

COMMUNITY CENTERS IN CLIMATE CHANGE

Building elderly resilience with social
cooling centers in Rotterdam South



Delft University of Technology
Resilient Rotterdam Graduation Studio - Veldacademie
2024 - 2025
AR3RE100

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1. Introduction.

The 'Resilient Rotterdam graduation studio' addresses the human social side of architecture and the impact the built environment has on the health and wellbeing of city dwellers of Rotterdam. The project area is the south of Rotterdam with its more deprived neighborhoods.

Within this field, each student explores their personal focus area through research and design.

The studio is a collaborative effort of the faculty of Architecture and the Built Environment at the TU Delft and the Rotterdam-based research organization for socio-spatial development Veldacademie. This collaboration allows for direct contact with experts from the Municipal Department of City Development, giving graduation students the chance to experience real-life stakeholder interactions and municipal planning processes.

To me, the main appeal of the Resilient Rotterdam graduation studio was the free choice of topic within the studio topic of health and well-being of urban dwellers, which allowed me to dedicate my time to architecture and its relation to urban heat, a topic that I personally think is urgent and which was not being addressed in any of the architecture graduation studios during my graduation year.

Considering the environmental, social and societal impact of the built environment, I believe that as designers and planners we carry a lot of responsibility. The livability of our cities in the future will largely depend on the planning and design choices we are making now and as a future architect I want to use this thesis as an opportunity to inform myself and to find my own voice on this topic.

Additionally, the studio's aim to address the real and urgent social-spatial challenges of a diverse harbor city like Rotterdam intrigued me, as did the opportunity to interact with a variety of stakeholders: researchers, residents, volunteers at community centers, civil servants, city planners and community builders.

I also appreciated the human-centered design approach of the studio, that encourages looking at the social side of architecture and its focus on fieldwork as a key method to realistically gauge the needs of residents in the socially more deprived areas of Rotterdam.

The problem field I would like to address are the growing challenges of urban heat in climate change and how architecture can play a role in solving them. While the earth has been rapidly heating up over the past decades, heatwaves have become more prevalent. In the US, heatwaves account for more deaths than any other weather-related disaster (US Department of Commerce, n.d.). Elderly, young and ill people are the most likely victims. Considering the steady ageing of societies in many countries, this is cause for great concern. City dwellers are more likely to be affected by heatwaves because of the urban heat island effect. Adjusting indoor climate via traditional air-conditioning is often in conflict with the financial realities of poorer residents on one hand and further exacerbates the heat outdoors on the other hand. This highlights a need for passive cooling solutions in buildings.

While elderly people are the ones mainly suffering currently, future climates with higher temperatures could render all types of people vulnerable in the future. Preparing the (built) environment now to be thermally safe for elderly people will lower future exposure and the overall amount of affected people in the future.

2. Research problem

In the context of this problem field the research seeks to answer the following question:

RQ:

How can “age-friendly” climates be achieved sustainably in challenging environments?

“Age-friendly” as defined by the WHO age-friendly city guidelines (World Health Organization, 2007) is inclusive to all ages. An age-friendly climate is one that is also acceptable and healthy for those who are more vulnerable to heat stress due to age.

The urban heat island effect (UHI) is a substantial contributor to heat exposure in the urban context and mitigating it is the most common approach towards heat resiliency in urban contexts. When mechanical cooling is used to counter the indoor effects of the heat island, the heat problem can also turn into an energy problem. The sustainable mitigation of UHI often relies on large-scale blue and green infrastructure like canals or street trees, however in some environments, e.g. dense historical contexts, implementation can prove spatially challenging. Here there is a need to explore complementary strategies to address vulnerability holistically.

Additionally, the following subquestions will be addressed:

- *How can heat-related vulnerability be reduced?*

- *What are the current problems of Bloemhof in relation to heat?*
- *How age-friendly is the mobility infrastructure of Bloemhof?*
- *What is the state of “social infrastructure” in Bloemhof?*

My goal with this project is to create guidelines to inform the function and form for a building that can provide shelter to elderly people (and others) during the hot summers of the future and that will encourage behaviors that will reduce heat sensitivity. The role of public architecture as part of a larger resilience strategy will be defined. On a neighborhood scale the research investigates the integration of cool infrastructure in an age-friendly way.

3. Methodology.

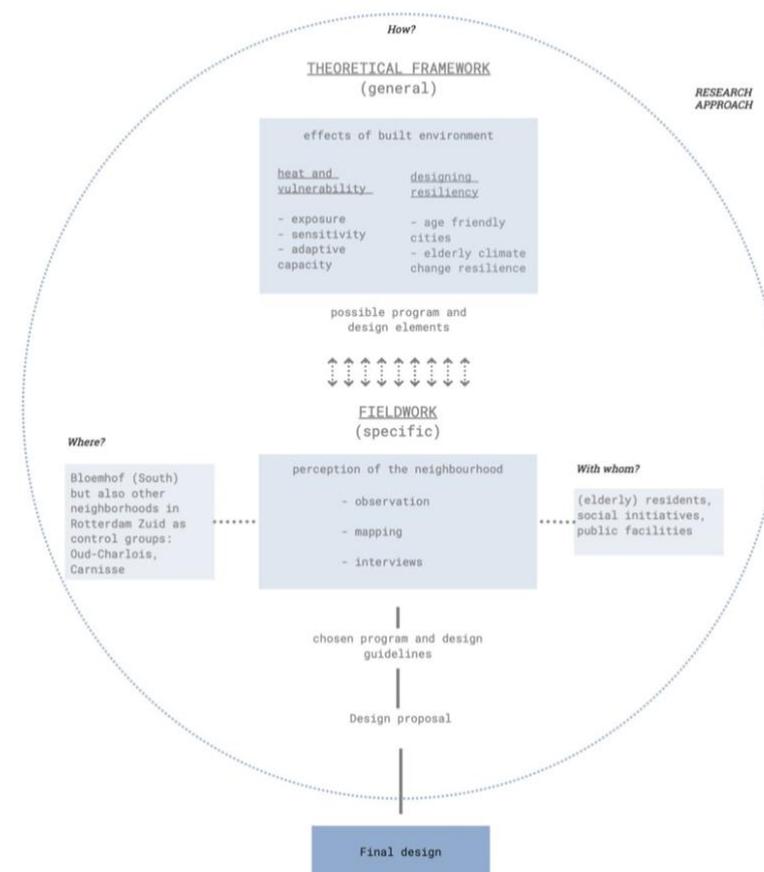
The Rotterdam Resilient Graduate Studio is focused on the health and well-being of the urban dwellers in Rotterdam South. This means that research is done with the future users in mind, and the design is human- and social-centric. For the topic of elderly resilience against heat, a mixed-methods approach was chosen. Literary research was used as a lens for finding suitable themes in the “Age-friendly city guidelines” (World Health Organization, 2007) which in turn informed observations, interviews and mapping. As the topic of (urban) heat is underrepresented in the WHO guidelines, additional

sources such as Kleerekoper et al. (2016), Stichting Climate Adaptation Services (CAS) (n.d.), Kluck et al. (2020), were used within the “heat” chapter of the research.

The mixed-methods approach mirrors the range of strategies needed to effectively build resilience:

- mapping is used to identify areas of heightened exposure and spatial barriers/inaccessibility
- interviews examine lived experience and community systems needed for reducing sensitivity
- observations/fieldwork captures first and second-hand experience of the “user-friendliness” of the existing infrastructure in a neighborhood that affect thermal comfort/resilience especially for the elderly.

RQ: How can “age-friendly” climates be sustainably achieved in challenging contexts where conventional methods are difficult to apply?



- Fig. 1: Research plan (methodology). Graphic by author.

3.1 Secondary research.

The topic of heatwaves and resiliency of elderly touches health, climate, and city planning, among other fields, so understanding it requires multidisciplinary literary research. The literary research examines heat-related vulnerability, it uses the IPCC vulnerability index to define different factors of vulnerability: exposure, sensitivity, and adaptive capacity. Current policies in place to deal with heatwaves are examined as well of the possible impact of climate change. Exposure is explained with urbanism scholars and urban heat researchers Kleerekoper et al. (2012), as well as Kluck et al. (2020), both are used to illustrate conventional cooling methods. The focus, however, lies on the reduction of sensitivity and enabling of adaptive capacities. Data uncovered by Semenza et al., Bouchama et al., Klineberg, and Laverdiere during the Chicago heatwave of 1995 uncovers the importance of social ties and refocuses the research from controlling factors in the natural environment to the reshaping of sensitivity factors into adaptive capacities. Theoretical framework based on the WHO guidelines for age-friendly cities (World Health Organization, 2007) and "Adapting to Global Change: Ageing, Urbanisation and Resilience" by Birks and Praters (2014) is used to translate the social and environmental needs of the elderly into general design guidelines for an age-friendly, resilient neighborhood.

* Designated civil servant who works as a contact person for a certain neighborhood in Rotterdam

3.2 Primary research.

The literary research results showed that older people's sense of community and social activeness are closely tied to their resiliency to heat. Determining whether their built environment enables them to stay active and engage with the community and their surroundings is therefore crucial for assessing their vulnerability. This done by exploring the existing heat in the environment, the extent to which the surroundings enable elderly mobility and the level of development of social infrastructure.

To this end, fieldwork involved sociological observations of older people's mobility behaviors and how they used their neighborhoods and community services.

The neighborhood of Bloemhof was also spatially assessed for its age-friendliness and climate resilience, looking at public space and amenities.

These behavioral and spatial observations were compared with the recommendations outlined in the literary research. An in-depth interview with a resident and volunteer at the local community center, as well as the local stadsmarinier*, helped provide background for the documented observations and outlined the needs and coping strategies of elderly residents. A third interview with community builders revealed strategies for fostering community engagement and social participation, which had proven important protective factors in preventing heat-related illness. Short interviews on the street helped paint a picture of awareness of cooled public places in Rotterdam South.

4. Secondary research

4.1 Heat and vulnerability

4.1.1 Vulnerability

The goal of this thesis is to build elderly resilience against heat, present and future, in other words, reduce vulnerability. In climate research vulnerability can be defined as the result of an equation of exposure, sensitivity and adaptive capacity. While exposure describes to which extent someone is exposed to heat (e.g. living in a UHI), sensitivity shows how susceptible someone might be to heat stress (e.g. being elderly). Finally, adaptive capacity describes the ability to adjust to heat, this could for example be the use of cooling devices or moving to a cooler place on hotter days (Intergovernmental Panel on Climate Change (Ipcc), (2007), Intergovernmental Panel on Climate Change (Ipcc), (2001)).

4.1.2 Heatwaves and exposure

People in the Netherlands experience their biggest exposure to heat during heatwaves. While there is no single definition of a heatwave, considering their relation to the usual climate of a country, the Royal Netherlands Meteorological Institute (KNMI) defines heatwaves as a *'series of a minimum 5 days with a max temperature of 25 degrees (or higher) of which at least 3 have a maximum temperature of 30° and above,'* as measured in their weather station in De Bilt (KNMI - Hittegolf, n.d.).

This suggests that a heatwave may take place regionally even when a national heatwave hasn't been declared. This would especially be the

case for cities as they are usually affected by urban heat island effect (UHI), rendering them several degrees hotter than their rural surroundings (Oke et al., 1991). In the city of Rotterdam, an air temperature difference of 8°C has been measured in comparison to its surroundings (Heusinkveld et al., 2010)

To prevent exposure and subsequent morbidity for vulnerable groups, the National Heatwave Plan (Nationaal Hitteplan) is in place. Its purpose is to raise awareness among health care providers and care institutions during hot weather. It is activated by the National Institute for Public Health and the Environment (RIVM) if there is a high probability of 4 or more consecutive days having a maximum temperature (Tmax) over 27°C (*National Heatwave Plan | RIVM, n.d.*). Additionally, the KNMI sends out color-coded weather warnings corresponding to temperatures. While a code yellow is issued for a single day of 35°C and above, a code orange is issued when there are either: 3 consecutive days with a Tmax of ≥34°C, 2 day with a Tmax of ≥36°C or a single day with a Tmax of ≥38°C. A code red is issued if the conditions potentially will have a major impact on society, or if a low-probability event comes with high safety risks (*KNMI - KNMI Waarschuwingen, n.d.*).

In a recent assessment of the National Heatwave plan the RIVM confirmed that despite rising temperatures heat-related deaths had indeed decreased in the decade since the initial implementation, underlining the importance of awareness when dealing with heatwaves (*RIVM, 2025*).

