4 Evaluation of climate change adaptation measures by Dutch housing associations

This paper is a follow-up to the previous chapter. Because Chapter 3 focused on reports which do not usually include detailed information on individual buildings, it was possible that adaptation measures were already being implemented on a larger scale but without these being described in the documents analysed. For this reason, in Chapter 4, policymakers at housing associations were interviewed on how they would assess the feasibility of a number of predefined climate change adaptation measures.

Although the thesis takes into account climate change adaptation measures relating to extreme rainfall and urban heat, this study only focused on heat-related problems because the measures to cope with the effects of both heat and rainfall were too many to cover in one interview. The heat issue was prioritised because the main effects relate directly to human health issues, while flooding tends to cause 'only' financial damage to properties. Moreover, heat-related measures can be adopted solely by the housing association, while water-related measures are in many cases a responsibility that is shared with municipalities, because they own the sewage system and are responsible for its performance. However, the barriers to the implementation of adaptation measures for heat and water-related impacts are similar in the sense that there is no policy framework for adaptation measures for either of them; the financial barriers are the same and for both topics counts that some measures are difficult to implement while others are more easy to implement.

The paper has been published as: Roders, M., Straub, A., & Visscher, H. (2013). Evaluation of climate change adaptations by Dutch housing associations. *Structural Survey, 31*(4), 267-282.

Abstract

Purpose – Research into climate change adaptation measures has resulted in the identification of 155 such adaptation measures that contribute to making the built environment more climate resilient. These measures mainly focus on new construction. This paper assesses the feasibility of the measures for the existing social housing stock in the Netherlands.
Design/methodology/approach – Interviews were conducted with 12 property managers and policy staff members from Dutch housing associations. The interviewees

judged 21 measures that were designed to adapt dwellings to heat-related problems caused by climate change, and they also answered questions regarding their awareness of climate change and regarding the feasibility of the measures.
Findings – Low awareness of climate change adaptations, the financing of the measures and the technical complexity of adaptation measures are perceived barriers to implementation. Several possibilities to remove these barriers are discussed.
Research limitations/implications – The sample of 12 interviewees provides valuable insight into the opinions of a select group of policymakers from housing associations. The judgments were made based on the personal experiences and expectations of the interviewees.
Originality/value – This paper provides valuable insight into the opinions of policymakers and decision-makers in Dutch housing associations on climate change adaptation measures in the existing building stock. These insights will be of use for policymaking at the local and national levels directed towards creating a resilient building stock.
Keywords – adaptation, climate change, social housing, technical measures.
Paper type – Research paper.

§ 4.1 Introduction

There is clear evidence that the global climate is changing (Füssel, 2009; Smith et al., 2009). The IPCC scenarios show an increase in temperature by up to 4°C globally by 2099 (A1FI scenario: IPCC, 2007). For the Netherlands, the predictions are that by 2050 the average temperature will have increased by 0.9°C to 2.8°C in summer (Klein Tank and Lenderink, 2009). One of the threats of climate change in the Netherlands is an increase in temperature in urban areas, the Urban Heat Island effect (UHI). This occurs because cities have a high concentration of construction materials in streets and buildings that retain heat. The largest temperature differences may reach up to 10°C at the end of the day (Salcedo Rahola et al., 2009). Too much heat can lead to serious health problems (Luber and McGeehin, 2008), as it can affect the human cardiovascular system (Hess et al., 2009) and cause respiratory problems (Stafoggia et al., 2006). Moreover, it may even lead to mortality (Anderson and Bell, 2009). Heat can cause lower labour productivity and dangerous conditions for workers (Health Council of the Netherlands, 2008). From a social point of view, heat can cause problems in the general living environment because of a direct relationship between increased temperatures, higher irritation levels and lower tolerance levels (Anderson, 1989). In addition to labour productivity problems and an unsafe working environment, the effects can occur in or around dwellings. Fortunately, people can change their behaviour to avoid these negative impacts of heat (see, for example, Department of Health, 2012; Oakman et al., 2010; MinHWS, 2007).

Moreover, these impacts can be reduced by carrying out adaptation measures on dwellings. Several studies have elaborated on these measures, such as external wall insulation and solar reflective wall coatings, which are effective at reducing the heat generated on sun-exposed walls (Porrit et al., 2012). Applying shading above windows has also been found to be an effective measure for reducing high temperatures and the hours of overheating in dwellings (Coley et al., 2012).

The Dutch Building Code deals with overheating as part of the Energy Performance Coefficient (EPC). Although there are no specific limits on overheating hours, overheating is expected to be prevented by translating interior temperatures over 24°C into a cooling demand. The higher the cooling demand, the higher the EPC value. To meet the requirements of the building code this value must be decreased, either by decreasing the overheating load or by introducing compensatory energy-saving measures (NEN, 2012; Van Wolferen, 2012). However, it should be emphasised that the EPC is a measure of energy efficiency, not of the comfort of the dwelling.

In the Netherlands, housing associations own and maintain 2.4 million dwellings (www.cfv.nl), equivalent to one-third of the total stock of 7.2 million dwellings (CBS, 2013). As such they are major potential providers of adaptation measures to dwellings. Moreover, the Social Rented Sector Management Order (BBSH) lays down the legal responsibilities of housing associations concerning quality of life and healthy dwellings (MinIKR, 2005). In this regard, special attention needs to be paid to the development of measures for the existing building stock, as new construction in the last ten years represents only 1 percent of current total stock (CBS, 2012). This means that at least 60 percent of the building stock which will be in use in 2050 has already been built today and these dwellings will have to be adapted.

