URBAN STRESS

Marijke Koene

Image 1 (cover page): London skyline (by author, based on Shutterstock, n.d.)

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Research into the reduction of
urban stress through urban design

COLOPHON

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TU Delft

Urbanism

PREFACE

This report is a graduation thesis about the topic Urban Stress. The graduation project is part of the master Urbanism at the faculty of Architecture and the Built Environment at the TU Delft. The project is guided by Maurice Harteveld, from the chair of Urban Design and Remon Rooij, from the chair of Spatial Planning and Strategy.

READING GUIDE

This report is built up in 5 parts:

Part 01 - introducing urban stress
Part 02 - project approach
Part 03 - stress reduction
Part 04 - design
Part 05 - conclusion and reflection

Part 01 introduces the topic of urban stress by exploring stress, urban stress and urban stressors. Part 02 describes the project approach, presenting the research questions and the used methods for this thesis. Part 03 finds and generates knowledge towards reducing stress in the public space through urban design. Part 04 introduces the project location and shows how the theory can be implemented in urban designs. Finally, in part 05, conclusions are drawn and both a reflection and recommendations are given.

The exploration of urban stress is already done before part 02, because the information is a good introduction into the topic in general. The project location is introduced only in part 04, because this thesis started from a topic instead of a location. The location is therefore merely a testing area and not crucial to understand the theoretical part of this thesis.

All the images and pictures are taken or made by the author, unless stated otherwise.

SUMMARY

Stress is a well-known phenomenon and something everyone experiences. Urban stress however, stress caused by and in the built environment of urban areas, is less known. Still, quite some research has been done on this topic from the fields of sociology and psychology, but there are not many resources that focus on urban stress - with all its stressors - in general, and the relation between urban stress and urban design is also still thin. Therefore, this thesis focusses on getting a better overview of urban stressors, their relation to the public space and how urban stress can be reduced through urban design. This is mainly done by literature research and design, and the interaction between them, but is also supported by interviews, site analysis, data review and testing.

Stress can be reduced using a direct approach or an indirect approach. The direct approach focusses directly on the stressor, while the indirect approach tries to decrease the negative effect of the stressor, or of the stress itself. The indirect approach can be divided into three sub-approaches: perceived control, pro-social places and restorative environments. Perceived control is important because people experience less stress if they feel like they are in control of their environment. Pro-social places, or social support, is one of the ways to cope with stress. Restoration is recovering from stress and might therefore be the most important indirect approach.

It turns out that the scale of the public space within the scale of the project area of this thesis is very suited for the indirect approaches. An urban design is made for four different locations in Caledonian, London, using these indirect approaches.

It seems as if the direct approach is more suited for a larger scale, this could be interesting for future research.

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PART 01

PART 01
INTRODUCING URBAN STRESS

Part 01 is an introduction of this thesis, as well as an exploration of urban stress and urban stressors. It is explained why this topic was chosen, the definition of stress and urban stress is given and a collection of urban stressors is made of which a few are selected to address in this thesis.

PART 01

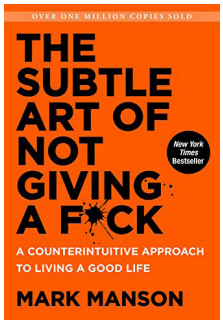
1. MOTIVATION FOR THE STUDY

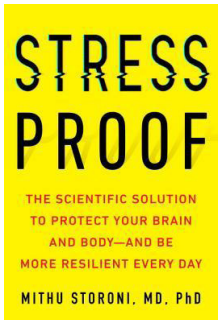
The idea for a graduation project about stress originated from a personal motivation. I am very sensitive to stress and I know that too much stress can have a negative effect on our health. Because of my interest in the topic of stress in general, I found out that a lot of people, especially nowadays, are also struggling with large amounts of stress. It is therefore not strange that we can find many books, newspaper articles, magazines, workshops and other things dedicated to this subject everywhere. And not only because stress and its consequences are very disturbing, but also because the mental diseases caused by it are a serious problem. Because of all this, I realised that stress is not only a subject that is interesting for me, but is also something that is relevant for many others.

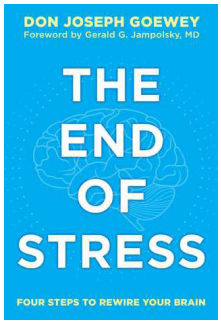
For that reason, I was wondering if there were things that can be changed so people would feel less stressed throughout the day. Because I am an urban design and urban planning student, that is where I started. It might seem as if stress is a subject more related to psychology or sociology, but I was, and still am, convinced that also from the field of urbanism a positive contribution can be made to the reduction of stress. Because I am very interested in large cities and I could imagine that a lot of stress is experienced there, the topic went from stress to urban stress. This also translates nicely to the field of urban design. After a quick exploration of this topic, I found out that quite a lot has been written about it in literature, which confirmed my earlier conviction. In these resources, the relation between stress and the environment and between stress and cities are discussed among other things, which made me confident enough to build a graduation project around the topic of stress from the field of urbanism. I hope that this project can contribute in any way to creating a less stressful world.

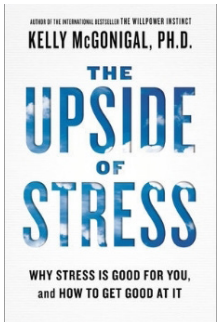
ATTENTION TO STRESS

RELEVANCE IN SOCIETY



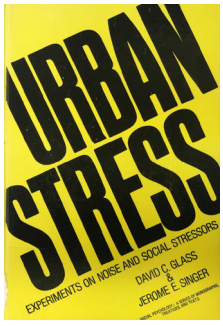


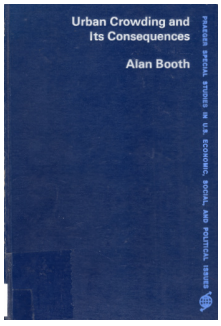


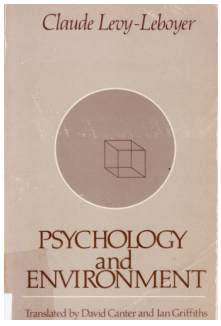


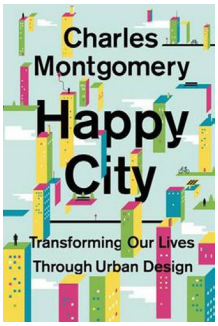
Britain in the grip of a stress epidemic because of 'always on' culture, survey finds

URBANISM RELATED









Does City Life Pose a Risk to Mental Health?

Recent studies shed light on the link between urban living and psychosis

Sick cities: why urban living can be bad for your mental health

Is our headlong rush to live in cities bound to increase incidences of stress and other mental disorders?

Image 2: Collage showing the relevancy of urban stress in society (Francis, 2018; Kwon, 2016; unknown, 2017; Benedictus, 2014).

2. WHAT IS STRESS?

Currently, more than half of the world's population lives in cities. It is expected that in 2050, 66% of the world is urbanised (United Nations, 2005). Although urbanization and living in the city comes with many advantages, they "do not always compensate for the disadvantages" (Levy-Leboyer, 1982). One of the disadvantages of city living is urban stress. To be able to get a proper understanding of urban stress, it is first of all important to have a general understanding of stress. This chapter therefore briefly explains what stress is.

In this project, the word stress is used by its meaning of 'worry' (Cambridge Dictionary), to describe a mental state. However, according to the Cambridge Dictionary, there are three more definitions of stress: pronunciation, force and emphasis. Especially the definition of stress as a force is very important, also in other fields. This definition of stress has a long history and is related to stress in its meaning of worry. Lazarus (1993) has written about this:

The word stress already originates from the 14th century. In the 17th century however, the physicist Hooke used the term stress to describe an area of a built structure on which a certain load impinged. Even though this is a concept strongly related to physics, it has later influenced models of stress in physiology, psychology and sociology. There, stress was understood as an external load or demand on a biological, social or psychological system.
During World War II, it became clear that the stress of combat was comparable to feelings caused by ordinary life-events. This resulted in a "growing interest in stress as a cause of human distress and dysfunction" (Lazarus, 1993, p.2).