Conclusion:

The current definition of a heatwave does not help with awareness around heat as a natural disaster as it does not classify regional heat events thus skewing the public perception of how frequent high temperatures are becoming.

The existing heatwave warning system (Hitteplan) has proven effective but addresses professionals rather than the people themselves, and at the time is targeted only towards elderly. While warning the public is achieved through KNMI weather warnings, a future with higher temperatures might heighten the overall vulnerability of the population. In that case a more integrated, universal heatplan with unified temperature thresholds that addresses all people would be preferable to the current two system solution.

4.1.3 Climate change and the High emissions dry scenario

Due to the effects of climate change, the Netherlands are predicted to have hotter weather and more heatwaves in the future (van Dorland et al., 2023).

The '23 KNMI climate scenarios for the Netherlands are based on the predictions of the IPCC, and for the first time also consider scenarios with less precipitation. Should the current CO² emissions continue, and not be lowered in accordance with the Paris climate agreement, a global temperature 4.9°C higher than that at the end of the 19th century could be possible (*KNMI - KNMI'23 Climate Scenarios*, n.d.). For this thesis project, we will assume the scenario with the highest overall temperature rise of the described scenarios, the “High-emissions dry scenario” (HD scenario) and consider its implications for the year 2050. In De Bilt in 2050, the number of days with a

maximum temperature of 20°C and over would take up more than half of the year. In comparison: around the turn of the century, days with a T_{max} of 20°C and above only made up a third of the year. Of the 194 days over 20°C, 54 days will have maximum temperatures between 25°C and 30°C (an increase of 192% compared to the last three decades), and 13.7 days (increase 274%) will have maximum temperatures between 30°C and 35°C.

Considering this, it is safe to say that heatwaves as per the current definition will become a yearly phenomenon. As the calculations are based on KNMI weather stations which are situated outside of cities, a much higher exposure for city dwellers due to UHI is to be expected.

This is especially relevant to the number of tropical nights (min. temperature ≥20°C) which is expected to have a tenfold increase (from 0.3 to 3.1 nights) compared to the time interval of 1991 – 2020 in De Bilt (data from figure *a* in appendix, *KNMI Klimaatscenario's*, n.d.)

A much higher number of tropical nights is expected for cities, as the temperature difference of the UHI effect is greatest at night. For comparison: the *Klimaateffectatlas* by Stichting Climate Adaptation Services (n.d.) estimates around 1.5 weeks of tropical nights for Bloemhof in the current climate.

Conclusion:

Should the HD scenario occur, this would mean quite a substantial change for climate and life in the Netherlands. As we can only diagnose the direction in which the global climate is heading as we go along, preparing cities and citizens for a life in higher temperatures needs to start now, if we want to heighten the chances of a desirable life during climate change in 2050.

4.1.4 The rationale of the case 'Bloemhof'

Bloemhof and several other neighborhoods in Rotterdam South consist of the Dutch 'volkswijk' typology, as defined by Kleerekoper et al. (2016) and the Klimaateffectatlas (Stichting Climate Adaptation Services (CAS), n.d.). This dense typology is highly receptive to heat as its materiality is very stony, same-height buildings counteract ventilation, and the height-to-width ratio of the street canyon does not shade well. This makes them vulnerable environments with high exposure for residents, with the outdoor heat also translating into difficult indoor climates.

Adapting to these difficult conditions via air-conditioning can be counterproductive. For one, exhaust air heats up the outdoor environment even further. Additionally, pressure on the electricity grid due to high cooling demands has caused power outages in the Netherlands during heatwaves in the past, complete reliance on domestic air conditioning puts citizens at risk during a heatwave (*Netherlands Climate Resilience Policy Indicator – Analysis, 2022*). This shows a need for buildings that cool passively.

Reducing exposure can also be achieved by mitigating the UHI, this is usually done with an urban or neighborhood scale strategy that involves greenery such as street trees, parks and green facades, blue infrastructure (water), changing urban materiality to more porous, reflective and less heat-absorbent materials on facades and streets, as well as ventilation and shading through building geometry (Kleerekoper et al., 2012).

However, the narrowness of the streets in the Volkswijk typology, as well as parking, usually doesn't allow for street trees, which are the most cost-effective methods of cooling (Kleerekoper et al., 2016).

In case studies for the volkswijk typology in Ondiep (Utrecht) and Transvaal (Den Haag) research opts for demolition in parts to make space for cooling infrastructure and changes the typology. Additionally white roofs are in Ondiep for higher Albedo levels (reflection), and green roofs are used in Transvaal to make up for the lack of open spaces that could be greened (Kleerekoper et al., 2016). Unfortunately, white roofs (and green roofs, unless accessible) do not make an impact on the local microclimate (Kluck et al., 2020), which would be important in a high-exposure neighborhood.

Conclusion:

The Volkswijk neighborhoods are inherently sensitive to heat due to their morphology. Adaption via urban methods is difficult and usually intensive, changing the typology. In cases where the visual character of a neighborhood needs to be preserved, exposure may not be able to be reduced to enough by the feasible cooling options. Complementary strategies targeting the other aspects of vulnerability may be needed.

In Bloemhof the width of the streets is usually around 9m, the street profile already has trouble accommodating the existing functions, making space for trees is usually not possible (described in more detail in the primary research). While a typological re-model might be possible as Bloemhof needs rebuilding counter sinking buildings, the municipality currently wants to retain the visual character of the neighborhood in new building projects (H. Mattaich, personal communication, 18.12.2024).

4.1.5 Physiological sensitivity of elderly and thermal comfort

Elderly people are especially sensitive to heat-related illnesses such as heat exhaustion and heat stroke. This is due to several factors, lack of thirst with the consequence of dehydration, troubles with thermoregulation through age or medication and risk through co-morbidity especially with cardiovascular and respiratory diseases (Daanen et al., 2010).

This poses the question of the temperature range that is healthy and acceptable for elderly people.

In general, a temperature between 17° C and 24°C results in thermal comfort, although the upper threshold is lower with higher humidity (Asseng et al., 2021). However, this doesn't answer the question of health.

Regarding indoor climates, the WHO differentiates between an ideal temperature for health ("indoor minimal risk temperature for heat-related health effects") and an upper room temperature threshold that should not be surpassed in an age-friendly climate ("indoor maximum acceptable temperature").

Both temperatures not only depend on factors like age or health, but are also locality specific, considering the usual climate a body is exposed to. Differences between locations in different climate zones can be dramatic ('High Indoor Temperatures', 2018).

For example: For London, the indoor minimal risk temperature for heat-related health effects lies between 22°C and 23°C, the indoor maximum acceptable temperature is 25°C.

Compared to this, Thailand has a much higher indoor minimal risk temperature of approximately 30°C and an indoor maximum acceptable temperature of 32°C (Table 5.1, Examples of Estimated

Minimal Risk Temperature for Heat-Related Health Effects and Maximum Acceptable Temperature, 2018. See figure b appendix).

Conclusion:

For this thesis, data determined for London will be used to define the temperature thresholds for the Rotterdam location, as both share a temperate oceanic climate and a similar climate profile. A sufficiently cooled building's temperature would therefore never exceed 25°C. This should be taken into consideration when determining whether a building's cooling system is sufficient.

3.1.6 Historic heatwaves and protective factors

While there are physiological factors that heighten elderly people's sensitivity there are also social factors that studies on historic heatwaves have uncovered.

The devastating Chicago heat wave of 1995 has become the subject of many studies regarding heatwaves, mortality, and the part social activities and ties play as protective factors.

Medical researchers identified *being confined to bed, pre-existing medical problems or psychiatric illnesses, being unable to care for oneself and not leaving home daily* as factors associated with higher risk of death during a heatwave, as well as *living alone* and the *inability to pay for air-conditioning*.

Protective factors were a *working air-conditioning at home, access to transportation and visiting climatized places*, the latter two perhaps being connected.

While these factors were within prediction, the same cannot be said for the other circumstances that showed a protective capacity:

Having social contacts in the area, be it through friendship or the participation in social activities proved surprisingly effective (Semenza et al., 1996; Bouchama, 2007).

These findings confirm the observations that sociologist Eric Klinenberg made in the wake of the same heatwave: that even more than wealth, the amount of 'social infrastructure' and social ties in a neighborhood protected elderly from heat death during disaster (Klinenberg, 2015).

Conclusion:

These findings validate alternative programmatic and architectural solutions to the issue of age-friendly climate.

Promoting social participation and community engagement becomes an effective strategies to alleviate heat-related health issues and the age-friendly city approach could become vital in reaching those who are most vulnerable (Laverdière et al., 2016).

Instead of focusing solely on exposure, the research will also explore in which other ways the vulnerability of elderly of Bloemhof Rotterdam South can be reduced.

4.2 Theoretical framework

After identifying the factors contributing to the vulnerability of elderly people against heat, existing literature and strategies for age-friendly in cities will be used to determine which strategies can be used to mitigate components of the vulnerability.

The work used are the WHO guidelines for age-friendly cities (World Health Organization, 2007) and research by Birks & Prater (2014) focusing on climate change and disaster resilience for elderly.

The following themes have been identified in the previous chapter as crucial for heat protection:

good health – (*see: being confined to bed, pre-existing medical problems or psychiatric illnesses, being unable to care for oneself and not leaving home daily*),

mobility – (*see: not leaving home daily, access to transportation, visiting climatized places*) and

social participation and community engagement – (*see: not leaving home daily, participation in social activities*).

The WHO addresses these themes in the chapters *community and health services, outdoor space and buildings, transportation, social participation, respect and social inclusion and civic participation and employment*. This shows a significant overlap between heatwave adaptation and age-friendliness.

Birks & Prater (2014) further explore this by adding strategies for resilience in climate change in peak (natural disaster) and plateau (adaptation to climate change) situations.

In disaster situations they emphasize the need for:

- disaster relief hubs (should be in established buildings or places that are known to the user)

- access to transportation, well-lit and safe green spaces, age-friendly pavement and walkways, ample outdoor resting area, access to public toilets
(making transfer to disaster relief hub easier)

The latter can be easily addressed with WHO guidelines from the chapters *outdoor space and buildings* and *transportation*. Although emergency planning is briefly mentioned in *community and health services*, disaster relief hubs themselves are not mentioned within the WHO guidelines.

For design solutions for plateau situations (long-term resilience) Birks and Prater recommend:

- designing for connectivity (knowing your neighbors)
- ageing in place (higher quality of life and surroundings)
- new residential models (co-living fosters stability and sociability in later life)
- centralized housing and amenities (locating housing and amenities in the center)
- co-location of necessities (doctors, pharmacies, grocery stores) so mobility impaired can still casually join social life

They apply these rules on an urban scale as well as a smaller, indoor scale, designing for connectivity for instance, is illustrated by

recommending shared areas where neighbors and housemates paths might cross during their daily duties (Birks & Prater, 2014).

These topics are all covered in the guideline chapters *outdoor space and buildings*, *housing* and *transportation*, so it can reasonably be said that the current guidelines form a solid base for designing environments that promote heat-resiliency of elderly.

As the focus of this research is not on the topic housing and heat, the main take away from the last section will be that services need to be clustered and in context with the housing, the environment must be accessible and foster connectivity.

Conclusion:

Considering age-friendliness and climate change, especially long-term resilience can be achieved by following the age-friendly city guidelines, when considering the fields “housing,” “outdoor spaces and buildings” and “transport”.

Regarding disaster preparedness, the term disaster relief hub is not discussed directly. In “Health and community services” preparation of the elderly for emergencies is mentioned, but this is not anchored to a place in the area. While Birks & Prater (2014) emphasize the need for emergency relief hubs and cool green spaces, the desired density and other requirements are not mentioned. There are however already recommendations for the latter, based on current research (e.g. (Kleerekoper et al., 2012; Kluck et al., 2020).

The WHO guidelines do not mention heatwaves specifically or go further into which measures need to be taken to create appropriate outdoor or indoor climates for elderly in the face of climate change. As the guidelines specify requirements for the built environment when it comes to accessibility and inclusion, the disregard of general

measures related to climate change and age-friendliness seems like an oversight. The same can be said for Birks & Prater (2014): when it comes to long-term resilience, the importance of a thermally safe outdoor and indoor environment and the measures that can be taken to achieve this are not mentioned.