The Dutch social rented sector is relatively easy to approach as, despite the number of dwellings, they are owned by just a few organisations. In 2012, there were 381 housing associations in the Netherlands, owning on average 6,300 dwellings (www.cfv.nl). Despite their important role and responsibilities, in a recent study of policy documents, Dutch housing associations demonstrated a limited awareness of climate change adaptation (Chapter 3). Consequently, if there are no changes in policy development, they are not expected to introduce physical adaptation measures to their dwellings that will reduce the harmful effects of climate change. Although governance instruments have been developed to implement climate change adaptations, the focus of the instruments to date has mainly been on the national (e.g. Biesbroek *et al.*, 2010) and municipal levels (e.g. Bulkeley, 2010). The owners of real estate who are in a position to take action and start implementing physical adaptations are currently not addressed. Several governance strategies, such as information provision, incentives or regulation, can be used to make housing associations take action. However, in this regard it is important to discover what housing associations actually know about physical adaptation measures so that effective governance strategies can be developed. The aim

of the study was to gain an indicative overview of the state of awareness among policymakers in housing associations throughout the Netherlands and gain insight into their initial perceptions of the feasibility of physical adaptation measures. The study focused on measures for the existing building stock, designed to make dwellings more robust to heat-related problems caused by climate change. The research question was: With respect to the existing building stock, how do policymakers from Dutch housing associations judge the feasibility of physical adaptation measures for heat-related problems caused by climate change?

§ 4.2 Physical adaptation measures

Recently, the Dutch Ministry of Infrastructure and Environment listed 155 adaptation measures for the built environment. The measures focus on the climate change issues present in the Netherlands: inner and outer dike safety, safety around water barriers, water hindrance, drought, salinisation, ground shrinkage, heat, water quality and air quality. In addition, the levels of intervention were delineated, starting with buildings as the smallest unit of intervention, followed by plot, street, neighbourhood, city and region (MWH, 2012).

The characteristics associated with each measure were derived from the literature and collected in a database for easy access. A factsheet was also produced for each measure, which contains a short general description of the measure and a report on the characteristics of the measure in terms of effectiveness, finance, feasibility, maintenance and organisation. Furthermore, the factsheets show the interrelationship with other measures and contain references to the sources in the literature from which the measure is derived.

Of the 155 measures, 21 focus on both heat and the level of the building (Table 4.1). The Ministry recommends the implementation of the measures when a building is first constructed because this limits the additional costs (MWH, 2012). This is specifically the case for 76 percent of the measures (symbolised by '+/-'), while another 14 percent are considered to have equal or lower costs than a conventional measure (measures with '+'), and 10 percent are more expensive (measures with '-'). Most measures (71%) are expected to have the same intensity of maintenance as conventional measures, represented by the '+/-', while 24 percent have an increased intensity of maintenance and 5 percent require less maintenance.

		NEW BUILT	
Measure	Description of measure	Costs of implementation	Intensity of maintenance
Heat and cold storage in the ground	Usage of ground mass for cooling in summer	-	+/-
Cooling by river water	Usage of river water for cooling in summer	-	+/-
Green roofs	A layer of vegetation on the roof, plants provide evaporative cooling	+/-	-
Green facades	Vegetation on a vertical structure attached to the facade, providing evaporative cooling and shade	+/-	-
Green spaces	Areas with trees and vegetation close to or in buildings where people can go and relax	+/-	-
Blue roofs	A layer of water on the roof for evaporative cooling	+/-	+/-
Shading of buildings	Using sheets of fabric or blinds	+/-	+/-
Spray systems on roofs and terraces	Spray water on the roof for evaporative cooling	+/-	+/-
Natural ventilation in buildings	Create natural ventilation system in case there is a mechanical system (adapted from original)	+/-	+
Insect screens	Provision of natural ventilation by opening windows without insects entering	+/-	+/-
Architecture	Changes in the design, such as materials used and the sizes of windows	+/-	+/-
High albedo material	Materials with light colours to reflect solar radiation	+/-	+/-
Insulated, heat reflecting buildings	Use insulation to keep the heat out	+/-	+/-
Mediterranean construction style	Adopt a mediterranean construction style which is prepared for a warm climate	+/-	+/-
Roof overhang	The overhang provides shade in summer	+/-	+/-
Bedrooms facing north	The north facade is not hit by the sun	+	+/-
No bedrooms on the upper floor	Heat accumulates in the highest point of the building and the upper floor is hit by direct sunlight	+	+/-
Extra sun blinds	Glass panels to reflect sunlight	+/-	-
Pitched roofs	Pitched roofs provide more shade compared to flat roofs	+	+/-
Water in an atrium	Evaporative cooling	+/-	-
Double facade	Additional outer skin of glass	+/-	+/-

TABLE 4.1 Source: MWH, 2012 Evaluation of the measures for new construction

§ 4.3 Methodology

Approach

The answer to the research question was derived through a qualitative research approach, as this is 'useful for exploring new topics or (...) for explaining people's beliefs' (Hennink *et al.*, 2011, p. 10). This approach is well suited to the aims of the research because, regarding their policy documents, the topic of climate change adaptation is new to Dutch housing associations (Chapter 3). In addition, the focus of the study was on the judgments of individual policymakers. Since there was no awareness of climate change adaptation among housing associations at the corporate level, people in the organisations were targeted who were critical to future policymaking on climate change adaptations.

