature
b) relative humidity
c) wind speed and wind direction on a 10 m mast on top of the roof
d) precipitation
e) radiative components

2) Indoor measurements at a number of positions in an empty building (by TU/e) (project 2.1):
a) temperature
b) relative humidity
c) CO_2 concentration

3) Outdoor fixed and mobile measurements at street level (by WUR) (project 1.3 and 3.1)
Fixed measurements at street level for project 1.3 and outdoor mobile "Bakfiets" measurements at street level. ***To be discussed on April 10 and 19 meetings.***

4) Outdoor perception research (by WUR) (project 3.1)
Interviews (questionnaires) in combination with outdoor mobile "Bakfiets" measurements at street level. ***To be discussed on April 10 and 19 meetings.***

5) Implementation of adaptation measures (project 1.3, 3.1, 3.5 and 3.8)
Measurements need to be performed before and after implementation of climate adaptation measures in the street and for a few buildings. Choice of adaptation measures to be implemented during the measurement campaign: ***to be discussed on April 10 and 19 meetings.***

TILBURG

Indoor thermophysiological measurements and questionnaires (by TNO) (project 2.2):

The project Human Health Impacts has focused on acclimatisation. A set of measurements in residential buildings in Tilburg has been performed. Eight elderly were monitored during the hot July days in 2010. A weather station outside the building measured air temperature, air humidity, wind and radiation. Air temperatures inside were monitored in the living and sleeping room of the elderly using ibuttons. The Hidalgo system was used to monitor heart rate, pill temperature, body position and breathing rate. I-buttons at the back of the hand and just below the collar bone gave an indication of peripheral and central skin temperatures respectively. A questionnaire was filled in to quantify thermal behavior and experienced heat strain.

Additional measurements will be performed in the TNO Environmental Chamber.

II. NUMERICAL SIMULATIONS

The numerical simulations will be used to evaluate both the impacts of climate change and the effectiveness of various adaptation measures.

Four main types of numerical simulations will be performed:

1) CFD-I: Computational Fluid Dynamics (CFD) simulations of outdoor wind flow, temperature and relative humidity distribution (project 1.3 and 2.1)
2) CFD-II: Computational Fluid Dynamics (CFD) simulations of microscale effects of direct (flash) evaporative cooling (project 3.2)
3) BES-I: Building Energy Simulations (BES) of the relationship between outdoor and indoor temperature and relative humidity (project 2.1 and 3.5)
4) OTC: Thermophysiological simulations of outdoor thermal comfort (including adaptive behaviour) (project 3.8).

These simulations will be performed for three categories of situations/cases:
1) Simulations for the situations/cases for which the measurements are performed, for model validation.
2) Simulations for generic configurations of cities and streets, based on the classification of buildings and streets that is developed in project 2.1. These simulations will provide generic information that will be useful for all hotspots and stakeholders. These simulations will also be used to evaluate the effectiveness of different adaptation measures (see below).
3) Simulations for the situations/cases where no measurements were performed, for testing the classification of buildings and streets, for direct applicability and for illustration and demonstration purposes.

The simulations of category (1) and (3) will be performed for the following cases:
1) Bergpolder Zuid - Rotterdam
2) J.P van Muijlwijkstraat, Arnhem
3) Temporary non-insulated school buildings in Tilburg

The following adaptation measures will be evaluated:

1) CFD-I:
   - vegetative features and water ponds
   - alternative building arrangements and building aspect ratios
   - alternative building properties (albedo, green facades and green roofs)
   - alternative street properties (albedo, street cooling with water)
2) CFD-II: direct (flash) evaporative cooling in streets
3) BES-I:
   - building and street typology
   - alternative building properties (albedo, green facades and green roofs, indirect evaporative cooling of building facades and roofs, street cooling with water)
   - occupant behaviour
4) OTC:
   - building and street typology
   - occupant behaviour

III. GOVERNANCE - IMPLEMENTATION

The main research question is:
How can climate change adaptations be applied in social housing when using lifespan conscious maintenance as governance strategy?

The sub-questions are:
1. What are the challenges of climate change adaptations for housing associations?
2. How do housing associations show their awareness to climate change and how can they be classified in awareness categories?
3. Which governance strategies appear to be successful for implementing energy saving and sustainability measures, and which of the successful strategies can be used by housing associations to apply climate change adaptations to their building stock?

4. Which aspects of currently practiced national and international lifespan conscious maintenance processes can be suitable for applying climate change adaptations in the existing building stock?
5. How can the lifespan conscious maintenance process be modeled to meet the requirements of applying climate change adaptations?
6. Which are the strong and weak elements and opportunities and threats of the developed lifespan conscious maintenance process on a national and international level?