5. Primary research

Introduction: The neighborhood of Bloemhof

The neighborhood Bloemhof lies in the district Feijenoord in Rotterdam Zuid and has around 14.000 residents. The focus of this research will mostly lie on the South of the neighborhood. Most of the neighborhood was built around 1920s during urban sprawl to create new housing fast. This has resulted in mostly poor quality building stock without proper foundations and insulation ('Hillesluis, Bloemhof', n.d.). The neighborhood is densely populated and built, there is a high percentage of soil-sealing ('Rotterdamsweerword', n.d.) and close to no shade due to the low-rise typology. This translates into very hot summers in the neighborhood. The 1920s buildings (60% owned by the housing corporations (*Buurt Bloemhof (gemeente Rotterdam) in cijfers en grafieken*, 2016)) are not equipped to deal with these temperatures and indoor temperatures of 37,5°C have been measured in housing at night during the summer of 2021 ('Hittestress vooral in oude woningen', 2021). The neighborhood has a very high percentage (80%) of first- and second-generation migrants and the average income is one of the lowest in all of Rotterdam's neighborhoods. The majority of elderly residents perceive their health as bad (*AlleCijfers.Nl*, 2025). The low

income gives cause to believe there is less capacity to adjust thermal comfort with air-conditioning.



Fig.: 2. Street in Bloemhof South with characteristic zoning and buildings. Picture by author.

5.1 The heat capacity of Bloemhof

To imagine the impact of the HD-scenario in 2050, the neighborhood will be analyzed for its susceptibility to heat in the current day. The research will look at the broader picture through the lens of UHI effect and perceived equivalent temperature, as well as the subjective perception of summers in Bloemhof and then move on to more in detail analysis of the site by looking at selected street canyons for ventilation and solar exposure. The current infrastructure in place to adapt to heat will also be mapped. (Outdoor) “cool spaces” as defined by (Stichting Climate Adaptation Services (CAS), n.d.) as well as climatized indoor space open to the public (‘De Koele Kaart’, n.d.) and their distribution and density will be documented. This should help getting a clearer picture of the current level of vulnerability to heat in Bloemhof.

5.1.1 Summer of a Bloemhof resident

When asked for her perception of heat and summer in Bloemhof, Christine says that it usually becomes very hot in summer and the old houses make it worse. The heat usually stays for some weeks. She experiences health issues during that time, her asthma gets worse. As for cooling measures, nobody in her street has air-conditioning, the electricity would be too expensive. She uses an electric fan and keeps her windows open to cool her apartment. Her combined living room and kitchen faces south, so she puts an umbrella outside to shade it. One of her windows out to the front is

stuck, she thinks it is due to the buildings in Bloemhof sinking and fears opening it for ventilation.

When it gets too hot, she might linger a little in the cool supermarket in Hillesluis while shopping. Sometimes during the hot weeks, she and her friend will take the tram to the beach and spend the day there (C. Ridders, personal communication, 16.12.2024).

5.1.2 Map UHI

To gain initial understanding of the physical properties of Bloemhof, the urban heat island effect for the area was examined. The previously discussed secondary research showed that the UHI for Rotterdam could reach up to 8° C on hot, wind- and cloudless nights (Heusinkveld et al., 2010) resulting in difficult night rest, especially for sensitive groups. Population density, amount of vegetation and water, possible windspeed as well as soil sealing play into the intensity of the effect.



Figure 3.: Map UHI in Rotterdam. Source: Kaarten | Atlas Natuurlijk Kapitaal, (n.d.).

Analysis:

The UHI effect is shown to significantly affect Rotterdam South. The Bloemhof area is colored red, signaling temperatures of at least 2°C above those of the rural surroundings on the average summer month during our current climate (unfortunately it does not specify how much above 2 °C the temperatures lie).

Additionally, the map uses a temperature average over the summer months of June, July and August (*Stedelijk Hitte-Eiland Effect (UHI) in Nederland | Atlas Natuurlijk Kapitaal, n.d.*), which means the effect may be significantly higher during heat waves due to temperature

lags caused by the city's materiality. The map also doesn't look at the maximum of the UHI during the day which would occur at night, when rural areas cool down faster

However, the map clearly shows the overall impact that soil sealing and low building have on the area.

On the upside, the impact of the blue-green infrastructure along the two canals surrounding Bloemhof South and by the larger trees along bigger roads is also visible.

Conclusion:

Overall, de-sealing and implementing green in the area where possible is of the utmost importance to help the local micro-climate. Green or white roofs could help with the non-local impact of the urban heat island effect, but do not help the microclimate.

5.1.3 Map PET.

PET is the perceived equivalent temperature considering different factors like wind, humidity, direct solar or ambient heat radiation, or clothing to portray how a temperature is perceived by a human. The graphic is based on a the Klimaateffectatlas (Stichting Climate Adaptation Services (CAS), n.d.) map by Witteveen+Bos, that looks at a representative tropical day with nearly windless conditions (1st of July 2015) with 33,1°C in De Bilt.

Analysis and recommendations:

The map shows PET values above 40°C during a day with 33°C air temperature and thus extreme heat stress (Nouri et al., 2018) almost

everywhere in the south of Bloemhof. Not only the streets are affected, but also backyards are a source of heat. Open space in the area gets particularly hot, massive solar exposure happens as result of lacking trees and low adjacent building heights. The south of Bloemhof is hottest, and the area around Kiefhoek reaches a PET around 48°C.

In their guidelines “De Hittebestendige stad,” Kluck et al. (2020), set the threshold of 41°C PET for walking routes and recreational spaces. Rotterdamsweerword, a municipality-backed initiative for climate resilience, defines cooler neighborhoods as ones that average below 41°C PET.

As Kiefhoek is the area affected most by higher temperatures and is also unlikely to be rebuilt due to its monument status, residents need to have access to additional resources for cooling. The adjacent open space of the Zwijndrechtse plein currently suffers from high PET but also provides an opportunity to for transformation, so not only a cool indoor, but also a cool outdoor space could be provided. The area with the greatest need is chosen as the general area of intervention.



Figure 4.: Mapping PET. Drawing by author based on map by Klimateffectatlas.

Overall, there a lot of buildings with the same height, and it is unclear if the tilted parts of the roofs of the typology would help with the ventilation, since the inclination stops before the facades.

5.1.4 Analysis street canyons

5.1.4.1 Ventilation

Increasing ventilation by street orientation can be controversial in the Netherlands, as winter and summer wind directions can turn soothing summer winds into relatively brutal winter winds. Another option for better ventilation is to create an air mix of the canopy and boundary layers of the street. For this to happen, the ratio can only be up to 0.6, full ventilation across the entire street profile occurs at 0.2 or lower (Xiaomin et al., 2006). Tilted roofs or different building heights can also help with this process, catching and funneling the wind at the 'mouth' of the street (Givoni, 1998, p. 284, Rafailidis, 1997). Trees, on the other hand, will mostly hinder ventilation. It is however important to note that there tends to be no wind during heatwaves, so trees' cooling functions need to be considered.

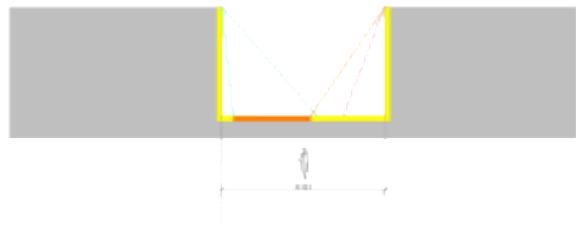
Analysis and recommendations: In an analysis of six select streets in Bloemhof South, all streets except the alley in Kiefhoek and the Oostendamstraat in parts have a h/w ratio up to 0.6, guaranteeing full ventilation, thanks to the low typologies of the area. While the Kiefhoek alley may look problematic on paper, in reality it is not framed by building blocks but passes through the streets, gardens and short ends of buildings, which would give it sufficient ventilation.

5.1.4.2 Solar exposure

The same six street canyons can also be described with solar exposure in mind. As the housing typology of the neighborhood is flat, comprised of mostly two-story buildings, streets and facades accumulate a lot of exposure over the day. The following analysis is based on diurnal solar exposure diagrams for Rotterdam by Hotkevica (2013) that explore different street orientations and height-to-width ratios. In addition, ratio and location of different zones within the specific street canyons are visualized, to see which zones are affected: Are pedestrians able to walk in shade, will parking cars be heated up?

The street grid of Bloemhof South consists of northeast to southwest and northwest to southeast streets. While NW to SE streets with H/W ratio of 1:2 and wider have a cooler side walk on the west side, that only receives four hours of sun in the morning, the entire street canyon of NE to SW streets with a the same H/W ratio receives a minimum of 6 hours per day, with the longest exposure taking place in the middle of the street, where pedestrians mostly walk in Bloemhof.

Individual analysis and recommendation:

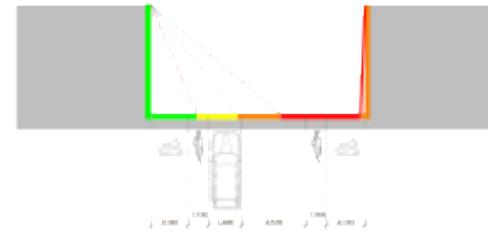


Kiefhoek
alley
h/w: 0.66
SW to NE

Fig.: 5. Drawing by author.

Kiefhoek alley.

Between the short ends of the building mostly shade on the south side of the alley, sun only 4h per day, façade greening and de-sealing the hot area and planting a tree there could help make this a better thermal experience.



Kiefhoek
normal
h/w: 0.5
SE to NW

Fig.: 6. Drawing by author.

Kiefhoek (normal street).

Mostly shade on the west half of the street, but a hot façade and front yard on the east. Green facades and de-sealing front yards could improve the thermal experience, especially on the east side, not just for passers-by but also for the people living in the building. Ideally, the sidewalk on the eastside should accommodate two people passing each other by on wheelchairs (→180cm). Preferably, the parking zone would be removed from the street as it heats up either the “safe” sidewalk or causes further heat stress on the already hot side of the street. Peripheral parking garages could be an option to deal with this issue.

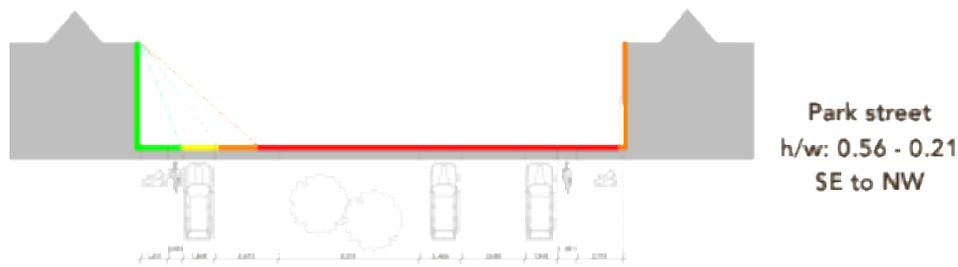


Fig.: 7. Drawing by author.

Park street.

The wide section of the street generates a lot of exposure, the safest way for pedestrians to traverse this area would be to create a shaded path within the existing park strip in the middle of the lane, making sure that the canopy is always dense enough and there is permeable ground that will heat up less. In this case, moving cars towards the park strip away from the narrower sidewalks next to the buildings might be appropriate. Façade greening and de-sealing of the front yards on the east side is needed.

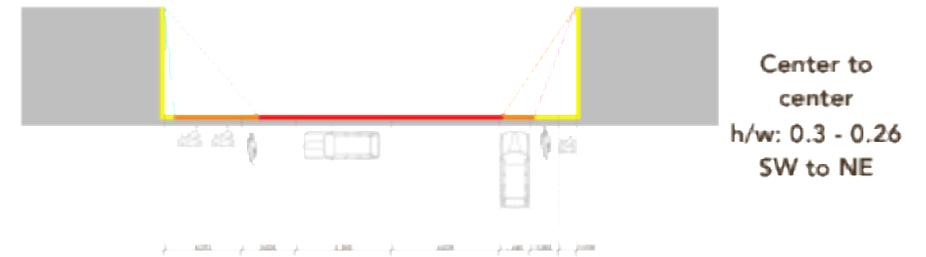
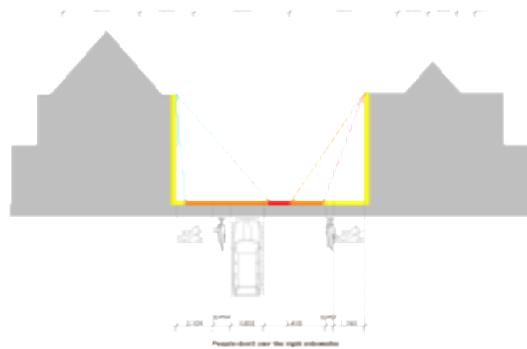


Fig.: 8. Drawing by author.

Center to center.