To collect the data, three approaches were found potentially suitable: sending out questionnaires with open and closed questions, interviewing people using open questions and setting up a focus group discussion. The suitability of the questionnaires lies in the fact that they 'offer an objective means of collecting information about people's knowledge, beliefs, attitudes, and behaviour' (Boynton and Greenhalgh, 2004, p. 1312). However, some arguments against effective use of questionnaires, such as 'Problems of motivating respondents' and 'The need for brevity and relatively simple questions' (Gillham, 2000, p. 6), were also applicable to the current study. The risk of a lack of motivation among respondents to address all of the questions was high due to the newness of the topic. Moreover, judging the list of adaptation measures was complex, so guidance from an interviewer was expected to be necessary. A focus group discussion might also have been used as it is suitable for generating a range of views on a research topic (Hennink *et al.*, 2011). However, at this stage of low climate change awareness among housing associations, it was not expected that the policymakers would be willing to come together from across the country for a meeting. It was already difficult to find the right people willing to spend one hour in an interview in their own office. In summary, the decision was made to conduct interviews among policymakers from the housing associations in their offices, as this approach was expected to provide the best insights. Interviews generate 'information on individual, personal experiences from people about a specific issue or topic' (Hennink *et al.*, 2011, p. 109). The interviews were conducted in December 2012.

The sample

The research took a qualitative approach, which 'necessitates the recruitment of participants with specific characteristics that can best inform the research topic' (Hennink *et al.*, 2011, p. 84). Therefore, a non-probability sample was created using a purposive sampling approach, which resulted in a sample that was as varied as possible (Bryman, 2008).

The sampling consisted of two phases. In the first phase, the housing associations were selected on the basis of their size and geographical location (Figure 4.1). The aim was to include a small (< 2,700 rental units), a medium (2,700-6,845 rental units) and a large (> 6,845 rental units) housing association in the North, East, South and West of the Netherlands (Table 4.2). The selection on size was based on the number of dwellings a housing association possessed on 31 December 2011.

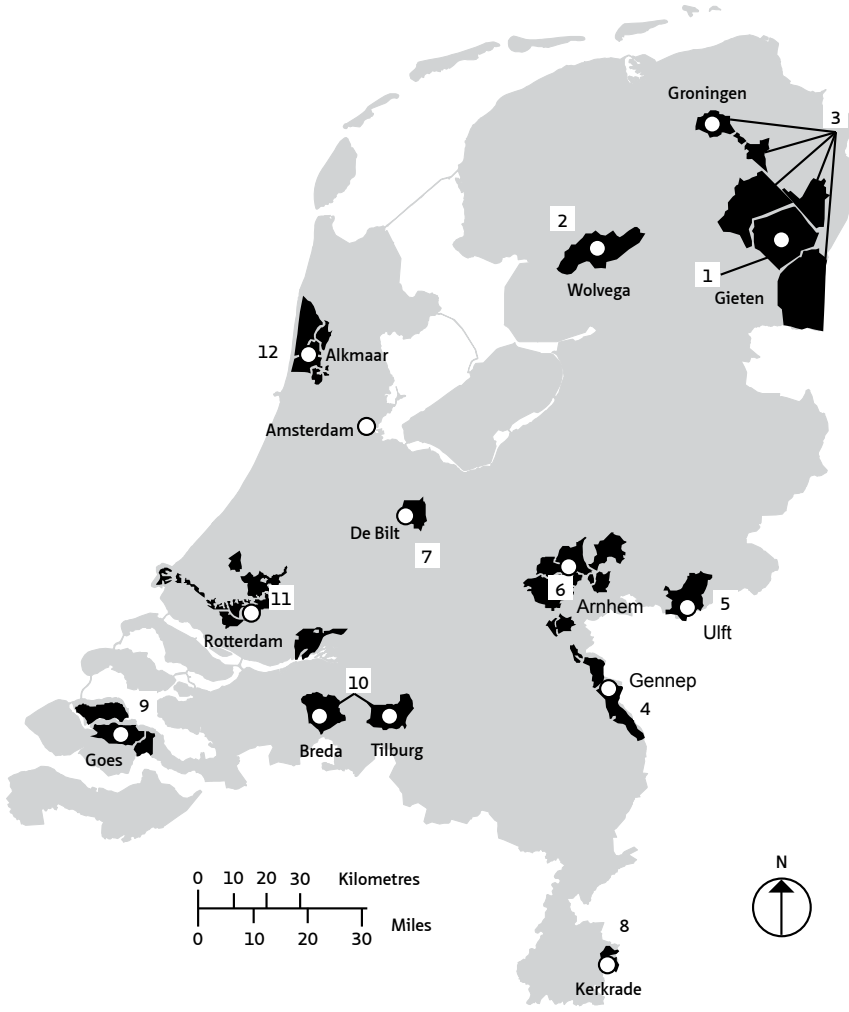

FIGURE 4.1 Working areas of housing associations (based on municipality borders)

TOC

The second phase entailed the selection of the interviewees. The selection criteria were involvement in policymaking concerning technical measures and a working field encompassing the entire building stock of the housing association. In the small and medium-sized housing associations the interviewees mainly had a decision-making background, holding positions such as property manager. In the larger housing associations, mainly technical advisors were interviewed, who, although having a lesser role in decision-making, held positions in which they dealt with the complete building stock of the housing association. In total, twelve people were interviewed. During the interviews, various arguments and responses were repeated, which from a qualitative analysis point of view means that the size of the sample sufficed. As Hennink et al. (2011, p. 88) state: 'The number of participants to recruit for qualitative studies is guided by a theoretical principle called saturation (...). This is simply the point at which the information you collect begins to repeat itself'.