By now, human distress and dysfunction caused by stress is well-known. In some headlines (Fink, 2016), stress is even referred to as the disease of the 21st century. So what is stress, and what does it do to us?
From a medical point of view, stress can be described as a reaction from the body to a potentially dangerous situation. The blood pressure in the body rises and hormones such as cortisol and adrenaline are released. This is not necessarily a problem, it actually prepares us to 'fight and flight' and therefore helps us to focus and deal with complex or dangerous situations (Abbot, 2012). The

problem arises when the stress lasts longer or becomes chronic. It then raises the risk of mental and physical diseases and can even lead to sudden death (Abbot, 2012; Krantz, Thorn & Kiecolt-Glaser, 2013). Figure 1 shows the relation between health and stress. It illustrates that to some extent stress can be healthy, but when there is too much stress or for too long, then it starts to be a problem.

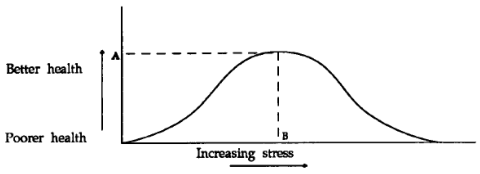


Figure 1: Relation between stress and health (Burton, 1990, p. 84)

This is basically how we see mental stress today, as a negative impact on our human body, which influences how we feel and hinders us in what we do. So stress causes mental discomfort or even diseases, but it also affects our physical well-being in many ways:

- Stress makes our muscles tense up. Over a longer period of time, this can "trigger other reactions of the body and even promote stress-related disorders" (American Psychological Association[1], n.d.).
- Stress makes us breathe harder and/or faster. This can result in hyperventilation and panic attacks and is harmful for people with lung conditions.
- When the body is stressed, stress hormones are released: epinephrine (adrenaline) and cortisol.
- Cortisol and epinephrine make the liver produce more glucose. This blood sugar gives us the energy to 'fight or flight', something the body prepares for when stressed, because the stress could be the result of a dangerous situation. So for most people the extra glucose is not a problem or even a good thing, but for some people it could result in or worsen diabetes.
- Adrenaline and cortisol influence the heart, increasing the heart rate and making the heart muscle contract more strongly. Again, this is part of the 'fight or flight' response, controlled by the nervous system. Stress of long duration can "increase the risk for hypertension, heart attack or stroke" (American Psychological Association[1], n.d.). Moreover, cholesterol levels can be affected.
- Stress can have influence on what we eat, it can give us a sensitive stomach and affect our digestion.
- Chronic stress and a continuous activation of the nervous system can have a negative effect on the male and female reproductive system.

(American Psychological Association[1], n.d.)

Some of the reactions of the body happen immediately when experiencing stress and others are a result of stress over a prolonged period of time. There are three types of stress, based on quantity and duration:

- Acute stress: this is the most common type. It is of short duration and is caused by events in the recent past or near future. Acute stress can be thrilling, but to much stress is exhausting.
- Episodic acute stress: when one experiences acute stress frequently, it is called episodic acute stress. A second form of episodic acute stress is when people see danger in everything and everywhere. The symptoms of this type of stress are those of extended overarousal and this can already take months to treat.
- Chronic stress: chronic stress can come from an apparent unsolvable bad situation or from traumatic childhood experiences. Chronic stress has a destroying power and can even be lethal through "suicide, violence, heart attack, stroke and, perhaps, even cancer" (American Psychological Association², n.d.).

(American Psychological Association², n.d.)
In general, it can be said that acute stress is often a normal coping process and that the problem lies with chronic stress and its consequences (Hansmann, Hug & Seeland, 2007).

Looking at what has just been described, it might not be easy to understand what stress does to our body, but at least it is known. The reasons for stress however, are much more difficult to discover. According to Lamb, stressors are generally physical or psychological.

"Physical stressors involve the anticipation of or confrontation with a situation that is characterized by physical harm, danger, pain, or discomfort. Psychological stressors involve the anticipation of or confrontation with situations that are potential threats to selfesteem and that often involve fear of failure or personal evaluation" (Lamb, 1979, p. 52).

In both cases, but especially in the last one, these stressors mean something different for everyone. Everyone has a different view on what might me a physical or psychological threat and therefore the amount of possible stressors is endless. Because the topic of stress in this thesis is investigated from an urban design perspective, stressors that are related to spatial environments are considered first and foremost. The next chapters are therefore dedicated to urban stress and urban stressors.

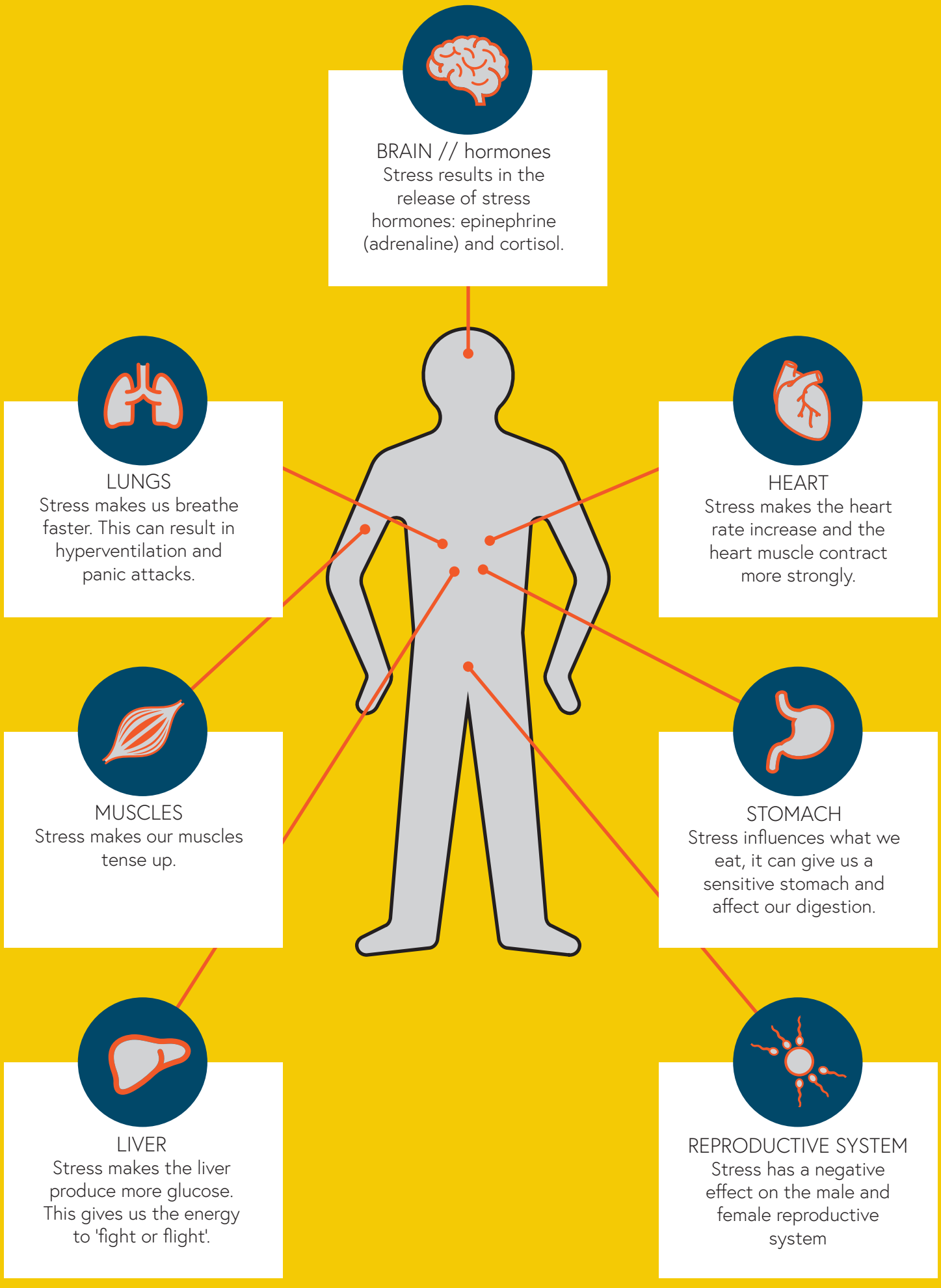


Figure 2: Impact of stress on human body (by author, based on American Psychological Association[1], n.d. & American Psychological Association[2], n.d.)