Here the implementation of trees or shading pergolas is urgently needed. While trees already exist on the sidewalk of the north-side, canopy coverage would have to be continuous. The car parking in the part of the street that experiences 8h of sun light is unfortunate and should be discontinued, parking garages could make up for the lost spaces.

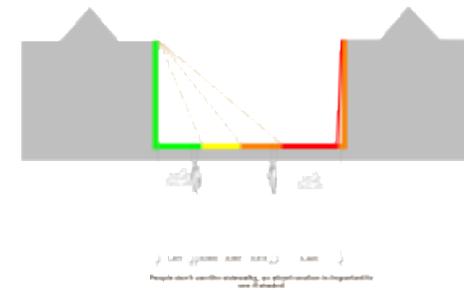


Oostendam
straat
h/w: 0.6 - 0.54
SW to NE

Fig.: 9. Drawing by author.

Oostendamstraat

The street would need overhead coverage like street wide sun sails or shading pergolas. Façade greening is needed on both sides. The widths of the sidewalks need to be reconsidered, at least one side should have a proper width of 120cm to accommodate one person using crutches. However, getting rid of the mostly sealed front yards in favor of wider sidewalks or getting rid cars in the street altogether for the possibility of a pedestrian zone with street trees should be options to seriously consider.



Side street
h/w: 0.58
SE to NW

Fig.: 10. Drawing by author.

Side street.

While the SE to NW orientation helps with shading, this street profile forces pedestrians to walk in the middle of the road, sunny during 8 hours of the day. The street itself barely fits a parked and a driving car. In this case, ratio of the street section needs to be rethought, the sidewalks are inadequate. If the sidewalk on the shadier west side was widened to fit two wheelchairs appropriately, parked cars would have to leave the street. Alternatively, a pedestrian zone with planting could work.

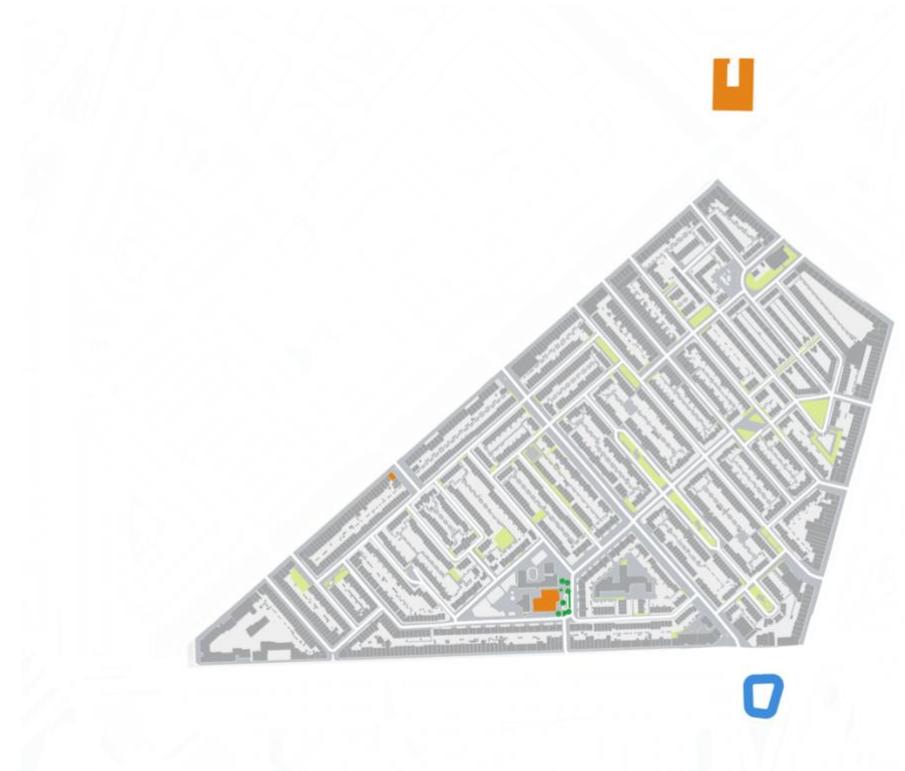
The front yards on the east sides are in the right spot to reduce exposure but need to be de-sealed, façade greening is needed.

5.1.5 Cool space. Outdoors and indoors.

Public space plays an important role in the heat management of a neighborhood. When greened, places that reaches max 35°C can be used as so-called “cool spaces”, heat-reliefs within a neighborhood. These spaces should be a maximum of 300m from any home, a walking distance of 5 minutes for a healthy elderly person (Stichting Climate Adaptation Services (CAS), n.d.).

Simultaneously, there is a need for accessible cool indoor space. Rotterdamsweerword, an initiative for climate resilience backed by the municipality, shows cool indoor spaces in a map (‘De Koele Kaart’, n.d.). Since the focus is on public institutions, it disregards commercial semi-public spaces like the shopping center Zuidplein or supermarkets.

Christine doesn't rate the greenspaces very high, it would be nice to have more benches, preferably in plastic “for the rain.” The promenade along the Lange Hilleweg is “for ducks”, but at least everyone has their own garden. She enjoys the Zuiderpark and thinks it is a good location for summer, however sometimes there are festivals so you cannot pass, and during the night it is dangerous as there is no lighting. (C. Ridder, personal communication, 16.12.2024)



Public indoor space (not cooled)

Public indoor space (cooled)

Green space (insufficiently cool)

Green space (cool space as defined by Stichting Climate Adaptation Services (CAS), (n.d.) map see figure c appendix.

Figure 11.: Mapping cool public indoor and outdoor spaces. Based on data from ‘De Koele Kaart’, (n.d.) and Stichting Climate Adaptation Services (CAS), (n.d.)

Conclusion:

Data from (Stichting Climate Adaptation Services (CAS), n.d.) shows clearly that the area around Kiefhoek is the most affected and needs a heat-relief. Considering that open space for transformation is rare in the neighborhood, the high PET values of the Zwijndrechtseplein should be tackled and the place transformed into a shaded green area.

The entirety of Bloemhof does not have a climatized indoor space, the Feijenoord library in Vreewijk being the closest accessible cool space. There is urgent need for climatized public indoor space.

5.1.6 Street interviews. Use of cool spaces in summer.

Awareness of the dangers of heat and how to cope with it rely largely on dissemination of information, however thermal comfort is easily detectable. To understand the level of awareness concerning climatized gathering spaces in the neighborhood, I conducted a series of short interviews in different places in Rotterdam South. After a short introduction I would ask:

“Do you know any cool/climatized places in your neighborhood?”

I would usually add **“Where do you go when it is hot?”** to also check for results outside of the neighborhood or to see whether people preferred staying at home during hot weather.

General findings from neighborhoods in Rotterdam Zuid:

Overall, not many people knew which places were climatized in their neighborhoods. Generally, recommended locations could be found in the bigger area of Rotterdam South and not necessarily inside the neighborhoods.

Common recommendations were the Zuiderpark recognized for its cooling values and the port/beach along the Maas where people could go for a beach day with friends or for fishing. Apart from that, people knew the Zuidplein shopping center as a climatized place (between neighborhoods, although not entirely suitable because of the intense UHI/PET in surroundings) and were willing to travel longer distances to get to a cool place.

Specific findings from Bloemhof:

People from Bloemhof feel very sure that there are no existing climatized places in their neighborhood. The adjacent library Feijenoord was generally overlooked. Instead, people described traveling longer distances to get to cool places.

Conclusion:

Overall, there seems to be a lack of indoor places perceived as cool and close by. The false identification of some spaces as cool spaces and lack of knowledge about some of the existing places such as libraries, shows that people do not yet perceive heatwaves as the natural disasters that they are and do not know about resources to meet them. This may leave elderly people alone in their houses on hot days if the municipality does not check in on them.

As Birks & Prater (2014) point out, it is important that elderly people be aware of the cooling/emergency centers long before crisis hits. It

is therefore recommended to cluster them with other uses that elderly might visit in their everyday life.

5.1.7 Conclusion heat

In the secondary research part of the paper, the importance of cooling centers for the wellbeing and safety of elderly during heatwaves has been established. The primary research now shows the urgency and precariousness of the current situation in Bloemhof. Badly insulated building stock and a lack of cooled publicly accessible indoor spaces within walking distance for most of the neighborhood puts elderly people in harm's way. While individual air-conditioning may seem like a simple solution, the interview with Christine clearly shows that this is often beyond people's financial means. Additionally, conventional air-conditioning contributes to thermally hostile outdoor conditions in the summer and leaves people defenseless in case of a power outage.

Therefore, a **public indoor space that uses more than just mechanical means of cooling** to keep temperatures acceptable to elderly is needed within the neighborhood. The building should also provide **space for overnight guests**, should housing get dangerously overheated.

The result of the PET analysis and existing indoor and outdoor cool spaces determined the location of the building site within the neighborhood: The area of Kiefhoek. As the street interviews showed, there was some uncertainty among residents in Rotterdam South about which buildings in the neighborhood were actually cooled, so it would be helpful if the building was **readable as "cool"** in the way maybe a park or a swimming pool would. Planting,

biophilic architecture, cool colors or water may be means to visualize the refreshing qualities of such a building.

The cooling center should be embedded in a **network of "cool streets"** as safe routes to the cooling center with plenty of places of (shaded) rest along the way. Considering possible future temperatures there must be cooler places closer to home. As determined by the canyon analysis, **northwest to southeast streets have cooler sidewalks** on the west side, whereas northeast to southwest are warm all day, making them less suitable as cool streets. Many of the analyzed streets needed a **redistribution of their ratio of sidewalks, streets, front yards and parking ratio to ensure that people don't walk in the hot middle of the street**. In addition to this, parking should be relocated away from the streets, possibly into **parking garages** as cars add significantly to the PET for pedestrians. Lastly, the high PET in back and front yards should be met with a de-sealing strategy: **"Wijktuinmannen" (city gardeners) should help residents de-seal their gardens** and help with maintenance and planting choices to achieve the best microclimate. The cooling center could be used as a headquarter/office for the gardeners.

5.2 Accessibility and the street network of Bloemhof

During his research on the Chicago heat wave of 1995 Eric Klinenberg (2015) discovered that those most affected by the heat were elderly individuals who were reclusive. A perceived hostile environment kept elderly people indoors and isolated. So did the lack of infrastructure for elderly like elevators.

The WHO guidelines for age-friendly cities (World Health Organization, 2007) names transportation and easily accessible surroundings as important criteria for age-friendliness. Bouchama et al. (2007), and Semenza et al. (1996) identify leaving the house once a day and access to public transportation as protective factors against heat-related mortality.

The following chapter will investigate the overall accessibility of the Bloemhof neighborhood for elderly people. The goal is to determine how successful elderly mobility is within the neighborhood at the moment and how accessible for people of every age a public cooling center could be. Birks & Prater (2014) see accessibility in neighborhoods as crucial for the safe evacuation of elderly residents in the case of disaster.

This means it should be reached with ease and the way there should feel safe, also regarding heat.



Fig.: 12. Electric wheelchair next to door with pavement heightened to form a ramp. Picture by author.

5.2.1 Mobility experience of a Bloemhof resident

Christine doesn't have a car, hasn't ridden her bike since her surgery some years ago. Using a walker and later a cane in the time after her surgery was difficult on the streets.

Walking on the street is a problem, people drive to fast, cars do not wait.

She walks over to Hillesluis for groceries. Most people go for groceries by car or order by groceries through different services.

She perceives the neighborhood is well-connected by bus and tram.

(C. Ridders, personal communication, 16.12.2024)

5.2.2 Transportation

While the south of Bloemhof is reachable by trams 2 and 25 as well Bus 66, the stops are on the periphery of the area. Additionally, public transport not available between 1am and 5am in the morning. This means cars are indispensable for some of Bloemhof's working class families, but parking cars everywhere significantly changes the visuals and safety of the streets and are a source of heat in summer.

Most people in Bloemhof don't know how to ride a bike (N.

Riemersma, personal communication, 07.01.2025).

Elderly people can call bus services like "trevvel" or the "wijkbus" to travel within or outside the neighborhood, which cost a small fee. (C. Ridders, personal communication, 16.12.2024). However, this service does not extend to other groups like families with young children

who might also need a more door-to-door transport on a regular basis.

Conclusions:

Reducing the hazards created by parking and driving cars in a neighborhood with sub-par pedestrian infrastructure, is key. Every year around 80 car accidents happen in Bloemhof, some with personal injury. The overall car density in the neighborhood is close to 5000 per km² (*Buurt Bloemhof (gemeente Rotterdam) in cijfers en grafieken*, 2016).