NO.	FUNCTION	CITY	LOCATION	UNITS (31/12/2011)	CATEGORY
1	Director	Gieten	North	1,537	Small
2	Head Technical Services and Vice Director	Wolvega	North	2,809	Medium
3	Sustainability Coordinator	Groningen/ Hogezand/ Stadskanaal/ Emmen	North	29,304	Large
4	Team Leader Real Estate and Development	Gennep	East	2,531	Small
5	Manager Real Estate	Ulft	East	4,053	Medium
6	Policy Development Advisor	Arnhem	East	23,515	Large
7	Manager Real Estate	De Bilt	Centre	4,978	Medium
8	Technical Quality Manager	Kerkrade	South	5,948	Medium
9	Senior Real Estate Specialist	Goes	South	6,129	Medium
10	Senior Consultant Strategy and Policy	Tilburg/Breda	South	26,316	Large
11	Manager Real Estate	Alkmaar	West	10,069	Large
12	Technical Advisor	Rotterdam/Delft	West	37,663	Large

TABLE 4.2 Overview of interviewees and housing association characteristics

The interview

The interview consisted of several parts. It started with an introduction containing three open questions focusing on the level of awareness of climate change among the interviewees. The earlier study on policy documents of housing associations showed that in their corporate strategy, housing associations demonstrate a low awareness (Chapter 3), but that does not necessarily mean that every employee has a low awareness. These questions were thus introduced to gain an initial impression of the level of awareness of the interviewee and his or her general mind-set.

The awareness questions were followed by a short presentation on the threats of climate change, designed to create an equal level of awareness among all interviewees. The reasoning was that if the interviewees were aware of the threats of climate change they would be better able to judge the feasibility of adaptation measures. After the presentation, the list of climate change adaptation measures was judged by each interviewee.

The final section again contained open questions. The interviewees were asked which of the previously judged measures could be implemented directly, which measures were likely to be implemented and which measures were not likely to be implemented. Moreover, the interviewees were asked which measure they would implement if they had to choose one, and why they would implement that measure.

Judgments of measures

The measures were judged on eight factors which are considered decisive for the implementation of measures in the existing social housing stock. The factors costs of implementation and complexity of implementation were assessed to make it possible to compare the measures with respect to the existing stock and new construction. The factors: intensity of maintenance, disruption to quality of life of tenant during implementation of measures, and impact on comfort of tenants during period of use of the dwelling, were considered because they concerned tenant satisfaction, an important performance indicator regarding the service delivery of housing associations (Van Mossel, 2008). With respect to these first five factors, the interviewees could supply one of three possible answers: high, medium or low (see Table 4.3 for a description of the boundary values).

COSTS OF IMPLEMENTATION	
L	Limited unprofitable investment, ≤ €1,000; or profitable investment ≤ €5,000 and payback time < 10 years
M	Profitable investment ≤ €5,000 and payback time ≤ 25 years
H	Profitable investment > €5,000 or payback time > 25 years
X	Non feasible
COMPLEXITY OF IMPLEMENTATION	
L	Small effort to apply in existing situation (DIY or handyman of housing association)
M	Medium effort (specialised company, but low effort for company; ≤ 2 working days)
H	High effort (specialised company, high effort for company; > 2 working days)
INTENSITY OF MAINTENANCE FOR HOUSING ASSOCIATION	
L	Lower maintenance intensity than existing situation
M	Equal maintenance intensity to existing situation
H	Higher maintenance intensity than existing situation
DISRUPTION TO QUALITY OF LIFE OF TENANT DURING IMPLEMENTATION OF MEASURES	
L	Little/no impact on tenant's quality of life during implementation
M	Small disruption to tenant's quality of life during implementation
H	High disruption to tenant's quality of life during implementation
IMPACT ON COMFORT OF TENANT DURING PERIOD OF USE OF THE DWELLING	
L	Little/no impact or positive impact on comfort during period of use
M	Small negative impact on comfort during period of use
H	High negative impact on comfort during period of use

TABLE 4.3 Legend of judgment values

The next factor dealt with the necessity of asking the tenant for permission to apply the measures to the dwelling. A binary scale was applied (yes/no). The second last question was on expected difficulties in obtaining permission to apply the measures, also using a binary scale (yes/no). This is crucial information for the housing association, because without the consent of the tenant the measures cannot be applied. The last factor concerned the best moment to apply the measures (years).

The interviewees were encouraged to assess all measures, but in some cases it was obvious they had difficulties imagining the implementation of the measures. If so, the interviewer allowed them to answer that the measure was not feasible. The factsheets were used if more clarification of the measure was necessary.

§ 4.4 Results

Awareness of climate change

The answers to the questions on the awareness of climate change were post-coded. They could deal with any issue related to climate change.

On the question, 'What do you know about climate change?' most interviewees stated that the global temperature would rise. Some directly named impacts such as sea level rise and melting ice on the North and South poles. Al Gore's movie 'An Inconvenient Truth' was the main source of information for the interviewees. Other sources were education and the media.

When asked more specifically about their knowledge of the risks of climate change, all interviewees were able to name one or more risks, among which heat and flooding and/or sea level rise were mentioned most. Although all of the interviewees were aware of at least one of the risks, only one interviewee provided a positive answer to the question, 'Do you deal with the impacts of climate change in your daily work?' Others did not demonstrate that they dealt with the impacts of climate change in their daily work. Although three interviewees initially answered positively, after further questioning it became apparent that they were dealing with mitigation issues.