3. WHAT IS URBAN STRESS?

In the last years, research has shown that human stress levels are higher in cities. It has been shown by a group of researchers, led by dr. Meyer-Lindenberg, that people who live in cities, are less capable of dealing with stress than people who live in the countryside (Benedictus, 2014). Also, city living is associated with a more stressful and demanding social environment, which increases the risk of mental illness (Lederbogen et al., 2011). Moreover, those mental illnesses are found more often in cities. The risk of anxiety and mood disorders is raised by urban living with respectively 21% and 39% (Benedictus, 2014; Lederbogen et al., 2011).

The problem described above is dependent on many different factors. One of those factors is the influence of urban stressors. Unfortunately, it is impossible to say how big the share of urban stress is in comparison to other causes for stress. One of the obvious reasons for this is that everyone is sensitive to other stressors and that the distribution in general is very difficult to make. Another explanation is that the stress caused by the urban environment is too unknown, both with the population and with many researchers unrelated to this field. The image on the next page shows for example how significant a group of respondents find a particular stressor (research by the American Psychological Association[3], n.d.). Urban stress is not mentioned here. It is possible that this is because people do not find it significant, but it could also be because urban stress is too unknown as a stressor. In order to still be able to paint a picture of urban stress in relation to other stressors, it can be seen as follows: urban stressors are actually present around all the other stressors. Work is mentioned as a significant stressor for example, but when going to or from work, one is exposed to urban stressors, which only increases his or her stress levels even more. This is also true for many of the other well-known everyday stressors.

Apart from knowing how urban stress relates to stress in general, it is also necessary to understand the definition of urban stress in order to understand this thesis.
Urban stress can be explained in two ways. The first is stress on the city or the environment caused by human behaviour. Examples are a population that is growing

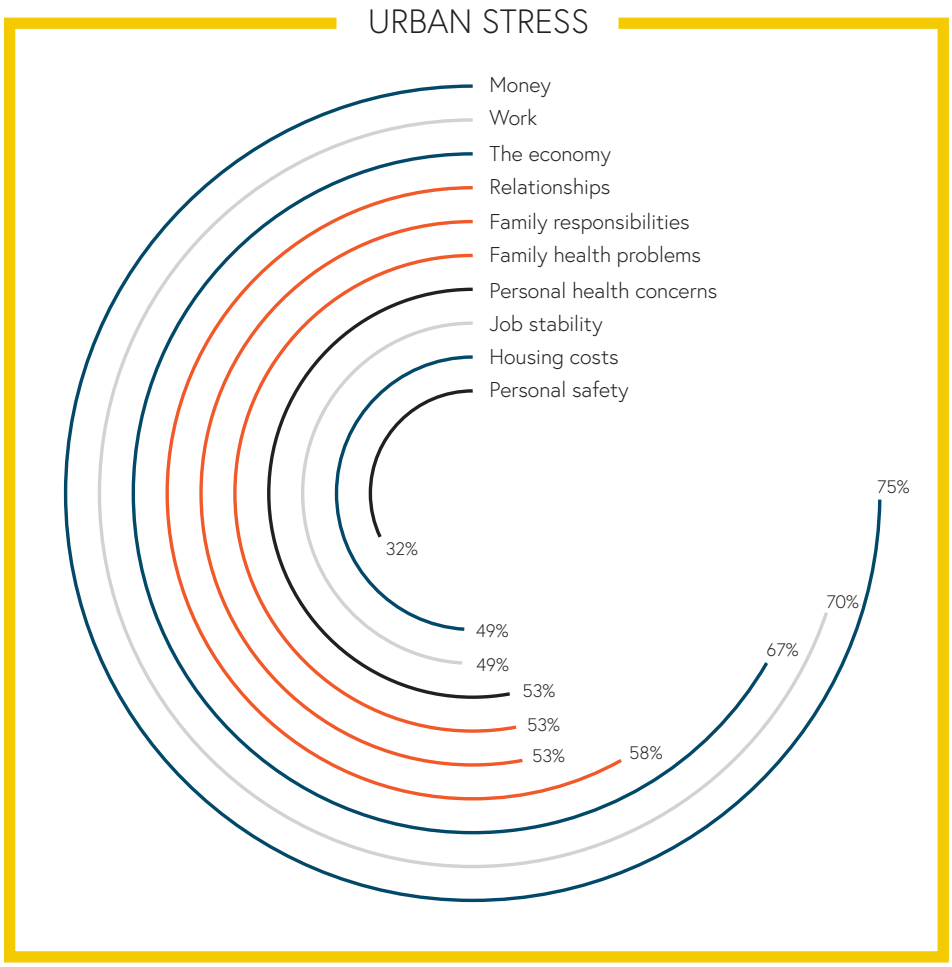


Figure 3: The role of urban stress within the topic of stress (by author, based on American Psychological Association[3], n.d.)

faster than the city can handle, or pollution of the air and soil.
This project however, is concerned about stress in humans, caused by urban environments. When reviewing literature, it is difficult to find a definition of this meaning of urban stress. It could be explained as stress that occurs when environmental stimuli exceed one's ability to cope with them, "when there is an imbalance between environmental opportunities and individuals' goals" or when someone is incapable of dealing with their environmental demands (Evans & Cohen, 1987, p. 573).
There are four types of environmental stressors: "cataclysmic events, stressful life events, daily hassles, and ambient stressors" (Evans & Cohen, 1987, p. 574; Matheson et al., 2006, p. 2605). Although all of these types can take place in urban environments, this project focusses mainly on ambient stressors. Ambient stressors are stable background conditions present in our daily activities (Evans & Cohen, 1987, p. 574; Campbell, 1983, p. 360). They are not as easily noticed as other stressors, but they are still stressful and often not easy for individuals to solve or escape.

To get an even better understanding of urban stress, it is good to look at a few examples of urban stressors. In the literature, the stressors can often be found spread out over many works from many different researchers, but to get a clear overview now, two examples are chosen where a reasonably complete set of stressors is given. The first is from Zipjet, who ranked 150 cities from least stressful to most stressful, using 17 indicators divided over 4 themes: city, pollution, finance and people (Zipjet, 2017). The second is a paper from Burton, who uses indicators in the themes environmental stressors and socio-economic, behavioural stressors (Burton, 1990). Besides that the image hopefully gives a better idea of what urban stress is, it can also be used to discover different themes within urban stress. Since many different urban stressors are going to pass by in the rest of the thesis, this is useful to keep the overview. The five themes that have been found after comparing Zipjet and Burton are urban environment stressors, stressors from urban conditions, economic urban stressors, social urban stressors and health stressors. These themes and their corresponding urban stressors are more extensively explained in chapters 4 and 5 and are important input for the rest of this project.

ZIPJET STRESSFUL CITY RANKING

CITY
- Density
- Green spaces
- Public transport
- Traffic
- Perception of security
- Sunshine hours

POLLUTION
- Air pollution
- Noise pollution
- Light pollution

FINANCE
- Unemployment
- Dept per capita
- Social security
- Family purchase power

PEOPLE
- Mental health
- Physical health
- Gender equality
- Race equality

FACTORS IN URBAN STRESS - IAN BURTON

EXPOSURE TO CHEMICALS
- SO_2
- NO_2

EXPOSURE TO PHYSICAL FACTORS
- Noise
- Radiation
- Climatic and geophysical hazards
- Architecture and urban lay-out design
- Housing conditions
- Accessibility to urban green space

EXPOSURE TO BIOLOGICAL FACTORS
- Germs
- Virus
- Microbes
- Bacteria
- Diet

TECHNOLOGICAL HAZARDS
- Accidents
- Falls

SOCIO-ECONOMIC, BEHAVIOURAL STRESSORS
- Lack of exercise
- Obesity
- Mental illness
- Sense of security
- Crime-robbery
- Unemployment
- Lack of social support networks

URBAN ENVIRONMENT

CONDITIONS

ECONOMY

SOCIAL

HEALTH

Figure 4: Themes in urban stress (by author, based on Zipjet,2017 and Burton, 1990).