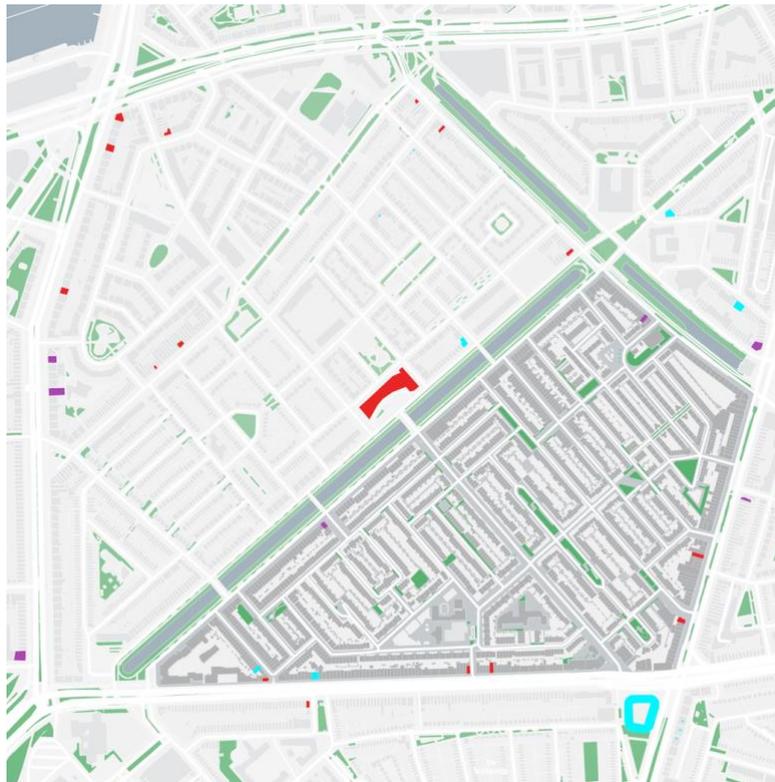
Hourly night buses (or trams) on weekdays could help reduce the overall car use. Parking garages on the periphery could be implemented during a potential restructuring of the neighborhood and encourage travel on foot where possible.

5.2.3 Getting around. Facilities of everyday life.

Medical facilities and stores for everyday need are found in the periphery of Bloemhof, the next big Dutch supermarket is in Hillesluis.

There are not a lot of cafes or other places to meet up, inside or outside.

Christine is content with the amenities and services for elderly: She thinks there are enough GPs and other health services around and doesn't think there is more need for program for elderly. However, there are no Dutch supermarkets in the neighborhood anymore which she says is difficult for elderly people as products are unfamiliar and cannot be identified by reading, and there is no one to ask questions to in Dutch. (C. Ridders, personal communication, 16.12.2024)



Health related facilities

Retail and Services such as hairdressers

Groceries

Figure 13.: Mapping of facilities of everyday use. Drawing by author, based on data by (Leefveldenkaart | Onderwijskaarten, (n.d.).

Conclusion:

The services are found around the periphery of Bloemhof South and in the north of the neighborhood, leaving the center as a monoculture of residential buildings. Health services are plenty and within reasonable walking distance, e.g. a cluster can be found in the building of the Bibliotheek Feijenoord. The nearest Dutch supermarket (not shown on map) lies to the east in Hillesluis, while the shops in Bloemhof are corner shops with a smaller range of groceries or polish grocery stores that may be difficult to navigate for elderly people. Cafés or bakeries are relatively rare considering the population density of Bloemhof, so there are no places to go to during the weekend resulting in quite empty streets during my observation time in winter.

Overall, the facilities of everyday need are decentralized and spread out in Bloemhof, this makes cars or scoot-mobiles more attractive modes of transportation. New developments should aim to cluster functions for this reason, preferably bringing institutions of everyday needs together with places for socializing and community. Placing a cooling center within this cluster would help with familiarizing elderly people with it before a heatwave occurs (Birks & Prater, 2014).

5.2.4 Getting around. Places to rest in transit.

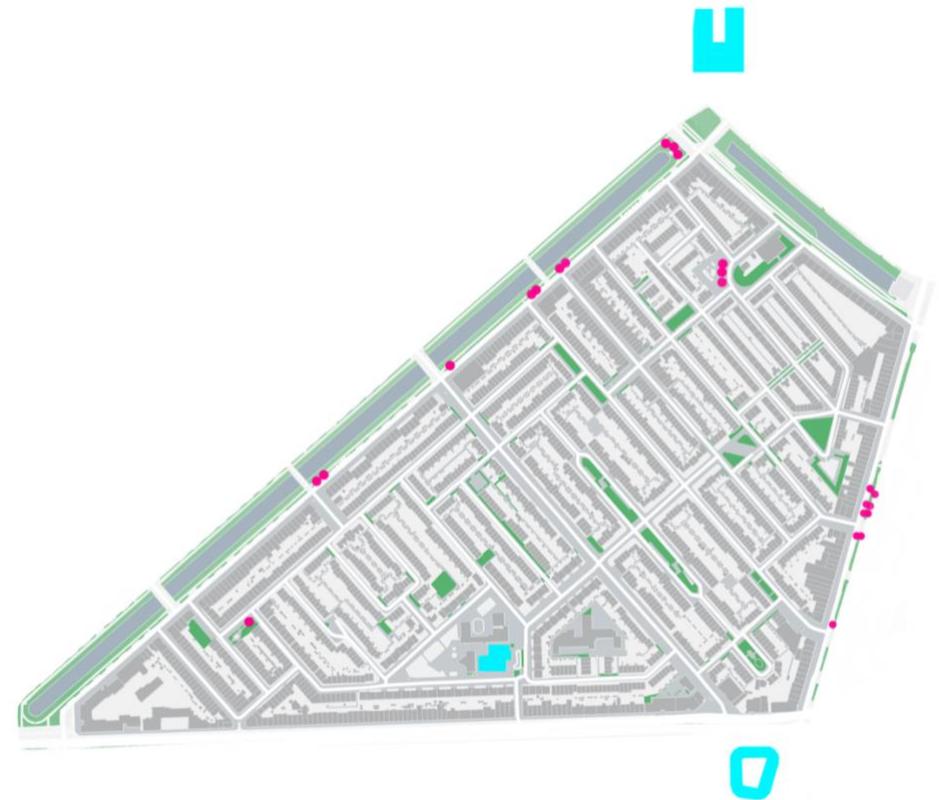
The WHO puts transportation as one of its eight key values for age-friendly cities and emphasizes barrier-free sidewalks, pedestrian crossings, outdoor seating for rests while walking and toilets accessible for elderly people when they are away from home (World Health Organization, 2007). Mapping benches and publicly accessible bathrooms shows how accessible a neighborhood is for the elderly and many other groups.

Observations and Recommendations:

Benches are only placed on two of the playgrounds, the canal and on the planted traffic island on the Beierlandselaan. They are not always shaded.

There are no public (accessible) toilets apart from the ones at the Feijenoord library, Huis van de Wijk Irene and the Hillevliet.

It would be crucial to place resting places at bus stops, in cool streets and along routes to cooling center. A public, clean and barrier free toilet in the area around Kiefhoek would add much relief and mobility for many of Bloemhof's residents.



Places with publicly accessible bathrooms
Benches in Bloemhof South

Figure 14.: Mapping places for rest and relief. Drawing by author.

5.2.5 Map barrier free sidewalks.

During my observations I realized that most of the time while I was exploring Bloemhof South, I was walking in the middle of the streets, and not on the sidewalk. This was due to the sidewalks being very narrow in general, but also being blocked by parking cars, streetlights and sometimes even by hedges from front yards. Another day, trash was being collected and even the walkable sidewalks were blocked.

Moreover, the sandy, sinking ground beneath the pavement has caused it to warp almost everywhere, a tripping hazard that I soon became aware of. The age-friendly city guidelines recommend that pavements should be “...wellmaintained, smooth level, non-slip and wide enough to accommodate wheelchairs with low curbs that taper off to the road. (...) Pavements are clear of any obstructions (e.g. street vendors, parked cars, trees, dog droppings, snow) and pedestrians have priority of use.” (World Health Organization, 2007) I wondered how the current situation in Bloemhof would impact someone with limited mobility and decided to map the accessibility of sidewalks in South Bloemhof.

Observation:

While I first intended to look for sidewalks that would let a wheelchair driver and a person on foot pass each other (min. 120cm), It soon became clear that most sidewalks did not even provide enough space for a person with crutches to use them (min. 90cm).

The following map marks sidewalks over 90cm (yellow) and shows sidewalks that are inaccessible due to width or such interruptions as lamp posts, overhanging hedges and other obstacles that make the already narrow sidewalks unusable.



- insufficient sidewalk width (<90cm)
- sufficient sidewalk width (≥90cm)

Figure 15.: Mapping accessible sidewalk. Drawing by author.

Conclusion:

In many places aside from the two main axes, the sidewalks are less than 90cm wide or have built obstacles (e.g. streetlights) that narrow it down to less than 90cm. Front yards, sidewalks, car parking space and the lane for cars are competing for space in the narrower streets. The sidewalks are not suitable for pedestrians, but pedestrians also don't have "priority on the street" (World Health Organization, 2007). While cars generally drive relatively slowly, signs on to streets tell drivers to slow down for children's safety. People who walk the streets rely on their hearing to identify nearing cars and quickly step through the gaps between parked cars onto the sidewalks when a vehicle approaches. This would become increasingly difficult with age.

It would therefore make sense to re-construct sidewalks at least along the main routes and make cool streets car-free when possible.

5.2.6 Mobility Observations.

During my days walking through the neighborhood, I also observed the different ways the residents moved through it. Mobility is key to leaving the house daily and staying agile, both reducing sensitivity. Understanding possible mobility challenges and how people deal with them is crucial.

Observation 1:

A family of five is walking on the street as they hear car coming: all hurry to get on the sidewalk which is so narrow and blocked by cars that they must walk in a line behind each other

Observation 2:

An old lady with a walker walks on the middle of a narrow street, taking space. She doesn't seem too worried about cars.

Observation 3:

During a walk through the park, we see two men drives past on a bicycle, one of is sitting in a side car. Christine explains the passenger is blind and a volunteer is driving him around so he can experience a nice drive though park.



Figure 16.: Sketch by author.

Observation 4:

During my observation the community walk, the participants encountered a difficult set of stairs. Despite most of the group still being in their 50s and 60s almost all of them needed a hand to overcome the obstacle



Figure 17.: Sketch by author.

Observation 5:

A Man comes out of a bar, walking on crutch. He puts the crutch on his bicycle and drives off



Figure 18.: Sketch by author.

Observation 6:

Before a terraced house a man parks car on the street only meters from the door and helps an elderly woman out. He supports her as she attempts to get on the sidewalk, then half carries her up the stairs to her front door and inside



Figure 19.: Sketch by author.

Observation 7:

Electric wheelchairs are rarely seen on the interior streets; on the bordering streets there are many and they drive around very fast

Conclusions:

People from Bloemhof seem to mostly have adjusted their mobility to their difficult environment:

A bike is preferable to foot passage (although most people don't know how to ride a bike (N. Riemersma, personal communication, 07.01.2025), electric wheelchairs might drive on the wider streets of the border until they reach the access point nearest to their destination. Things become more complicated when mobility is lost: people in regular wheelchairs or who have mobility issues are utterly dependent on outside support and the mindfulness of drivers.

Observations 1 and 7 show that the (pedestrian) infrastructure is lacking, and how people have adapted to this. Observation 3, 4, 6 visualize the big role informal support systems play in elderly people mobility now, and observations 2 and 4 show the lack of consideration for mobility impaired in their everyday surroundings. When Bloemhof's pedestrian infrastructure is adjusted, inclusive design should be integrated.

5.2.7 Safety.

Klinenberg (2015) describes perceived unsafety of a neighborhood as one of the reasons of elderly people becoming reclusive. Frightened by what they see on in the media and highly aware of their own vulnerability, they avoid going outside.

This is relevant to Bloemhof: In 2024 data by the municipality showed that the neighborhood had become much safer in the last

ten years. The subjective feeling of safety on the other hand had decreased, the score 35/200 placed the neighborhood second-to-last out of all neighborhoods in Rotterdam in 2024 (*Wijkprofiel Rotterdam*, n.d.).

Nienke Riemersma also describes the problem of perceived unsafety: when women do not go onto the streets after dark, the street also is perceived as a street where women are unsafe (N. Riemersma, personal communication, 07.01.2025).

Christine feels generally quite safe in Bloemhof, she has a WhatsApp group with her neighbors that can be group-called in cases of emergency.