The final question in the awareness section was, 'Do you know of any adaptation measure?' 'Cooling' was mentioned and so were 'Insulation' and 'Crates for local water infiltration'. Flood prevention measures on a regional level (e.g. 'Increase dike height') were named as well. Six interviewees could not name any adaptation measure, but their responses focused on mitigation policies such as 'The energy efficiency of existing stock will be improved until 2026, we have reserved €25 million'.

Assessment of the measures for the existing building stock

Not all of the interviewees had the same opinion about the factors, therefore only those where consensus was apparent will be discussed. For this study, the criterion for consensus was that the score for the most frequently given response had to be double that of the second most frequent response (see Table 4.4).

The assessment found that it was not feasible to apply the measures 'Bedrooms facing north' and 'No bedrooms on the upper floor' in the existing situation.

MEASURE	COSTS OF IMPLEMENTATION	COMPLEXITY OF IMPLEMENTATION	INTENSITY OF MAINTENANCE	DISRUPTING. QUALITY OF LIFE DURING IMPLEMENTATION	NEGATIVE INFLUENCE ON COMFORT DURING USE	PERMISSION NEEDED	PERMIS-SION DIFFICUL	MOMENT OF INTERVENTION (YEARS)
Heat and cold storage in the ground	H	H			L	Y	Y	25-40
Cooling by river water		H			L			25-40
Green roofs	M	M		L	L		N	25-40
Green facades				L	L	Y		
Green spaces				L	L		N	25-40
Blue roofs	H			L	L	N	N	25-40
Shading of buildings			M	L	L	Y	N	
Spray systems on roofs and terraces					L	N	N	
Natural ventilation in buildings			L		L	Y		25-40
Insect screens	M	L	L	L	L	Y	N	direct
Architecture	H		L		L	Y		25-40
High albedo material	M			L	L		N	25-40
Insulated, heat reflecting buildings	M		L		L	Y		25-40
Mediterranean construction style		H	L	H	L	Y	Y	25-40
Roof overhang		M			L			25-40
Bedrooms facing north	x	x	x	x	x	x	x	x
No bedrooms on the upper floor	x	x	x	x	x	x	x	x
Extra sun blinds	H				L	Y		
Pitched roofs			L	H	L	Y		25-40
Water in an atrium				L	L	Y	N	
Double facade	H			M	L	Y		25-40

H=high; M=medium; L=low; Y=yes; X=?; N=no

TABLE 4.4 Judgments with consensus of interviewees (Blank fields have no consensus)

Concerning the costs of implementation, it can be assumed that they were expected to increase, because in cases where consensus was apparent, the measures were expected to be of medium or high expense.

Opinions on the complexity of implementation were quite divergent; the judgments with consensus vary from low to high complexity. The judgments on the intensity of maintenance, on which consensus was apparent, indicated that a low intensity was expected. The interviewees reached consensus on disruption to the tenant's quality of

TOC

life during implementation of the measures, with the measures generally considered to have a low impact on the tenant. The interviewees showed a strong consensus on the influence of the measures on comfort during the use of the dwelling, having a low negative impact or even positive influence on the comfort during the use phase.

On the question of whether permission from the tenant was needed before implementing the measures, consensus was reached for fourteen measures. According to the Dutch Civil Code, housing associations must ask permission to make changes to a property if there is no urgent need. Interviewees stated that many of the measures required permission before implementation. Of these, permission was expected to be gained easily in eight cases, while in relation to two measures, gaining permission was expected to be difficult. The best moment of intervention was in combination with minor or major improvement works, which occur every 25 to 40 years. One measure was expected to be directly applicable as an independent activity.

Analysis of the feasibility of the measures

The measures 'Bedrooms facing north' and 'No bedrooms on the upper floor' were found to be unfeasible in the existing situation. To a large extent, this judgment has to do with the typology of Dutch social housing, which mainly consists of terraced houses and apartments, 42 percent and 32 percent respectively (Agentschap NL, 2011). Generally, the terraced houses have four spaces on the first floor, one of which is the bathroom. It is technically impossible to move all the bedrooms to the same (north) facade and have no bedrooms on the other facade. In addition, the measure 'No bedrooms on the upper floor' was found to be too intrusive to be feasible, as the layout of the terraces almost invariably has the living rooms on the ground floor and the bedrooms on the first floor. While apartments have a different typology, the problems with both measures remain. As most apartments are single-floor dwellings, moving bedrooms or living areas vertically is impossible: if the apartment is on the top floor, the bedrooms will automatically be on that floor as well.

One measure that was found feasible was 'Heat and cold storage in the ground'. However, it was found expensive because, when implemented, the whole heat delivery system in the dwelling would have to be changed from a high-temperature system to a low-temperature system. Many of the interviewees judged the 'Blue roofs' measure expensive, either because of the necessity to reinforce the underlying construction, or because of the permanent risk of water infiltration. Another measure that was judged expensive was 'Architecture', because this measure required changes to be made to the structure of the facade. The 'Extra sun blinds' measure was considered to be very expensive because the glass panels would require additional reinforcement of the facade. Finally, the 'Double facade' measure was also expected to be expensive, but was judged feasible nevertheless.