4. URBAN STRESSORS

Urban stressors are elements, events or situations in the urban environment that cause stress. In chapter 3, five themes of urban stressors were already found and on the next page, a list of 42 urban stressors is given, divided according to those themes. This list is based on Zipjet (2017) and Burton (1990), just as in chapter 3. However, the list has been cross-referenced against other resources to check its validity and some other stressors have been added to complete the list.

Some of the stressors have been given a name slightly different from how they were originally mentioned. This has been done because the original name suggested something that was the opposite of a stressor. Gender inequality for example, was named "gender equality" by Zipjet (2017). However, if an urban area supports gender equality and social inclusion, there is presumably no stress from this 'stressor'. This probably means that gender equality was used in the meaning of a stress indicator instead of an actual stressor, but for the clarity of this project, these 'stressors' have been given a name that immediately indicates what the stressor is about and what the problem is of this stressor.

There are still some stressors in the list of which it can be questioned whether they are also stress indicators instead of urban stressors. An example is stressor 30. mental health. This is not a stressor unless an urban area scores bad on this topic. However, the name does not imply the opposite of the stressor, which was the case in the previous example, and therefore it is clear enough what is meant by these stressors.

LIST OF URBAN STRESSORS

Urban environment stressors

01.	Density	(Zipjet, 2017)
02.	Crowding	(Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Cohen, 1987)
03.	Boring megascapes	(Weintraub, 2015)
04.	Garbage, graffiti and disrepair	(Montgomery, 2014)
05.	Sharp architectural angles	(Montgomery, 2014)
06.	Traffic (jams)	(Levy-Leboyer, 1892; Montgomery, 2014; Zipjet, 2017)
07.	Parking problems	(Levy-Leboyer, 1982)
08.	Accessibility & availability of green	(Burton, 1990; Zipjet, 2017)
09.	High-rise	(Gifford, 2007)
10.	Public transport	(Montgomery, 2014; Zipjet, 2017)
11.	Perception of security	(Zipjet, 2017)
12.	Lay-out of architecture and urban design	(Burton, 1990)
13.	Housing conditions	(Burton, 1990)
14.	Accidents	(Burton, 1990)
15.	Falls	(Burton, 1990)

Social urban stressors

16.	Gender inequality	(Zipjet, 2017)
17.	Race inequality	(Zipjet, 2017)
18.	Sense of security	(Burton, 1990)
19.	Crime & robbery	(Burton, 1990)
20.	Lack of social support networks	(Burton, 1990)

Stressors from urban conditions

21.	Sunshine hours	(Zipjet, 2017)
22.	Air pollution	(Zipjet, 2017; Evans & Cohen, 1987)
23.	Noise pollution	(Zipjet, 2017; Evans & Cohen, 1987; Burton, 1990)
24.	Light pollution	(Zipjet, 2017)
25.	Exposure to SO2	(Burton, 1990)
26.	Exposure to NO2	(Burton, 1990)
27.	Exposure to radiation	(Burton, 1990)
28.	Climatic and geophysical hazards	(Burton, 1990)
29.	Heat	(Evans & Cohen, 1987)

Health stressors

30.	Mental health	(Zipjet, 2017; Burton, 1990)
31.	Physical health	(Zipjet, 2017)
32.	Exposure to germs	(Burton, 1990)
33.	Exposure to viruses	(Burton, 1990)
34.	Exposure to microbes	(Burton, 1990)
35.	Exposure to bacteria	(Burton, 1990)
36.	Diet	(Burton, 1990)
37.	Lack of exercise	(Burton, 1990)
38.	Obesity	(Burton, 1990)

Economic urban stressors

39.	Unemployment	(Zipjet, 2017; Burton, 1990)
40.	Debt per capita	(Zipjet, 2017)
41.	Social security	(Zipjet, 2017)
42.	Family purchase power	(Zipjet, 2017)

Even though all of these stressors are urban and all of them take place in urban environments, some of them can be more easily related to urban design than others. One of the important aims of this project is to spatialize the topic of urban stress. This means finding the spatial causes of urban stress and creating spatial design examples on how to reduce stress. More specifically, this project focusses on doing that in the public space. For this reason, and because of the available time, a selection of stressors has been made that are used in the rest of the project. This is done according to the spatial potential of the stressors and their relation to the public space, which is explained below. The selection of urban stressors is shown on the next page.

Urban environment stressors
The name of the theme urban environment stressors already shows that these stressors have a strong relation to the urban environment. Therefore most of these stressors are still part of the selection. 13. housing conditions has been removed because this stressor is about the inside housing conditions which has no relation to the public space. Stressors 14 and 15 are removed because they are too much dependent on human action.

Social urban stressors
Stressors 19. sense of security and 20. crime-robbery have been placed under stressor 11. perception of security.

Stressors from urban conditions
Urban stressors 26-30 are removed from the selection because they have too little relation to public space and because they are too dependent on other factors.

Health stressors
Mental health is not on the list anymore because that topic is already being addressed throughout the entire project. Moreover, urban stressors 33-37 are removed because they do not have (enough) relation to public space. Finally 39. obesity has been placed under 37. lack of exercise.

Economic stressors
None of the economic stressors have made the selection. Although economic problems can be very stressful, they are more related to human behaviour and urban planning & strategy than they are to the public space.

The selected urban stressors are described in more detail in the next chapter.

SELECTED URBAN STRESSORS

Urban environment stressors

01.	Density	(Zipjet, 2017)
02.	Crowding	(Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Cohen, 1987)
03.	Boring megascapes	(Weintraub, 2015)
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11.	Perception of security	(Zipjet, 2017; Burton, 1990)
12.	Lay-out of architecture and urban design	(Burton, 1990)

Social urban stressors

16.	Gender inequality	(Zipjet, 2017)
17.	Race inequality	(Zipjet, 2017)
20.	Lack of social support networks	(Burton, 1990)

Stressors from urban conditions

21.	Sunshine hours	(Zipjet, 2017)
22.	Air pollution	(Zipjet, 2017; Evans & Cohen, 1987)
23.	Noise pollution	(Zipjet, 2017; Evans & Cohen, 1987; Burton, 1990)
24.	Light pollution	(Zipjet, 2017)

Health stressors

31.	Physical health	(Zipjet, 2017)
37.	Lack of exercise	(Burton, 1990)

5. URBAN STRESSORS EXPLAINED

The list of urban stressors gives a good indication of what urban stress is and by which factors it is caused. However, to be able to work on the reduction of urban stress through urban design, it is important to know why stress is caused and how the urban environment is related to it. This chapter therefore further explains the urban stressors that are part of the selection of chapter 4.

From some urban elements or situations it is known that they contribute to the reduction of stress. In some resources, these elements are also reported as a stressor, because the absence of this element reduces the possibilities to recover from stress. They are also included in the list of stressors in this project, in the texts however, it is questioned whether this is justifiable. Specifically, this concerns stressors 08. accessibility & availability of green, 20. lack of social support networks and 37. lack of exercise.

BUILDING DENSITY 01.

In case of density the problem lies both in the built and the unbuilt space. Because of the ongoing trend of urbanisation (United Nations, 2005), cities have to deal with an increasing amount of people - population density, see 01b. crowding. The spatial problem of density is that there is a lot of built space - building density - necessary to house and facilitate all those people. For one, this means that a lot of cities are forced to build high-rise and build up a large part of the available space, see 09. high-rise.

CROWDING 02.

Crowding occurs when people's need for space is bigger than the supply, whereas density is the amount of people per unit of space (Stokols², 1972). So crowding is a psychological state, in which people may feel like they are not in control of their environment. If there is no possibility to escape this environment, it leads to stress (Epstein, 1981). It is important that people have control over social interaction – "the balance between the desired and achieved level of social interaction" (van Dorst, 2005, p. 2).

BORING MEGASCAPES 03.

The sight of large buildings, building blocks or other urban elements with boring, blank façades without variety can cause stress. Boredom results in the release of cortisol, a hormone associated with stress (Weintraub, 2015). It can also generate "impulsivity, lowered levels of positive affect and risky behaviour" (Weintraub, 2015), which can result in people getting themselves into even more stressful situations.