Nevertheless, she avoids going out after dark and assumes not many people would come for help if you screamed. A friend of hers, who uses a mobility scooter, moves freely during the day but will use a bus service for elderly to get picked up after dark. (C. Ridders, personal communication, 16.12.2024)

Conclusion:

Nienke Riemersma highlights part of the issue when she notes that women do not go outside after dark: Bloemhof is a neighborhood where you do not see many people in the streets, everybody is inside. The feeling of being alone and unsafe after dark is



Fig. 20.: A barbed wire over a garden gate in Bloemhof South. Picture by author.

exacerbated by the fact that commercial and public institutions which could provide “eyes on the street” (Jacobs, 1992) are only found on the periphery of the south of Bloemhof. Creating more public and semi-public interiors with views and connections to public outdoor spaces and streets makes these outdoor areas seem more safer in turn.

This would be especially true of places with longer opening times, an area feels safer when you can expect more people, or at least the employees of shops or community centers to be around.

It is also noteworthy that Christine feels safe because she has community she can count on, not because she thinks there is an absence of danger.

5.2.8 Conclusion mobility

From the observations in this chapter, it becomes clear that the pedestrian infrastructure needs to be adjusted and inclusive design needs to be more incorporated, as residents with mobility issues are currently mostly reliant on (informal) support systems.

Firstly, **width and materiality of sidewalks need to be adjusted** to ensure even, barrier-free passage.

This might mean some **reorganization of the zones** in the street, specifically the ratio of parking, sidewalks and front yards. To maximize pedestrian friendliness and also make the streets safer for Bloemhof’s many children, **parking garages** should be implemented in the periphery. Simultaneously, as per WHO guidelines, **resting places** in the form of shaded benches should be implemented at bus

stops, parks and in the “cool streets” proposed in the conclusion of the previous chapter.

The cooling center itself should also **provide outdoor and indoor spaces for resting free of charge** and make sure that **all building areas are accessible to people with mobility issues**. A minimum of two barrier-free, publicly accessible toilets should be included in the design.

To encourage everyday mobility of elderly residents, creating a **central hub including everyday use functions** would be beneficial. A grocery store would address the current lack thereof in Bloemhof and improve perceived safety through presence after dark.

In line with making the area feel safer and more accessible during all hours of the day, there could also be a partially enclosed garden integrated into the cooling center, providing a **semi-public safe green interior**.

5.3 The community of Bloemhof.

Concerning the heatwave of 1995, Klinenberg (2015) identified the presence of social infrastructure (or lack thereof) as the defining factor whether or not a neighborhood suffered losses during the heatwave. To him, social infrastructure is not “social capital” (interpersonal networks, relationships) but rather organizations and physical places that help social capital develop and grow (Klinenberg, 2020). He sees the building of community (and support of it through built infrastructure) as a crucial adaptation strategy for climate change (Klinenberg, n.d.).

Bouchama et al. (2007) and Semenza et al. (1996) also identified social interaction and social activity as protective factors against heat-related illnesses and heat death.

On a broader scale, the WHO guidelines for age-friendly cities (World Health Organization, 2007) name social participation and social inclusion as keystones for health and wellbeing throughout life, thus making efforts to improve them is essential for age-friendliness. This chapter seeks to assess the current state of social infrastructure in Bloemhof by mapping community gathering places and observing community activities and community initiative. It also taps into the hands-on knowledge and experience of the community builders of Rotterdam South.

5.3.1 Bloemhof’s community from the perspective of a resident and volunteer

Christine perceives the communal ties as quite good in Bloemhof, people look out for each other: her neighbors have her keys and when someone moves to the street they are welcomed by all. She buys

groceries for her old neighbor, take her trash out and invites her for Christmas. She thinks that it is difficult for elderly people to ask for help. Being a volunteer herself, she thinks that volunteering can be important for the elderly, as it helps them feel useful and people will count on you to be present and will notice if you do not come. She also sees value in intergenerational activities, as elderly people enjoy younger people's questions, and she thinks both sides can learn from each other (for example with technical issues it can be helpful to have younger people around). She is satisfied with the amount of community centers in the area (she names them, upon later research, some of the centers have been closed). (C. Ridders, personal communication, 16.12.2024).

5.3.2 Self-organizing in Bloemhof

During my fieldwork I walked through several different neighborhoods in the South which gave me insights into the often diverse social fabric of adjacent areas. One thing that was very noticeable was how pro-active certain communities were when it came to organizing activities with their neighbors and trying to improve their surroundings and lives through community. Looking at Bloemhof, there are a couple centers where people can go to participate in activities, but there is noticeably less self-organized activity. This was especially visible when comparing Bloemhof to the neighboring Carnisse, where there are not only multiple grassroots community spaces but even during the brief time during which I observed the neighborhoods, I could see many Christmas parties organized by neighbors in different parts of the neighborhood, as

well as many places where “tegelwippen” had taken place, communal façade greening.

While there a lot of municipal support options and program in and around Bloemhof there seems to be less activities organized by residents themselves. The exceptions to this are Café Blend, which is run by two residents and aside from being a café and a store, hosts music evenings, community dinners and functions as a church; as well as the “Ons Bloemhof” donation cabinets where people can leave books, clothing and other small everyday items for each other.

Activities that communities organize themselves often create a sense of agency and belonging and become local traditions (*S. van der Ham, K. Welp, personal communication, 03.12.2024*), which would be crucial for future and current elderly people of the multi-cultural community of Bloemhof who do not necessarily have the support of family living close by. Self-organized activities also provide more opportunities to casually volunteer.

Community activities like “tegelwippen” also show people that they can improve their live on their scale in the face of climate change. (*S. van der Ham, K. Welp, personal communication, 03.12.2024*)

While empowerment may come from taking charge instead of just participating in top-down organized events, municipalities could still support and enable their citizens by allotting space for public gathering and working.

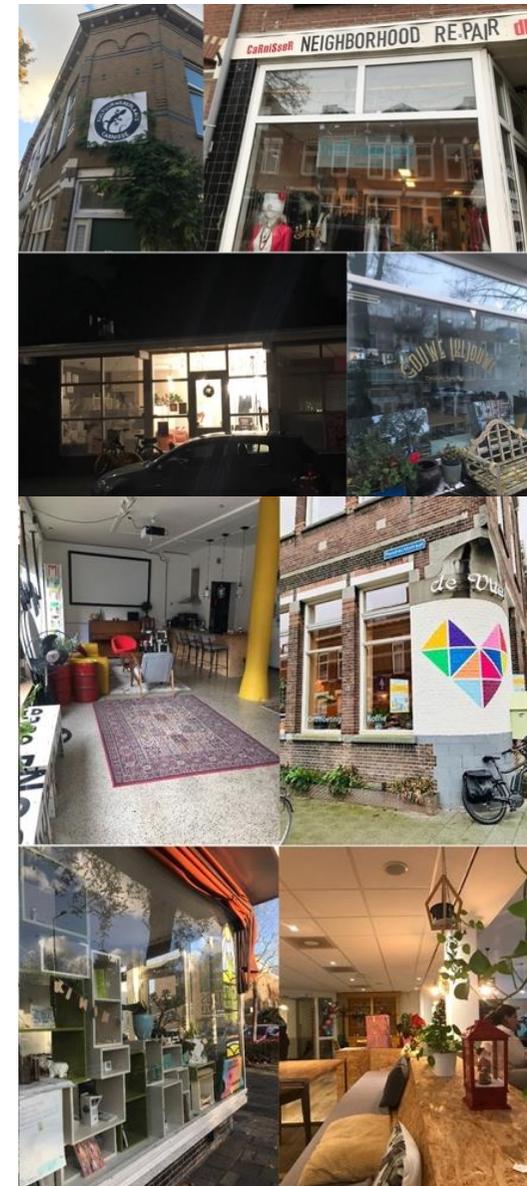


Fig.: 21. Comparison of observable community initiative in Bloemhof (left) Carnisse (right). Pictures by author.

5.3.3 Community activities

The age-friendly city guidelines recommend a wide variety of community activities at different, accessible locations.

The activities should encourage intergenerational and intercultural interaction as well as interaction of different user groups in multipurpose buildings. Activities should include family events specifically including older people. Activities can also provide elderly people with opportunity to share their knowledge, history and expertise with other generations for mutual enrichment (World Health Organization, 2007)

There are four community indoor spaces within and close to Bloemhof South: Huis van de Wijk Irene, Café Blend, Bibliotheek Feijenoord and De Hillevliet. According to the interactive map for cool indoor spaces by municipality initiative “Rotterdamseweerword” (‘De Koele Kaart’, n.d.), only the Bibliotheek Feijenoord is climatized. Considering the WHO guidelines the activities currently offered in the existing community centers were analyzed to see if they were inclusive and age friendly (list of activities: see figure d appendix)

Conclusions:

While the area provides a variety of activities and services, activities are often targeted towards age groups in a way that separate elderly from younger generations. There are no family events that are not targeted to just parents and children, and no places that invite elderly to share their experiences. The language café the library hosts could facilitate intercultural interaction. User mixes are achieved in Blend and Hillevliet, as well as in the library building. While rooms for new community initiatives and activities exist in Blend and Hillevliet

and could host the lacking activities this would depend on residents’ initiative and financial means to rent a space.

Overall, the activity profile also shows a lack of outdoor activities, for example gardening lessons, which could help residents take care of the abundance of sealed backyards in the neighborhood. Apart from that, the activities do not interact on with the neighborhood environment and are non-specific to it.

The activities provided also show some disregard to the lived realities of people from working class neighborhoods, as two of the community centers are closed the entire weekend and can therefore not be considered places for leisure, and Blend and the library are only open on Saturday.

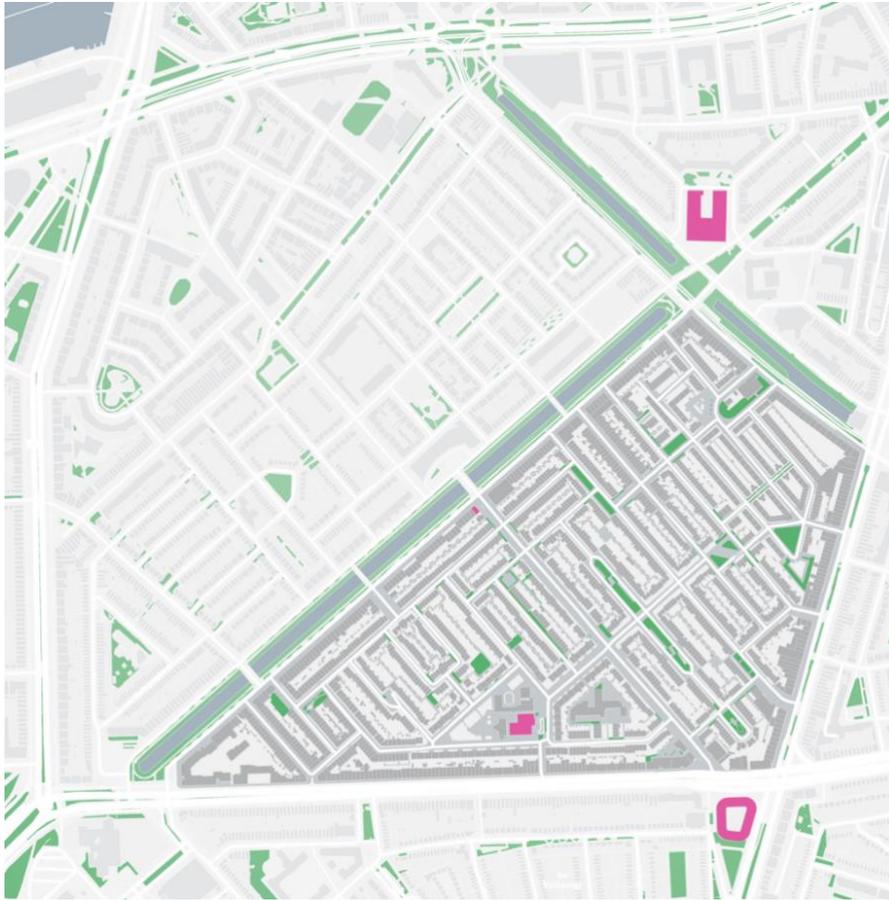


Figure.: 22. Mapping community centers. Drawing by author.

5.3.4 Observation Community Activity. Walking group.

To understand community activities for elderly related to health and wellbeing, as well as gaining more insights into the neighborhood I decided to join an activity offered by the local community center in southern Bloemhof, 'Huis van de Wijk Irene.'