The 'Green roofs' measure was expected to have moderately high costs. Many interviewees were familiar with the measure and some had already implemented green roofs on some of their buildings. The 'Install insect screens' measure was judged to be moderately expensive. The success of this measure is highly dependent on the willingness of the tenants to use the screens. Many interviewees stated that responsibility for the maintenance and correct use of the screens would not lie with the housing association but with the tenants, with the housing association only supplying the screens. The installation of 'High albedo material' was also judged moderately expensive. The measure in itself was not perceived as complex, but the intensity of maintenance was expected to be high, mainly because of rapid aesthetic degradation caused by pollution. A well-known measure was 'Insulated, heat reflecting buildings', from the point of view of energy saving on heating. This measure had already been implemented by many housing associations. It was considered 'proven technology', resulting in moderate costs and entailing moderate complexity of implementation.

Open questions on feasibility

The open questions on feasibility were designed to trace a willingness to take action among the interviewees. By assessing the 21 measures on several factors, as described above, it was expected that the interviewees would be at least a little more aware of the possible ways in which their building stock could be adapted to the negative climate change effects concerning heat.

In response to the first question, 'Which of the measures can be applied directly?' the interviewees were allowed to name several measures. 'Green roofs', 'Blue roofs', 'Shading', 'Insulated buildings' and 'Natural ventilation in buildings' were all mentioned more than once, while 'Installing insect screens' was mentioned by half of the interviewees. On the issue of whether they would actually implement the measures, only four interviewees answered positively. One of the interviewees who gave a positive answer was already implementing green roofs, while another stated that insulation measures were being implemented. Two others were slightly positive, stating that they 'would think about it'. The main reason for the negative answers was a lack of funds. Another important reason was that implementing adaptation measures was not part of the policy of the housing association.

The second question, 'Which measures are likely to be implemented?' resulted in a range of answers. Two interviewees generalised, stating that only the measures applied to the exterior of the dwelling would be easy to implement, whereas others were more specific. 'Shading of buildings', 'Green roofs' and 'Natural ventilation in buildings' were most frequently mentioned. Implementation was found to be more likely when measures were 'relatively easy to implement' and when the interviewees were familiar with measures, knowing from experience that they would have a 'positive effect'.

In response to the third question on feasibility, 'Which measures are not likely to be implemented?' some interviewees merely stated that those measures that they had judged to be 'unfeasible' in the assessment would be unlikely to be implemented. Others were more specific, with 'Cooling by river water' mentioned most frequently'. The reasons for implementation not being likely were that the measure had a high level of complexity or there would be high costs of implementation. In addition, interviewees gave 'Convincing the tenants of the necessity of the measure' as a reason.

The final question in this section was 'Which measures would you implement if you had to choose?' The measures chosen most often were 'Insulated buildings' and 'Natural ventilation in buildings'. The reasons for selecting the measures were acquaintance with the benefits in terms of comfort and financial aspects.

§ 4.5 Discussion

Awareness

In comparison to their own corporate policy documents (Chapter 3), the individual employees showed a relatively good awareness of climate change and were able to name a number of impacts and risks. However, in relation to climate change adaptation measures in the daily work of the staff members and policymakers, awareness is low, especially considering the threats resulting from climate change and the obligations of housing associations under the BBSH to provide a healthy living environment. If the employees of housing associations are unable to recognise these threats in daily practice it is unlikely that they will start implementing adaptations. The open questions concerning awareness have shown that they are barely able to name one climate adaptation measure, let alone implement them.

The first step towards the implementation of climate change adaptation measures requires the creation of an awareness among the employees of housing associations. In this study, such an awareness was created among the interviewees by the interviewer providing a short presentation. Thereafter, the assessment of measures for adaptation to heat-related problems caused by climate change took place. The results show that once they had been made aware of the need for such measures, the staff members and policymakers were able to judge the measures, both in the assessment section, where they judged the eight factors, and in the open questions section, where they provided their opinions on the feasibility of the measures. Moreover, awareness is necessary in order to develop policy that will provide the basis for the implementation of measures.

In the current situation, the absence of policy was one of the reasons why interviewees judged measures as not likely to be implemented.

Financial aspects

Nevertheless, an awareness of climate change and an ability to judge the adaptation measures does not guarantee their implementation. Many interviewees stated that even though some measures could be implemented directly, they would not do so. High costs were one of the reasons measures were not likely to be implemented. Compared to the judgments of the measures when related to new buildings (Table 1), the judgments for the existing building stock show that concerns about the costs of implementation are greater (Table 4.4). As a result, the financing of the measures was found to be an important barrier to the implementation of climate change adaptations in the existing building stock.

Regarding the financing of the measures, the timing of the interviews in December 2012 was probably not the best because the housing associations were facing an uncertain future due to planned changes to be introduced by the new government, installed in November 2012. Plans to impose heavy levies on housing associations were expected, which would greatly affect their financial position. At the time of the interviews, the consequences of these levies were not yet known, and therefore all expenses were to be reviewed. Under such circumstances, the financing of climate change adaptation measures was not likely to be given a high priority, which proved to be the case. Another financial aspect relates to the difficulty of obtaining permission for the measures. Generally speaking, if the housing association plans to finance the measure by increasing the rent, the tenant will be more reluctant to accept it. Thus, if the housing association wants to implement a measure without running the risk that tenants refuse to contribute and thus compromise implementation, it must find alternative financial means.