04. GARBAGE, GRAFFITI AND DISREPAIR

Garbage, graffiti and disrepair are urban stressors when people see them often. It creates "alienation and depression, especially among the elderly" (Montgomery, 2014, p. 160). The sight of garbage can also give an area a bad image and affect the perception of security, see stressor 11 (Melis, Gelormino, Marra, Ferracin & Costa, 2015, p. 14903; Rapoport, 1982, p. 132).

05. SHARP ARCHITECTURAL ANGLES

The sight of sharp architectural angles is a very specific urban stressor that frequently occurs in cities. The sharp angles of urban elements light up the brain's fear centres and stimulate the release of stress hormones, as if they were sharp dangerous objects. This also makes "people less likely to pause and engage with places and people" (Montgomery, 2014, p. 161).

06. TRAFFIC (JAMS)

According to Zipcar (2012), more than 50% of the people claim that commuting is a source of stress. Commuting by car already starts to have negative effects after only 15 minutes (Office for National Statistics, 2014). There are many reasons for stress in the car, such as traffic jams, construction, long distances (Cityclock, 2014), parking problems (Levy-Leboyer, 1982) and so on. Unpredictability, loss of control and being unable to communicate from the car are the reasons for stress in traffic (Cityclock, 2014).

PARKING PROBLEMS 07.

Levy-Leboyer (1982) states that parking problems make us "experience slavery and alienation" (p. 9). The stress is mainly caused by a lack of parking spaces. This does not only make us stressed, it also makes us violent towards other people (Wilde, 2017). Different resources indicate that 20-44% of the people think that parking is a stressful experience, mostly because of the lack of space, expensive car park charges, incorrect parking and people who take up too much space (Wilde, 2017; England, 2017).

ACCESSIBILITY & AVAILABILITY OF GREEN 08.

Both Zipjet (2017) and Burton (1990) state that green spaces are stressors or indicators of urban stress. However, in other resources green spaces are seen as stress reducers that calm the mind (Van den Berg, 2007; Montgomery, 2014), make us "more trusting an generous towards other people" (Montgomery, 2014, p. 160-161) and have a "lasting positive effect on our well-being" (Kinver, 2014).

HIGH-RISE 09.

Some researchers have found negative effects of high-rise on mental health (Gifford, 2007). Both being around them and living in them can cause stress. Living in them mainly causes stress based on fear (Gifford, 2007). Being around tall buildings can also cause stress, they can be perceived as oppressive (Gruebner, 2017) and they can increase wind speed and temperature and take away daylight - see stressor 20 (Arslan, 2014).

10. PUBLIC TRANSPORT

Montgomery (2014) states that public transport makes us stressed and unhappy. Commuting by bus is the worst, for trains, trams and subways, the negative effects only start to appear after 30 minutes of commuting (Office for National Statistics, 2014). This stress is probably mostly caused by human behaviour (Zipcar, 2012).

11. PERCEPTION OF SECURITY

In this case, this stressor focusses on crime, which is what Zipjet (2014) means with "perception of security". With crime, the stress is mainly caused by fear (Folk & Folk, 2014; Urban Age, 2011, p. 2). The fear of crime can be caused by many different environmental factors. One of them is an environment with no clear boundaries or territories, residents feel no responsibility for their neighbourhood there, which leads to an anonymous environment resulting in more crime and feeling unsafe (Van Dorst, 2012, p. 228).

12. LAY-OUT OF ARCHITECTURE AND URBAN DESIGN

This is a very general and broad stressor where the stress can be caused varying from the architecture of buildings to the (spatial) organization of the city or urban area. A more specific example of this stressor is urban stressor 05. sharp architectural angles.

GENDER INEQUALITY 16.

Sexist discrimination or gender inequality is not only seen as a form of stress (Belle & Doucet, 2003), but there is also a difference in stress experience between men and women. Apparently, "women experience more chronic stressors then men" and find them to be more threatening (Mayor, 2015, p. 2). In urban or living environments in general, this means the following: "Considered as a whole, a society that tolerates gender inequalities is ... likely to be a more unhealthy place to live for both men and women, compared to a more egalitarian one" (Kawachi, Kennedy, Lochner, & Prothrow-Stith, 1997, p. 31).

RACE INEQUALITY 17.

Inequality in this case should not be limited to race, but should also consider preference and class. Race inequality, social exclusion or discrimination can already have measurable impact after even a short experience and it has many negative effects, among which "elevated levels of stress" (Belle & Doucet, 2003, p. 106). Social exclusion is not only a result of human behaviour. There are also spatial aspects of social exclusion (Madanipour, Cars & Allen, 2011) and urban design can guide human behaviour.

LACK OF SOCIAL SUPPORT NETWORKS 20.

For stressor 08. accessibility and availability of green it was the question whether this really causes stress or if the lack of availability hinders the reduction of stress. In the case of social support networks, the same question can be asked. It is known that social support is directly associated with better mental health, see also chapter 12.2 (Thoits, 1995). Thoits (1995) also states that "differential vulnerability to stressors has usually been attributed to a ... lack of readily available social support" (p. 60), which means it can indeed be seen as a stressor. Recently, loneliness in cities is an often discussed subject, making this a relevant urban stressor.

21. SUNSHINE HOURS

The amount of sunshine hours and even hours of daylight can vary a lot between different climates and seasons. It can also be influenced by urban planning and design, think of building height for example. When we are exposed to sunlight, or more specifically to ultraviolet radiation, the level of endorphins in our blood increases (Mead, 2008). It is assumed that endorphins "play a role in the global defensive response to stress" (Amir, Brown & Amit, 1979, p. 77). Amir et al. (1979) also discuss the possible role of endorphins and the release of other stress related hormones.

22. AIR POLLUTION

Air pollution having a negative effect on physical health, is widely known (Pope, 2000). However, air pollution is also mentioned by many resources as an urban stressor, meaning that it has a negative effect on mental health as well (e.g. Melis et al., 2009; Gruebner et al., 2017; Peen et al., 2010). Still, all the resources seem to be uncertain whether this is actually true, because it has not yet been appropriately researched. Despite this uncertainty, noise pollution is considered an urban stressor in this project, since it was also mentioned by Zipjet (2017) and Evans & Cohen (1987) used to generate the list of stressors, chapter 3.

23. NOISE POLLUTION

Noise pollution often results in annoyance (Evans & Cohen, 1987), which can lead to stress responses (Stansfeld & Matheson, 2003) and higher levels of stress (Gruebner et al., 2017). It is also possible that noise influences health directly, depending on "characteristics of the sound, including intensity, frequency, complexity of sound, duration and the meaning of the noise" (Stansfeld & Matheson, 2003, p. 244). Moreover, noise can be a sleep disturbance (Stansfeld & Matheson, 2003), which hinders people from restoring. Noise is an urban problem, because it is more apparent in cities (Gruebner et al., 2017).

LIGHT POLLUTION 24.

When density increases, light pollution often does as well, which makes it a problem mostly related to urban areas (Litman, 2017). Where (day)light and sunshine during the day can have a positive effect on stress and mental health, see stressor 21, light during the night can have the opposite effect. Urban light exposure may cause stress and disturb sleep, which has "consequences for mental well-being" (Gruebner et al., 2017, p. 125; Litman, 2017).

PHYSICAL HEALTH 31.

There is a known relation between stress and physical illnesses (Hansmann et al., 2007), meaning that a large amount of stress or chronic stress can cause or contribute to the seriousness or emergence of physical illness. However, it also works the other way around. Personal health issues, or even health issues of family members are mentioned in the top 10 significant causes of stress (American Psychological Association[3], n.d.). This might not have an obvious relation to urban living or urban design, but it is definitely a form of stress that occurs in cities.

LACK OF EXERCISE 37.

This stressor falls under the same category as stressors 08 and 20: accessibility & availability of green and lack of social support networks. Again, it is known that exercise, or physical activity, has a positive influence on restoration from stress and on mental health in general (Barton & Pretty, 2010; Hansmann et al., 2007). This does not directly mean that a lack of exercise is really a stressor, but it does mean that a lack of exercise reduces the possibilities to restore from stress. The design of the urban environment can have an influence on the amount of physical activity being done (Litman, 2017).

PART 02

PART 02
PROJECT APPROACH

After the introduction of part 01, a problem definition and project aim are defined in part 02. In order to achieve this aim, a research question and several sub-questions are formulated, after which it is explained what methods are used to answer these questions.