Integration in Climate Proof Cities

Integration with hotspot Rotterdam: to be discussed in April 10 and April 19 meetings.

Integration with Arnhem/Nijmegen:
The results of SQ1 will be firstly retrieved from literature research, and will be specified by the results from the projects in work package 2 and 3 of Climate Proof Cities.
In SQ 2, the level of awareness of climate change adaptations of 25 Dutch housing associations will be compared with the awareness of the housing associations that have property in case study areas of 'building and street'. Focus will be on the areas in Arnhem and Nijmegen because of the presence of residential buildings. The main reason for this comparison is to find out if participation of a hotspot has already led to a higher level of awareness of climate change adaptation. Moreover, a comparison between housing associations and other property owners is possible because other hotspots have offered a school building and two office buildings as objects of study.
SQ3 consists of two steps. The first is drawing up a long list with governance strategies and the second is reducing this list to a short list in interviews with policy makers from housing associations. Policy makers from housing associations and building owners that have properties in the case study areas of 'building and street' will be invited to take part in the group of interviewees. Like SQ2, this step creates a bridge between the situation in the hotspots and in other parts of the Netherlands. Moreover, if the short list is ready prior to the application of the strategies for the case study measurements in the J.P. van Muijlwijkstraat, the strategies on the short list can be used in the case.
SQ4 and SQ5 focus on the development of a building process model to enhance climate change adaptations. This model will be evaluated by experts in SQ6 on the national and the international level. Representatives of the housing associations and building owners with properties in the case study area will be invited for the expert panel. Their participation will be highly appreciated because they will be able to evaluate the proposed building process models based on their experiences in the case 'building and street'.
At the end of the research, a set of building process models to facilitate adaptation will be delivered, that are beneficial for both housing associations (and possibly other property owners) with property in the case study area and those in the rest of the Netherlands.

IV. COLLABORATION WITH PROJECT I-HEATSITE (GGD ARNHEM & GRONINGEN)

In the framework of this project, CPC is working together with the GGD in Arnhem and Groningen in the framework of the project I-HEATSITE (Indoor Heat Exposure and Thermal Situations In a Town Environment). This project includes pilot measurements in houses in Arnhem and Groningen in summer 2011, and an actual measurement campaign in summer 2012. The intention of the project is to experimentally determine the relationship between outdoor and indoor temperature and the relationship between indoor temperature and thermal comfort / heat stress. Measurements will be made in and outside previously determined heat-island areas. The measurements/enquiries consist of:

- Outdoor meteorological data at a reference position
- Street-level outdoor temperature and relative humidity
- Indoor temperature and relative humidity
- Checklist and questionnaire for residents

The collaboration exists of:

1) Participation of Peter van den Hazel, Joris van Loenhout & Moniek Zuurbier in the Climate Proof Cities consortium.
2) Participitation of Bert Blocken in the steering committee of the project I-HEATSITE.

3) Exchange of measurement data
4) Exchange of results of building and street classification and simulation results.

Locations

The main locations of the case are Bergpolder Zuid in Rotterdam and the J.P. van Muijlwijkstraat in Arnhem.

Cooperation between projects

Case meetings are planned at regular intervals at which measurement and simulation data are exchanged and the case plans are further developed and executed. The projects involved in this case study and the contact persons are listed on the previous page.

Stakeholder Involvement

Rotterdam is a hotspot in Climate Proof Cities.
Arnhem-Nijmegen is also directly involved in the case study, in the framework of the cooperation between the project Future Cities and Climate Proof Cities.

Coordination/Consultation structure and Meeting frequency

Half-yearly case meetings are scheduled. More frequent meetings will be scheduled when needed for parts of the case team or for the entire case team.

Deliverables

1) Measurement data to provide insight in the relation between reference meteorological conditions and microclimate in the street (canyon) and the buildings.
2) Experimental evaluation of the effect of a few adaptation measures in Bergpolder Zuid (to be discussed).
3) Assessment of the accuracy of numerical simulation tools by comparison with the measurement data.
4) Numerical simulations for Bergpolder Zuid and the J.P. van Muijlwijkstraat.
5) Numerical evaluation of the effect of a wide range of adaptation measures in Bergpolder Zuid and the J.P. van Muijlwijkstraat.
6) Evaluation of application of lifespan conscious maintenance as governance strategy.

Time planning

Key dates for the measurements (duration 2 years):

To be determined after meetings in April.

Key dates for the numerical simulations:

To be determined after meeting in April.