On three separate occasions I accompanied the 'wandelgroep Irene'. Every week, between 10am and 11am, people from ages 28 and upwards can join the group to go for a leisurely stroll through Bloemhof and the nearby Zuiderpark between.

Over the three observed dates the group constellation changed slightly, but despite the wide range of age groups the activity was approved for, it consisted mostly of people between their fifties and seventies. Overall, there were more women. The group size fluctuated between six to nine people.

Two women were volunteers from the community center, leading the group, another woman volunteered in exchange for unemployment benefits. The other participants were a very diverse group of inhabitants from the neighborhood, with mostly migrant backgrounds.

The routes of the walk differed each time and could be adjusted accordingly to participants needs. Towards the end of the walk, some people would drop out to run errands while the others ended the walk with another cup of coffee at the Huis van de Wijk.

During my first visit we walked the farthest although always in an unhurried pace, allowing people to talk in smaller groups while they

walked and making sure nobody got left behind. Towards the end of our route, we made a five-minute break at some benches so a man with a bad leg could rest.

The second walk passed by some sports facilities (mostly for my benefit I assume, to show off some exiting qualities of the Zuiderpark) where the group encountered an unexpected obstacle: a downward slope into which a large set of stairs had been embedded to allow people to sit. A few smaller steps lead down the stairs, but despite a handrail they proved quite difficult for the group to overcome. Nearly everyone needed a hand.

A second elderly man had joined our group and he and the man with the bad leg walked ahead for some time in silence, seemingly enjoying each other's company. Later, we took a small break for the man's bad leg, but this time he sat down way shorter, maybe a bit embarrassed by letting the other man see his weakness.

The last walk took place shortly after new year's. We were a very small group this time, probably due to it being right after the holidays. The walk was brief this time, one of the participants had an upcoming knee operation and couldn't make the entire walk so we accompanied her back to the community center.

Conclusion

For the residents, the activity was not only an opportunity to move their bodies but also to socialize and alleviate loneliness, thus lowering sensitivity to heat. This is also done by interaction with nature and through it improving mental health. The casualness of the activity let people adjust the overall length of the activity to their needs.

The walking group facilitates looking out for each other, noticing each other's pace, hurts and obstacles, cultivating. An important exercise for awareness towards other people's frailty.

The activity also offers routine, every Monday, even during bad weather and it possible also to simply enjoy nature and socialize only passively. Unfortunately, the timing of the activity during the week and during working hours did not allow for children or working adults to join.

While the men were in a low number, other activities at the Huis van de Wijk had even less male participants, suggesting that there may be a genderedness to the offered activities that makes it harder for older men to stay social.



Figure.: 23. Documenting inclusive community activity. Pictures by author.

5.3.5 Community building.

Together with colleagues I had the opportunity to talk to community builders Karen Welp and Sander van der Ham. Both have years of experience with fostering community initiatives, for example the organization “buurtklimaatje”, whose goal is to help citizens prepare their neighborhood for the extremer weather of climate change through urban greening. Karen and Sander’s latest project is the circular workspace “Gouwe K(l)ouwe in Carnisse, which functions as a community meeting space, repair café and social incubator for projects dedicated to improving the livability of Rotterdam South.

The workplace sits in a small corner storefront, big windows display a cozy room with a big table lots of chairs with an amount of clutter that makes the place seem lived in. I noticed the place during an earlier site visit and the inviting atmosphere of the place emboldened me to step in and have a chat with someone working there.

Reaching out to people and what can make a place of gathering accessible

The working space opens its doors for workshops at least once a week, more would be preferable but cannot be done now because there is not enough staff. But the place is generally open anytime someone is in the office, you can always step in for a coffee.

You need to be available, and you need to invite people.

The threshold needs to be low, if the group is out on the street working on something, this can start a conversation. There need to be different methods of approach, some people you can invite with flyers, with others, only a “people to people” approach works.

Workshops are another possibility for outreach. A pizza workshop, for example, gives you at least two hours before the meal where you can talk about things.

If possible, workshops are free or only cost a small fee. Money changes the relationship between community and community builders.

Laying groundwork for community initiative

A lot of community gathering spaces are provided by welfare providers with an assignment by the municipality, this limits the activities and opportunities they can provide for communities. Activities that are organized by the communities themselves tend to become rituals and traditions in their neighborhoods.

These activities can give people a feeling of agency in their neighborhood, which contributes to their sense of belonging and communal ties.

Things to be considered: laying groundwork for initiative takes time, the “Gouwe (kl)ouwe” has been there for a year and still too little people know it, only now did the first residents start making workshops of their own.

It requires trust, Sander and Karen give out keys to communities who want to join the workspace.

The approach cannot be general, people’s talents, preferences and social connections need to be considered.

Designing community spaces

In the beginning, before you start organizing a space, you want to facilitate connection between people. This comes before providing/choosing/designing a meeting place. During activities,

people can get to know each other slowly and once they’ve met, they might ask for a place to meet regularly, like street furniture.

These kinds of places can also facilitate incidental meetings:

It helps when you have a bench.

Once a connection has been established and the need for a space has been expressed, the place can be tailored to the individual needs of the community. It is important to not lose this as the focal point.

When you zoom out too much you tend to make things less approachable because you lose contact with the specificity of the people and neighborhoods.

The place becomes functional when the designing of space goes hand in hand with the building of community, one is not effective without the other.

A place that facilitates meetings must carefully balance openness, lowering the threshold to enter, and intimacy that makes a place comfortable.

Conclusion:

The advice Karen and Sander gave for successful community building tackled how to attract people, what types of activities to offer and how community spaces work spatially.

Although certain built aspects like outdoor furniture for spontaneous meetings and facades/exterior spaces that balance invitation and intimacy were helpful, it became clear that soft factors were more important as a starting point. To reach different people, there needed to be a structured, but accessible approach like free workshops, but also on-street casual interaction with a low threshold.

And lastly, activities were more effective in bonding communities when they were tailored to the neighborhood. If they were organized

by the communities themselves instead of top-down by the municipality, these activities could provide a sense of agency and belonging.

5.3.6 Conclusion community

To encourage an active community life that will function as a safety net for the elderly during heat waves, there need to be soft and hard factors in place: While Klinenberg (2015) emphasizes the general importance of the built environment for social infrastructure, the interview with the community builders showed in more detail how such a ***space needs to be designed: welcoming, but also providing intimacy.***

Beyond this, a community center should also provide **rent-free space for activities self-organised** by the community.

The analysis of the currently provided activities at community centers, the interview with the community builders and the WHO guidelines have shown that Bloemhof has a need for activities that are:

- ***Easy to join*** (e.g. outdoors activities, community gardening)
- ***Specific to the neighborhood and its community*** (e.g. “living library”, self-organized activities)
- ***Intergenerational activities*** (skill sharing/repair café, multigenerational family days, “loan a grandparent”)

Additionally, a community center should provide the ***opportunity for volunteering***, the WHO guidelines recognize (paid) volunteering as

an important means to keep elderly people active and engaged in their community after their retirement.

Lastly, ***opening times should include weekends***, to accommodate all members of the community.

6. Conclusion: guidelines for the resilient, age-friendly neighborhood

Based on the initial research question “*How can “age-friendly” climates be sustainably achieved in challenging environments?*” the goal of the research was to investigate strategies for heatwave resilience in the built environment outside of those that focused solely on exposure. The envisioned product of the research would be guidelines to inform the function and form for community buildings that could serve their communities as part of heat resiliency strategies. On a neighborhood scale the research investigated the integration of cool infrastructure in an age-friendly way.

In the literature-based, secondary research the question of mitigation of heat-related vulnerability was analyzed.

Currently, most common solution to this is reducing exposure, so the amount of contact humans have with heat. This can be done by reducing the UHI in the built environment, outdoor cooling through blue and green infrastructure, shading and ventilation through building forms and changing materiality to more permeable or reflective materials. Indoor cooling can be achieved mechanically or passively, although the former may create energy problems. There are two other parameters of vulnerability that can be adjusted: sensitivity and adaptive capacity.

Adaptive capacity is heightened if there is awareness and clear communication about the dangers of heatwaves so people can

prepare accordingly, as well as providing public cool outdoor and indoor spaces (cooling centers) that people can move to if their own surroundings get too hot.

Sensitivity can be addressed by adjusting services and environments so that they promote elderly people’s health, enable autonomous mobility as far as possible, alleviate loneliness and strengthen community ties as a safety net for elderly residents during heatwaves.

These findings led to an additional selection of relevant chapter from the age-friendly city guidelines: Next to the initial “outdoor space and buildings,” “community and health services,” “transportation,” “social participation, respect and social inclusion,” and “civic participation and employment” became important research parameters for fieldwork and observations in Bloemhof.

The first part of the primary research did an inventory on the current problems of Bloemhof in relation to heat. This was done mostly by mapping and analysis, as it was winter during the time of research.

The neighborhood suffers from very high exposure to heat, the typology doesn’t shade well, there are rarely trees, there is soil-sealing even in the front and backyards and cars parked everywhere are an additional source of heat. The zoning of the street profile often forces people to walk out in the middle of the road in the sun.

The high exposure is an issue, as many people in the neighborhood perceive their health as poor and the area has a

lot of children who are also more vulnerable to heat. Furthermore, air-conditioning at home is often not an option due to the energy costs. Finally, there is a lack of awareness for already available climatized places like the nearby Feijenoord library.

Following this, the infrastructure of Bloemhof was analyzed, to see whether it enabled or hindered elderly people from interacting with their community, as social interaction and mobility had both been identified as important protective factors.

While Bloemhof has great official and unofficial support systems, sadly most people with mobility issues are utterly dependent on them as the (pedestrian) infrastructure is inadequate. Everyday use facilities are decentralized, pushing people towards car use or delivery services, leading them to leave the house less often. The design of the neighborhood and buildings is not inclusive; there is a lack of shaded resting places and public toilets. The high amount of car traffic in the narrow streets causes trouble and adds to the feeling of perceived unsafety in the neighborhood.

After determining the state of mobility infrastructure, the “social infrastructure” in Bloemhof was considered

While there is a strong presence of municipal support and welfare and the community is close and supportive within streets, there is comparatively little self-organized activities that could help elderly people stay more active and connected with

people of different generations. Activities offered at the community centers often separate age groups, family events are only targeted towards parents and their children and apart from the library, no activities take place during the weekends. There are also not many outdoor activities that engage with the neighborhoods themselves. This keeps elderly people as outside groups and at home, allowing them to disconnect from community.

The outcomes of the four chapters were translated into the following guidelines:

		Literature/ guidelines	Observation	Mapping/ Analysis	Interview
Policy	temperature threshold of 25°C indoors V	X			
	Classifying regional heatwaves V	X			
	Start of heat protection remodelling now V	X			
	Cool public indoor space in walking distance V H	X		X	X
Neighborhood	Complementary sensitivity and adaptive capacity strategies V	X			
	„Cool streets“ network VH	X		X	
	Parking garages HM	X	X		X
	Site next to open space for outdoor area and maximum PET impact H			X	
	Materiality/width sidewalks M	X	X	X	
Reorganising street canyon HM	X		X		
Program/activities	Wijktaunmannen for desealing H		X	X	
	Space for overnight guests H	X			
	Space for community-organised activities C		X		X

		Literature/ guidelines	Observation	Mapping/ Analysis	Interview
	Volunteering opportunities C	X			X
	Weekend opening times C		X		
	Central Hub of everyday functions M	X		X	
	Gardens integrated into building M				X
	Low threshold activities C				X
	Community-specific activities C				X
	Intergenerational activities C	X			
	Social and community engagement functions V	X			
Building design	Low tech building V	X			
	Cool public indoor space H	X		X	X
	Cool public outdoor space VH	X		X	X
	Visually "cool" H		X		
	Welcoming but intimate design C				X
	Resting places, benches M	X		X	X
	Accessible building M	X	X		
Accessible toilets M	X	X	X		
	V = Vulnerability	H = Heat	M = Mobility	C = Community	

Figure.: 24. Resilient and age-friendly guidelines. Graphic by author.

The guidelines work on different scales of the neighborhood and would typically inform different planners. The research of this project has shown building social resilience and adaptive capacity against is key when working in environments that are more challenging to cool, and that cooled community centers can be the corner stone of the resilient age-friendly neighborhood.

Considering these results, I would like to propose a definition for these places that bring together the different aspects needed to combat heat vulnerability: ‘Social cooling centers’ (SCC). The idea of an SCC at its core would be a cooled building with cool adjacent outdoor space. Accessibility is a must, in terms of reachability but also age-inclusive design within the building. A cluster with everyday use functions would ensure that people are already familiar with a place before they need to seek shelter.