PART 02

6. PROBLEM DEFINITION

There are a few different problems that can be defined around urban stress. The first problem is that stress is more apparent in cities than in rural areas, which is something that is already given away by the name urban stress.
The second problem is the health issues that can be the result of urban stress. Not only does this affect the people living in cities, which is the main concern of this thesis, but it also has a negative impact on the economy (Kalia, 2002, p. 50).
The third and final problem is that it seems as if there is still a lack of understanding of the relation between the theory of urban stress and the actual urban space or urban design. This is a problem for understanding both the cause and the reduction of urban stress. Evans and Cohen (1987) also state that a lot of sociological and psychological research has been done on urban stress, but that not much research has been done on this topic from the perspective of the built environment (p. 571). This means that there is a gap in the knowledge and this project aims to gather and create knowledge within that gap.

7. AIM OF THE PROJECT

This project aims to gather knowledge on urban stress, the reduction of urban stress and the relation between urban stress and the built environment. This knowledge is then used to 1) create a full overview of urban stressors, 2) find approaches to reduce urban stress and translate them into design criteria and 3) generate conclusions based on the application of the theory into design.

This project also aims to raise awareness of urban stress in the field of urbanism and inspire people to also work towards the reduction of urban stress. Moreover, it aims to function as an example of why and how to deal with urban stress through urban design, using designs of different public spaces.

8. RESEARCH QUESTIONS

In order to guide this project and to measure up to the aim that has been set in chapter 7, a main research question and supporting sub-questions are formulated in this chapter. The main research question of this thesis is:

How can the urban design of public spaces contribute to the reduction, relief or prevention of urban stress in metropolitan areas?

A few things can be found in this research question. First of all, there are 3 scales involved: the metropolitan scale, the urban or city scale and the scale of the public space. Second of all, it connects urban stress to urban design, and more specifically, to the design of the public space. The public space has been chosen as the main scale for this project because it is closest to the human scale, which is very important when talking about stress. Finally, the research question focusses on the decreasing stress in three different ways: by reducing, relieving or preventing it.

The sub-questions on the next page are both knowledge and application questions that contribute to answering the main questions.

The knowledge questions are used to get a better understanding of the general topic of stress and urban stress and create a clear overview of urban stressors, as well as to find the relation between urban stress and the built environment. The application questions are based on the application of the theory into the designs, this is where research and design come together.

The first set of sub-questions (1a-2b) has already been answered in part 01, because this information is very suited as an introduction of the topic of this thesis.

Sub-questions

1a.	What is stress?	(Knowledge question)
1b.	What is urban stress?	(Knowledge question)
2a.	What are urban stressors?	(Knowledge question)
2b.	Which urban stressors occur in the public space or can potentially be reduced by redesigning the public space?	(Knowledge (& Application) question)
3.	What are approaches to reduce, relieve or prevent urban stress?	(Knowledge question)
4.	Which spatial conditions can reduce or relieve urban stress?	(Knowledge & Application question)
5.	How can the public space be designed to reduce, prevent or relieve urban stress?	(Application question)

9. METHODS

This thesis has been built around a specific topic of which the problem is related to the built environment, but not around a spatial problem of a specific location, something that is common in urban design projects. Because it was built around a topic and especially since this topic belongs partly to the field of psychology, quite a lot of literature research has been done. Literature research alone, however, is not enough to be able to answer the research questions. Therefore, 5 other methods have been used as well, they are explained on the next page. It has turned out that some of these methods have been more useful than others, this is being reflected on in the reflection (chapter 20).

Another consequence of starting with a topic, rather than a location, is that a specific location is less important. In the case of this thesis, basically every metropolitan area suffices. For that reason, a project location has been chosen in a later phase of this project, and is only introduced for the first time in part 04.

The rest of this chapter shows which method has been used to answer which question and why.

Literature review
This method focusses on reviewing existing knowledge on urban stress. This is done both from the field of sociology and psychology and from the perspective of the built environment.

Data analysis
Since stress is a subject that is mainly about people, demographic data of the specific location of this project is analysed. Also data on health, well-being and economics is important. Moreover, data on the use of and events in the public space is reviewed.

Site analysis
The site analysis is done on two levels. The first is by analysing existing data and maps of the location, which is mainly done by mapping.
The second is a site visit, where observations are written down, drawn and photographed and where interviews are conducted.

Interviews
Interviews with both users of the public space and expert(s) on the topic of urban stress are conducted.

Designing
Both design criteria are formulated and a design for different public spaces within an urban area are made. This supports four purposes:

- creating a link between theoretical knowledge and actual urban environments
- creating applicable design criteria to reduce urban stress
- creating an inspiring example to motivate others to get engaged in this topic
- testing the outcome of the research

Testing
While designing, it is tested whether the design criteria can be implemented in the public space of a real life urban situation.

Methods for every sub-question

1a. *What is stress?*

Result:
A general understanding of the concept of stress as a background to be able to research urban stress. In the report this is presented as a text.

How:
Literature review - the topic of stress is reviewed from existing knowledge from the field of sociology, psychology and medicine.

1b. *What is urban stress?*

Result:
A general understanding of the concept of urban stress, as background knowledge to be able to work on and organize this thesis. This is presented as a text.

How:
Literature review - the topic of urban stress is reviewed from existing knowledge from the field of sociology, psychology and the built environment.

2a. *What are urban stressors?*

Result:
An overview of existing urban stressors that can be present in urban environments, presented in a list.

How:
Literature review - the information to answer this question is mainly a result of reviewing literature on urban stress from psychology, sociology and built environment studies.

Interviews - the focus of the explanation has been partly based on the information gathered during street interviews.

Site analysis - along with the interviews, observations from the site visit have had a small influence.

2b. *Which urban stressors occur in the public space or can potentially be reduced by redesigning the public space?*

Result:
A selection of the urban stressors found for sub-question 2a, that have a close relation to the public space in either cause or solution. The stressors of this selection

are explained more extensively and used also for the reduction approaches.

How:
Literature review - review literature from the field of the built environment to find which urban stressors can occur in actual urban 'space' and to research the emotions that different design features can evoke.

Site analysis - by analysing a specific site, it can also be found which urban stressors (could) occur there.

Design - by relating specific urban stressors to actual design locations, it can be found which stressors are more related to the public space than others.

3. *What are approaches to reduce, relieve or prevent urban stress?*

Result:
A text describing different approaches that can be used when designing a public space to reduce urban stress. (This is described in the written theory paper 'An urban design perspective on urban stress', which can be found in the appendix, as well as in part 03).

How:
Literature review - the information to answer this question is a result of reviewing information on coping with stress from literature from sociology, psychology and built environment studies.

4. *Which spatial conditions can reduce or relieve urban stress?*

Result:
A textual and visual collection of elements in the urban design of the public space that have the ability to reduce urban stress.

How:
Literature review - review literature from sociology, psychology and the built environment to find ways to cope with stress or reduce stress.

Interviews - ask users of stressful urban areas what they think would help to reduce urban stress.

Design - use design skills to translate theoretical text into usable and visual design criteria.

5. *How can the public space be designed to reduce, prevent or relieve urban stress?*

Result:
Urban designs for different public spaces, that show how the design criteria are implemented in the design and how this becomes visible in the actual space.

How:
Design - design skills are required for this sub-question, when making the designs for the different public spaces.

Testing - while designing it is tested how the design criteria can be implemented in the designs of the public spaces and which of the criteria may be more suited for actual designs and the scale of the public space.

Methods for main question

How can the urban design of public spaces contribute to the reduction, relief or prevention of urban stress in large urban environments?

Answering the sub-questions of course mainly leads to answering the main question, but when looking at the aim of this project, a final design or final designs are also an important product of this research project. So the process of answering the main question does not only lead to approaches to reduce urban stress in the public space, but also to an urban design for a public space or multiple public space areas. This means that for the main question, all the sub-questions and their corresponding methods are used, but there is also an extra focus on designing.

Scheme

On pages 50 and 51 two schemes are shown. The first is to very generally clarify the approach of this thesis and show the structure of this report at the same time. Although this is drawn in a very vertical manner, this is certainly not the case. The arrows show that insights and conclusions from every part are used also to strengthen and evaluate previous parts.