One financial solution might be based on the fact that the measures are expected to increase the climatic resilience of the dwelling and thus theoretically increase the future value of the dwelling (Lützkendorf *et al.,* 2011) and make investment more feasible. In another financial framework, insurance companies might play a role, offering lower insurance rates if a dwelling is well adapted (McEvoy *et al.,* 2010). For the adaptation measures focusing on heat-related problems caused by climate change, health insurers or employers could also be potential allies in encouraging environments which lower the risks of health problems and labour productivity loss respectively. Another group of actors that might be approached as allies to remove the financial barriers to implementation are companies in the construction sector. If collaboration in this sector improves, efficiency is likely to increase (Hong-Minh *et al.,* 2001; Akintoye *et al.,* 2000), leaving room for greater investment in adaptation measures.

Regarding the difficult financial situation of housing associations to date, the prediction of long implementation cycles (25-40 years) might be advantageous, as new opportunities may arise over time. Moreover, many of the impacts are projected for 2050 or even 2100 (Klein Tank and Lenderink, 2009). Nevertheless, the question of whether the implementation of the measures will occur in time still remains.

Complexity

As stated above, the construction sector can play an important role in overcoming financial barriers, but involving this sector also has benefits in reducing the complexity of measures, another barrier that has been distinguished. Although this factor was not as strong as costs of implementation, the interviewees showed consensus in their concern about the increased complexity of implementation of several measures. Moreover, in the open questions on the feasibility of measures, high complexity was one of the reasons for considering that a measure was unlikely to be implemented. In contrast, the measures that were found likely to be implemented were judged as such because of their low complexity. In other words, housing associations should use their positions as clients to demand innovation from the construction sector (Blayse and Manley, 2004) to address both the issue of complexity and financial barriers.

Future of adaptation

Housing associations are not the only property owners dealing with the threats of climate change, as this is a worldwide phenomenon. The impact on dwellings will have to be dealt with, whether the dwelling is owned by a housing association, a corporate investor or an owner-occupier. Sooner or later, all of these owners will have to find solutions to adapt to the impacts of climate change. However, the professional role of housing associations, their legal duties concerning the quality of dwellings and their performance, measured by the quality of service delivery, make them an important starting point in the implementation of climate change adaptation measures. The assessment of the measures revealed that by removing the barriers, the implementation of climate change adaptations brings many benefits to the occupiers, as consensus was apparent for all measures concerning their positive effects on comfort during use. Moreover, in the open feasibility questions, an increase in comfort was precisely one of the main reasons for determining that a measure was likely to be implemented.

§ 4.6 Conclusion

The open questions on the feasibility of climate change adaptations and the judgment of the list of adaptation measures by specialists from housing associations elicited a wide range of responses. However, many interviewees showed a low awareness of the fact that adaptations should be part of their daily practice, meaning implementation of the measures is currently not taking place.

Taking into account the wide interpretative boundaries by focusing only on the factors on which consensus was reached, it was possible to cautiously make some general observations that provide an answer to the research question. At the moment of interview, the policymakers from housing associations who were interviewed did not find the implementation of measures for climate change adaptation feasible. To increase feasibility, first, awareness must be increased, which is a challenging task in which the national government can play an important role. Only then will housing associations start developing policy regarding adaptation measures. Second, financial barriers must be removed, for example by introducing financial schemes based on the increased value of a resilient building, perceiving insurance companies as allies and enhancing collaboration in the construction industry to generate more cost-efficient production. When encouraged appropriately, the construction sector is capable of finding innovative technical solutions, which makes it an important player in overcoming the barrier of complexity. Further and broader research on these issues is urgently required.

The data were collected by interviewing people. This was a suitable method to formulate an answer to the research question at the time, given the newness of the topic of climate change adaptation and low corporate awareness among housing associations on this topic. However, for future data collection, one or more focus group discussions, rather than interviews, should be considered, in order to obtain a more collective view of the position of housing associations on the implementation of measures to adapt to climate change. Moreover, future research should not only include employees of housing associations but also of other kinds of property owners, such as corporate investors and owner-occupiers.

References

AgentschapNL. (2011). *Voorbeeldwoningen 2011 Onderzoeksverantwoording* [Reference housing 2011 Research account]. Sittard: Agentschap NL.

Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing and Supply Management, 6*(3-4), 159–168.

Anderson, C.A. (1989). Temperature and Agression: Ubiquitous Effects of Heat on Occurrence of Human violence. *Psychological Bulletin, 106*(1), 74–96.

Anderson, G.A., & Bell, M.L. (2009). Weather-related mortality: How heat, cold and heat waves affect mortality in the United States. *Epidemiology, 20*(2), 205–213.

Biesbroek, G.R., Swart, R.J., Carter, T.R., Cowan, C., Henrichs, T., Mela, H., ... Rey, D. (2010). Europe adapts to climate change: Comparing National Adaptation Strategies. *Global Environmental Change, 20*(3), 440–450.

Blayse, A.M., & Manley, K. (2004). Key influences on construction innovation. *Construction Innovation, 4*(3), 143–154.

Boynton, P.M., & Greenhalgh, T. (2004). *Hands-on guide to questionnaire research: Selecting, designing, and developing your questionnaire. BMJ*, 328(7451), 1312–1315.

Bryman, A. (2008). *Social Research Methods*. New York: Oxford University press.

Bulkeley, H. (2010). Cities and the governing of climate change. *The Annual Review of Environment and Resources, 35*, 229–253.

CBS, Centraal Bureau voor de Statistiek. (2012). *Energieklasse bekend van ruim 2 miljoen woningen [Energy grade known of more than 2 million houses]*.