Opening times should help fostering routines. Activities offered should appeal to people of all generations. Space should be left for the community hold their own events.

In the case of age-friendly climates in challenging contexts, a multi-strategy approach that targets all sides of vulnerability has been identified by this research to be the most promising.

By choosing a diverse tactic, the problem of urban heat can be addressed in a holistic way, generating an environment that is not only cooler but enriches lives of people of all ages.

7. Reflection

What is the relation between your graduation project topic, your master track (Architecture), and your master programme (MSc AUBS)?

The Resilient Rotterdam Graduation Studio conducts research on the built environment and its impact on the health and well-being of urban dwellers in Rotterdam South. This thesis recognizes social activity as a protective factor against heat-related morbidity and mortality for elderly residents in Bloemhof.

It relates to the master track of architecture by emphasizing community centers as facilitators of community ties and social participation. The

objective is to build resilience against heat. In the later design phase, the building as a cooling machine is explored.

The thesis addresses the master program in recognizing the crucial part of the built environment in creating heat resiliency and age-friendly neighborhoods.

How did your research influence your design/recommendations, and how did the design/recommendations influence your research?

Overall, I enjoyed making design decisions based on more detailed, in-depth data. In turn, it was interesting to see how the locality and people I interacted with influenced the tone of the research conversation. This happened on several occasions during the process:

After the choice of location, it was clear that the neighborhood of Bloemhof was an area where conventional methods of cooling—such as planting trees—were difficult to implement because of spatial reasons. This resulted in research on vulnerability that focused on reducing sensitivity to heat instead of reducing exposure, a more traditional approach in studies of the built environment.

Early in the research, I discovered that the hottest area in the neighborhood was a public square with greenery. One of the few green spaces in the neighborhood, being a heat hazard for the elderly and other sensitive groups, pushed the design towards incorporating outdoor space and nature.

My walks around other neighborhoods also gave me a good picture of Bloemhof's overall characteristics compared to other parts of the south. After my interview with community builders Karen and Sande, I felt that many neighborhoods could profit from community building and self-organization, so I integrated them into my design/program to increase social activity.

Lastly, after making the decision to focus on the high emissions' dry scenario in research, the design mission became one of making the building a "cooling machine" to ensure safety during heatwaves.

How do you assess the value of your way of working (your approach, your used methods, used methodology)?

The human-centered approach of Veldacademie focuses on user perspectives. This narrative not only helped me to identify the specific fields of research (heat sensitivity, resiliency through communities) but also the theoretical framework, the WHO guidelines for age-friendly cities, which was immensely helpful by giving me a clear idea of the practicalities of age-friendliness. My literary research exposed me to different disciplines, which was at times intimidating but ultimately the best way to deal with all the implications of climate change and heat waves and their impact on the elderly. Through my lecture on Klineberg's "Heatwave "and "Palaces for the People ", I gained a sociologist perspective, which strengthened the human-centric approach and guided me towards observation as one of my main methods of research in both the community and mobility part of my research. This was a big step, as I knew I could not implement sociological observations for the heat environment section of the research, due to the research taking place in winter. I also found the longer interviews with people involved in community work and local knowledge through living there quite helpful. I could generate far more than would have been possible with a literature study alone. These softer factors, like resident perspectives, meeting more hard factors like canyon studies, generated a productive form of work.

How do you assess the academic and societal value, scope, and implication of your graduation

project, including ethical aspects?

Larger social, professional and scientific framework.

Professional relevance:

The research could serve as a reference for urban planning policies regarding heatwaves and climate adaptation, and establish the importance of community centers as social cooling centers as well as keystones for reducing heat sensitivity and exposure in neighborhoods that are socially and economically deprived.

Social relevance:

The proposed program and design aim to offer physical protection from heat to the vulnerable group of the elderly in Bloemhof, foster social interaction and community engagement among elderly people to reduce factors for heat sensitivity as well as spreading awareness about how to improve microclimates around your home and how to act during heatwaves.

Scientific relevance:

As all projects in the Resilient Rotterdam graduation studio, the project makes a case for research-driven design, the discussed vulnerability of the elderly and the physical environment of Bloemhof inform the program and design decisions.

There is also a lack of research from an architectural perspective on the importance of public buildings for climate adaptation on a neighborhood level.

From a technical standpoint, the design looks at buildings that use thermal mass principle and nighttime ventilation, such as 2226 by Baumschlager Eberle Architekten, and discusses suitability for heatwaves.

Societal relevance and ethical aspects:

The rise of global temperature is a large-scale problem that will affect most societies on Earth in the next decades. Simultaneously, many developed countries are experiencing over-aging of their populations, making them more vulnerable to higher temperatures. While it is possible for some societies to adjust to this by providing individual cooling solutions for every elderly person, it is much more likely that in the face of power or emergency care shortages, public buildings will have to step up in terms of the resources they provide. Cooling and community are valuable resources, and we must invest in them now if we want to ensure that they are available to all and distributed fairly in the future.

How do you assess the value of the transferability of your project results?

While the outcome and research areas seem highly specific to the analyzed neighborhoods, the methods themselves were less specific and could be transferred.

They can work as a step-by-step approach for more challenging environments with little green, little shading, and a high amount of soil sealing.

When focusing purely on the generated results, the importance of age-inclusive, intergenerational activities for mitigating heat sensitivity of elderly is certainly very relevant and transferrable.

Further, the research makes a case for public buildings as cooling centers during heatwaves. While this would be necessary today for neighborhoods with poor physical cooling properties, the projected rising temperatures make it advisable for any neighborhood to have cooling social infrastructure to help its residents face the next decades.

Finally, the design phase will be working towards the feasibility of low-tech buildings in a high emissions dry scenario with warmer nights, making it a typology study of sorts and thus highly transferrable.

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APPENDIX

Kerncijfers KNMI '23

De Bilt

Seizoen	Waarde	Indicator	4 time periodes 1991-2020	2016-18		
Waardevolde temperatuur (gingen oplichteren 1991-2020)				1,3°C		
Waardevolde temperatuur (gingen oplichteren 1850-1990)				2,8°C		
Zaai	Temperatuur	gemiddelde	10,1°C	+1,8°C		
		gemiddeld dagmaximum	16,6°C	+1,3°C		
		gemiddeld dagminimum	4,3°C	+1,8°C		
		koelste dagen per jaar	-5,7°C	+1,7°C		
		warmste dag per jaar	25,3°C	+5,0°C		
		aantal warme dagen (min temp > 20 °C)	53 dagen	+32 dagen		
		aantal zomerse dagen (max temp > 25 °C)	28 dagen	+24 dagen		
		aantal tropische dagen (min temp > 30 °C)	5,8 dagen	+8,7 dagen		
		aantal dagen met max. temp. > 35 °C	6,2 dagen	+1,4 dagen		
		aantal dagen met max. temp. > 40 °C	6,8 dagen	9,0 dagen		
		aantal tropische nachten (min temp > 20 °C)	6,3 dagen	+5,3 dagen		
		aantal vorstdagen (min temp < 0 °C)	53 dagen	-20 dagen		
		aantal ijedagen (max temp < 0 °C)	6,4 dagen	-3,3 dagen		
		Neerslag	Max	gemiddelde hoeveelheid	855 mm	-5%
				aantal uren met dichtsinder dan 1 km	258 uur	+1%
aantal uren met dichtsinder dan 200 m	72 uur			+2%		
Winter	Temperatuur	gemiddelde windsnelheid	1,3 m/s	9,0 m/s		
		gemiddelde	3,9°C	+1,1°C		
		gemiddeld dagmaximum	6,6°C	+1,0°C		
		gemiddeld dagminimum	1,0°C	+1,2°C		
		koelste winterdag per jaar	-5,8°C	+1,8°C		
		zachtere winterdag per jaar	11,6°C	+8,8°C		
		Neerslag	Max	gemiddelde hoeveelheid	218 mm	9%
				aantal dagen > 10 mm	6,1 dagen	+0,2 dagen
		Wind	Max	aantal uren met dichtsinder dan 1 km	96 uur	+1%
				aantal uren met dichtsinder dan 200 m	23 uur	+1%
		Wind	Wind	gemiddelde windsnelheid	4,1 m/s	-6,1 m/s
				gemiddelde	6,9°C	+1,2°C
		Lente	Temperatuur	gemiddelde	16,6°C	+1,2°C
				gemiddeld dagmaximum	19,6°C	+1,3°C
				gemiddeld dagminimum	1,0°C	+1,3°C
koelste lente dag per jaar	1,2°C			+1,7°C		
warmste lente dag per jaar	19,8°C			+1,9°C		

FIG. A

Zomer	Neerslag	gemiddelde hoeveelheid	158 mm	-3%
	Grootte	maximaal neerslagbeant april en mei	79 mm	+18%
	Mist	aantal uren met \geq dits minder dan 1 km	25 uur	-1%
		aantal uren met \geq dits minder dan 200 m	11 uur	-1%
	Wind	gemiddelde windsnelheid	3,4 m/s	0,0 m/s
	Temperatuur	gemiddelde	13,4°C	+2,1°C
		gemiddeld dagmaximum	22,3°C	+2,2°C
		gemiddeld dagminimum	12,1°C	+2,3°C
		hoogste herftedag per jaar	13,3°C	+1,0°C
		laagste zomerdag per jaar	25,5°C	-3,0°C
Herfst	Neerslag	gemiddelde hoeveelheid	238 mm	-15%
		aantal dagen \geq 23 mm	2,0 dagen	-0,5 dagen
	Grootte	maximaal neerslagbeant april t/m september	166 mm	+43%
	Mist	aantal uren met \geq dits minder dan 1 km	36 uur	-1%
		aantal uren met \geq dits minder dan 200 m	8 uur	0%
	Wind	gemiddelde windsnelheid	3,0 m/s	-0,1 m/s
	Temperatuur	gemiddelde	10,8°C	+1,8°C
		gemiddeld dagmaximum	14,2°C	+1,8°C
		gemiddeld dagminimum	7,0°C	+2,0°C
		hoogste herftedag per jaar	1,0°C	+1,2°C
laagste herftedag per jaar		19,2°C	+2,2°C	
Neerslag	gemiddelde hoeveelheid	229 mm	-2%	
Mist	aantal uren met \geq dits minder dan 1 km	52 uur	-5%	
	aantal uren met \geq dits minder dan 200 m	26 uur	-5%	
Wind	gemiddelde windsnelheid	3,1 m/s	-0,1 m/s	

Deze tabel

De getallen voor de gregegedeneenheid van het gemiddelde over 1963-2014.

De relatieve verandering in de procentpunten (hoorbaar: AP% in de referentie, met 75 ed) wordt 07%.

De hoeveelheid neerslag in de referentieperiode is een hoeveelheid dagen (met een per jaar) en is water voorland. Het is het aantal dagen met een neerslag van \geq 0,1 mm, opdat er is een gemiddelde hoeveelheid.

De waarde op een andere methode en is de referentieperiode van de berekening. Het is de hoeveelheid dagen met een neerslag van \geq 0,1 mm, opdat er is een gemiddelde hoeveelheid.

FIG. B

Table 5.1 Examples of estimated minimal risk temperature for heat-related health effects and maximum acceptable temperature

City/country	Indoor minimal risk temperature for heat-related health effects	Indoor maximum acceptable temperature
Boston (United States of America)	21–22 °C	25 °C
New York (United States of America)	22–24 °C	27–28 °C
London/Manchester (United Kingdom)	22–23 °C	~25 °C
Harbin (China)	~24 °C	26 °C
Republic of Korea	~25–26 °C	~29–30 °C
Thailand	~30 °C	~32 °C

From: 5. High indoor temperatures



WHO Housing and Health Guidelines.
Geneva: World Health Organization; 2018.

© World Health Organization 2018.

FIG. C



FIG. D

The activities provided are:

Community building:

- casual hangout with coffee
- integration through dutch language classes
- children's activities
- mental health
- neighborhood walk
- daily soup
- financial support program

(Archief Agenda, n.d.)

Library:

- Digital competence
- Children's reading
- Language café
- Access to books and a study place

(Agenda - De Bibliotheek Rotterdam, n.d.)

Café:

- Worship
- Music
- Café
- Community dinner
- Board games
- Open for neighborhood activities

(Blend Bloemhof - Welkom op de website van onze huiskamer!, n.d.)

Community building Hilleliet (Hillesluis):

- Dance
- Art
- Coaching
- Workspace for social Entrepreneurs
- Food/cooking
- Library
- Rooms for events

(Hillelieters / De Hilleliet, n.d.)