The second scheme, on page 51, shows the summary of this chapter in more detail. Both the exploration of urban stress and the research on the reduction of urban stress lead to information and conclusions that can be used in the design.
The scheme also shows that this project

has 3 main products: the collection of urban stressors, approaches to reduce stress with supporting design criteria and the design of multiple public spaces.
From the scheme it becomes clear that the chosen city for this project is London and that the specific project location is therefore somewhere in this city. This is all explained in part 04.

Finally, there is one method that has not been specifically assigned to one of the (sub-)questions: data analysis. Still, it is introduced as a method and again shown in the methods to answer the main question as well as in the method's scheme. Data is used in this project not to answer a specific (sub-)question, but to support knowledge found in literature, to provide extra information for the site analysis or to support the argumentation when choosing a location.

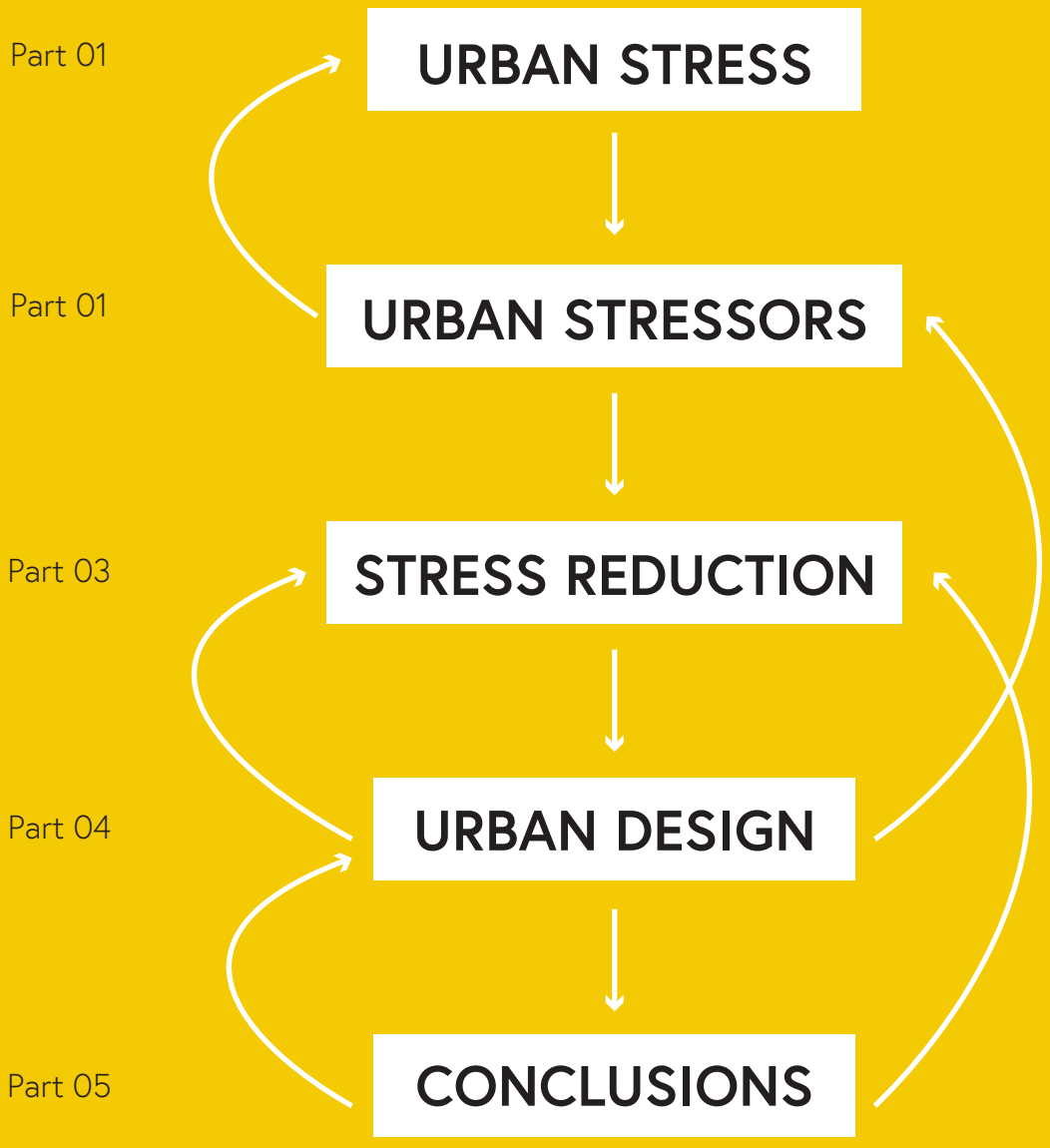


Figure 5: Thesis structure

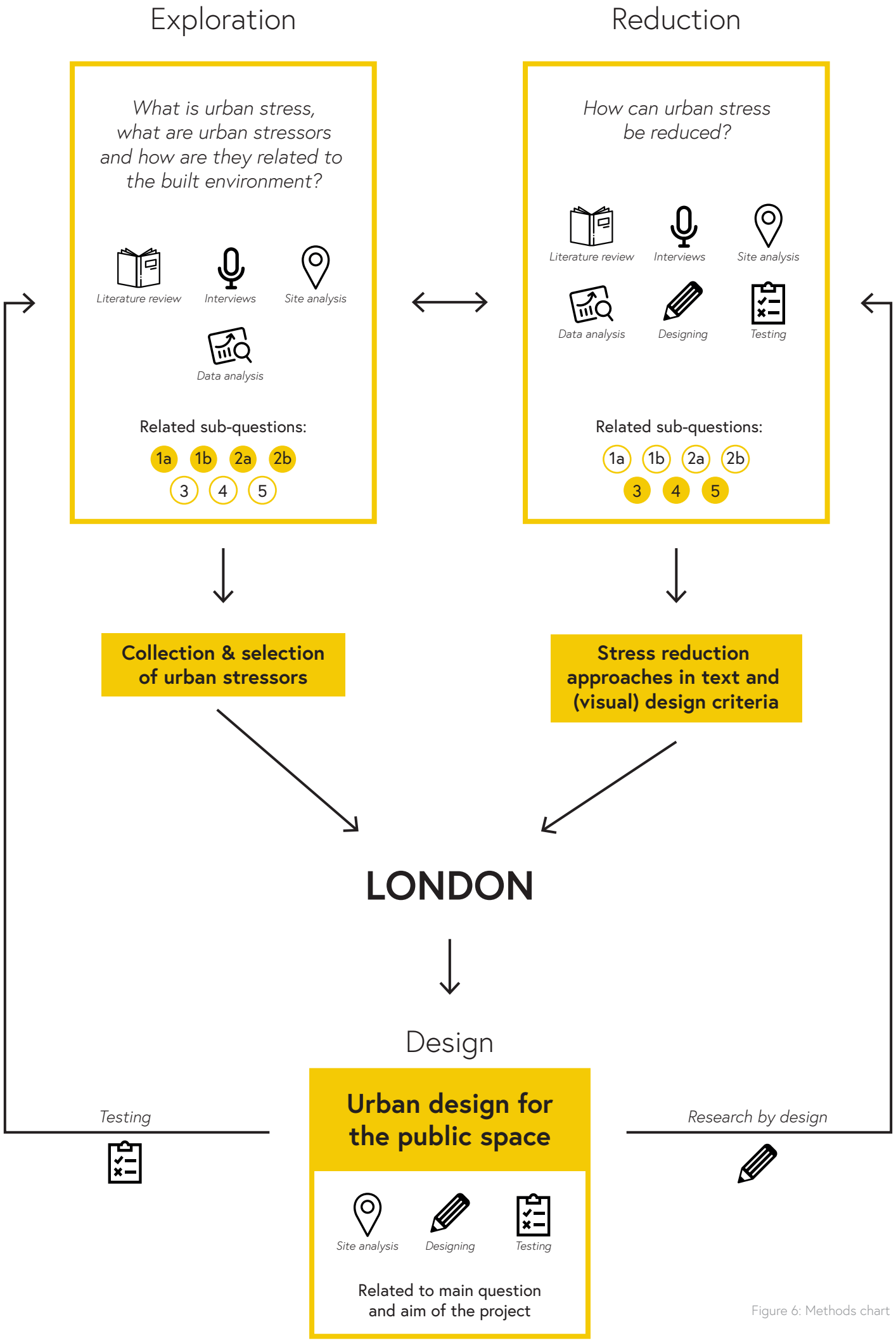


Figure 6: Methods chart

PART 03

PART 03
REDUCING STRESS

Part 03 of this thesis is solution oriented and focusses on the reduction of stress through urban design. In total, there is focussed on 4 stress reducing approaches of which one is the direct approach and three are indirect approaches. The indirect approaches are perceived control, pro-social places and restorative environments.