CBS, Centraal Bureau voor de Statistiek. (2013). *Housing stock by tenure.* Retrieved February 26, 2013, from http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=71446NED&D1=0-2,4-5&D2=0,5-16&D3=a&HD=100419-1534&HDR=T,G2&STB=G1

CFV. (2012). *Sectorbeeld realisaties woningcorporaties, verslagjaar 2011 [Sector image production housing associations, report year 2011]*. Baarn: Centraal Fonds Volkshuisvesting.

Coley, D., Kershaw, T., & Eames, M. (2012). A comparison of structural and behavioural adaptations to future proofing buildings against higher temperatures. *Building and Environment, 55*, 159–166.

Department of Health. (2012). *Heatwave plan for England, protecting health and reducing harm from extreme heat and heatwaves*. London: Department of Health.

Füssel, H.M. (2009). An updated assessment of the risks from climate change based on research published since the IPCC Fourth Assessment Report. *Climatic Change, 97*(3), 469–482.

Gezondheidsraad. (2008). *Hittestress op de werkplek [Heat stress in the workplace]* (No. 2008/24). Den Haag: Gezondheidsraad.

Gillham, B. (2000). *Developing a questionnaire*. London: Continuum.

Hennink, M., Hutter, I., & Bailey, A. (2011). *Qualitative Research Methods*. London: Sage.

Hess, K.L., Wilson, T.E., Sauder, C.L., Gao, Z., Ray, C.A., & Monahan, K.D. (2009). Aging affects the cardiovascular responses to cold stress in humans. *Journal of Applied Physiology, 107*(4), 1076–1082.

Hong-Minh, S.M., Barker, R., & Naim, M.M. (2001). Identifying supply chain solutions in the UK house building sector. *European Journal of Purchasing and Supply Management, 7*(1), 49–59.

IPCC. (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. (Core Writing Team, Pachauri, R.K., & Reisinger, A., Eds.). Geneva: IPCC.

Klein Tank, A.M.G., & Lenderink, G. (Eds.). (2009). *Climate change in the Netherlands; Supplements to the KNMI'06 scenarios*. De Bilt: KNMI.

Kovats, R.S., & Hajat, S. (2008). Heat Stress and Public Health: A Critical Review. *Annual Review of Public Health, 29*, 41–55.

Luber, G., & McGeehin, M. (2008). Climate change and extreme heat events. *American Journal of Preventive Medicine, 35*(5), 429–435.

Lützkendorf, T., Fan, W., & Lorenz, D. (2011). Engaging financial stakeholders: opportunities for a sustainable built environment. *Building Research and Information, 39*(5), 483–503.

McEvoy, D., Matczak, P., Banaszak, I., & Chorynski, A. (2010). Framing adaptation to climate-related extreme events. *Mitigation and Adaptation Strategies for Global Change, 15*(7), 779–795.

MinHWS. (2007). *Nationaal Hitteplan 2007 [National heat plan 2007]*. 's-Gravenhage: Ministerie van Volksgezondheid, Welzijn en Sport.

MinIKR (Ministry of the Interior and Kingdom Relations). (2005). *Besluit beheer sociale-huursector [Social Rented Sector Management Order]*. 's-Gravenhage: Sdu Uitgevers.
MWH. (2012). *Maatregelenmatrix, een overzicht met 155 klimaatmaatregelen [Measure matrix, an overview with 155 climate adaptation measures]*. Delft: Deltaprogramma Nieuwbouw en Herstructurering.
NEN. (2012). NEN7120+C2 *Energieprestatie van gebouwen [NEN7120+C2 Energy Performance of Buildings]*. Delft: The Netherlands Standardisation Institute.
Oakman, T., Byles-Drage, H., Pope, R., & Pritchard, J. (2010). Beat the Heat: don't forget your drink - a brief public education program. *Australian and New Zealand Journal of Public Health, 34*(4), 346–350.
Porritt, S.M., Cropper, P.C., Shao, L., & Goodier, C.I. (2012). Ranking of interventions to reduce dwelling overheating during heat waves. *Energy and Buildings, 55*, 16–27.
Salcedo Rahola, B., Van Oppen, P., & Mulder, K. (2009). *Heat in the city* (No. KvR 013/2009). Amsterdam: Climate changes Spatial Planning.
Smith, J.B., Schneider, S.H., Oppenheimer, M., Yohe, G.W., Hare, W., Mastrandrea, M.D., ... Van Ypersele, J.P. (2009). Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) "reasons for concern." *Proceedings of the National Academy of Sciences of the United States of America, 106*(11), 4133–4137.
Stafoggia, M., Forastiere, F., Agostini, D., Biggeri, A., Bisanti, L., Cadum, E., ... Perucci, C.A. (2006). Vulnerability to heat-related mortality: A multicity, population-based, case-crossover analysis. *Epidemiology, 17*(3), 315–323.
Van Daalen, E., & Van Riet, N. (2010). *Onderzoek naar warmtebeleving bij ouderen - Zomer 2010 [Study on heat perception among elderly - Summer 2010]*. Tilburg: GGD'en Brabant en Zeeland.
Van Mossel, H.J. (2008). Securing high performance maintenance service delivery. In Koopman, M., Van Mossel, H.J., & Straub, A. (Eds.), *Performance measurement in the Dutch social rented sector* (pp. 117–134). Amsterdam: IOS Press.
Van Wolferen, J. (2012). *Koeling in de herziene EPC-bepaling: wat gaat er veranderen? [Cooling in the revised EPC-assessment: what will change?]*. AgentschapNL, Sittard.