PART 03

10. STRESS REDUCTION APPROACHES

This project aims to find approaches to reduce urban stress. This section explains the theory of the two general ways in which this can be done.
The first way is to change the relation between the person and the environment, Lazarus (1993) calls this "problem-focused coping" (p. 8) and in this project it is referred to as the direct approach. The second way is to change the effect or interpretation of what is happening, Lazarus (1993) calls this "emotion-focused coping" (p. 8) and is this project it is referred to as the indirect approach.
For some urban stressors it is immediately clear what the spatial cause for stress is and what spatial elements should be changed to reduce the stress. In that case, the direct approach can be used, where the actual stressor is tackled. With other stressors, these spatial causes are not as clear, and sometimes there is not a direct relation between the stressor and the urban design. In that case, the indirect approach can be used, where the perception or effect of the stressor is altered by changing something else and the stress is reduced more generally. Both the direct and the indirect approach are explained in this chapter.

The direct approach

The direct approach focusses on making an urban design that removes the urban stressor, changes the stressor in a positive way or decreases the intensity of the stressor. An example is crowding or density. It is not realistic to remove people from the city, but by creating a little more open public space, the perceived density and experience of crowding will be lower (Rapoport, 1982, p. 34; Stokols[1], 1972, p. 82). It should be kept in mind that some urban stressors can also have benefits for people and are not necessarily always negative. Density increases the opportunity to "move around and have an active social life" especially for elderly and woman, which reduces the risk of depression (Melis, Gelormino, Marra, Ferracin & Costa, 2015, p. 14899) and there are more known benefits of density. In that case it needs to be weighed whether the stressor is more harmful than it is beneficial, or it has to be investigated whether there is a way to reduce the stress without reducing

the benefits.
Another example of an urban stressor where a direct approach can be used is crime. Designing the neighbourhood and housing in a way that there are more eyes on the street can help prevent crime (Gehl, 2013, p. 73). Creating spaces for people to meet, to create social interaction also helps (Van Dorst, 2012, p. 231). A lack of boundaries or territories can be a cause of crime, so another direct approach can be to design visible boundaries, or as Perkins et al. (1990) describe, design features such as "public space dividers, greater visibility, and small and low-rise designs", which "encourage residents to exercise territorial control" (p. 86).

The indirect approach
When people experience a lack of control, this often results in stress (Epstein, 1981). So the first indirect approach to improve a stressful urban environment is to give the users a perception of control. This is also described by Evans (2003) as one of three options to intercede between urban environments and human stress. An example of improving perceived control is by creating a gradient in the transition from private to public, from smaller individual spaces to small group spaces to bigger public spaces (p. 544).
The two other ways to decrease the amount of stress without changing the actual stressor - indirect approach - are social support and restoration (Evans, 2003). Social support has an overall positive influence on mental health. The built environment can influence this for example by connecting residential areas to pedestrian areas or meeting places (Evans, 2003, p. 454). With this example it should be kept in mind that the places should not become too crowded, because crowding is one of the stressors and causes social retreat, which is the opposite of what is needed in this case (Evans, 2003; Montgomery, 2014).
Restoration is the third and last indirect approach to interfere with stress mentioned by Evans (2003). Restoration is all about recovering from experienced stress. A well-known example of a solution is exposure to natural elements (Evans, 2003; Montgomery, 2014).

In another work from Evans, together with Cohen (1987), some other interesting concepts are described that have influence on the way stressors are perceived. These concepts can also be kept in mind when indirectly coping with the stressors. They are: "they value or valance of events", whether the stressor results in a gain or a loss; "the degree to which a stressor is perceptually salient or easily identifiable or noticable", this influences how much we get used to a stressor, which makes the intensity of the stressor lower; "predictability", which again influences how quickly we get used to a stressor; "the necessity and importance of a stressor", stressors that seem necessary are differently received than stressors that seem unimportant (Evans & Cohen, 1987, p. 574-575).

Stress reduction structured

On page 54 and 55, the general theory behind the different stress reduction approaches has been explained. To summarize, the direct approach focusses on adjusting the stressor, while the indirect approach focusses on altering the effect or perception of stress or stressors. The indirect approach is divided in three approaches: creating perceived control, stimulating social support and providing possibilities to restore. These three approaches, together with the direct approach, are used to structure the rest of this thesis. This is also shown in figure 7 on the next page. The colours are very important, since they are often used to show which approach is being explained or used. In the next chapters of this part, the 4 approaches are described more extensively, linking them also to urban design and the public space.

Figure 7: Stress reduction through direct and indirect approaches

11. THE DIRECT APPROACH

The direct approach to reduce urban stress focusses directly on the urban stressor. Therefore, the urban stressors found in part 01 are the main focus of this chapter. More specifically, the *selected* urban stressors mentioned in chapter 4 and 5, because they have the most potential for being improved through urban design in the public space. For every stressor, a short description is given of how this stressor can directly be reduced in the public space. This is done on the next pages. The texts and recommendations are based on a combination of literature, common sense and experience. Most of them are still open for the interpretation of urban designers, who can use their expertise and the context they are working in.

01. Density

Stress is caused by how people experience something, so the perceived density is probably more important here than actual density, being the built up space or FSI. According to Rapoport (1982) low perceived density can be achieved by the presence of recreational facilities and nature, privacy, spaciousness, low noise levels, open space, trees, variety and pleasant views (p. 169).

02. Crowding

Crowding occurs when people's need for space is bigger than the supply (Stokols², 1972). This means that people can experience stress when they feel like the amount of people is too big for the amount of space. One of the solutions is therefore to create more space for pedestrians. Another way to regulate social interaction is by creating clear territories or boundaries (Van Dorst, 2012, p. 234).

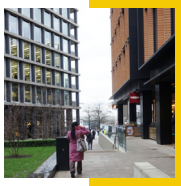
03. Boring megascapes

An example of a boring megascape is a building with a monotonous design that takes up the entire building block. In order to prevent this, steps have to be taken already in the planning process of the area, while making the regulations. In the public space however, elements can be added to interrupt the boring facade, think of trees, lampposts or decorating elements.

04. Garbage, graffiti and disrepair

Garbage, graffiti and disrepair are often a result of an anonymous and therefore antisocial environment (Van Dorst, 2012, p. 228). To improve this, a neighbourhood should have clear boundaries, this makes the 'ownership' more clear, which leads to people feeling more responsible for 'their' territory and to less deterioration, graffiti and garbage (Van Dorst, 2012, p. 228; Rapoport, 1982, p. 171).

05. Sharp architectural angles



Sharp architectural angles can cause stress by themselves, but it is also likely that they create blind corners, leading to stress from fear. Again, an obvious solution is to plan certain restrictions early in the planning process or to provide design guidelines for architects. However, focussing on the public space: trees, decorations or wider pavements might soften the effect of the sharp angles.

06. Traffic (jams)

Building more roads might seem an obvious solution for traffic jams, but the problem is not necessarily a lack of space, because more roads do not solve congestion problems but only generate more traffic (Duranton & Turner, 2009). It is therefore useful to make areas or cities less car dependent, by creating good public transit networks, walking and cycling opportunities and mixed-use neighbourhoods.

07. Parking problems

Not only is the lack of parking space a cause for stress, busy streets with a lot of parked cars are also less safe - stressor 11 (Wegman, 1995). The case of parking problems is similar to the case of traffic jams. More parking spaces will probably not help and it will also make streets less pleasant and aesthetic. An - expensive - solution could be underground parking for new buildings, but again, the main focus should be on being less car dependent.

08. Accessibility & availability of green

As stated in chapter 5, green spaces or natural environments are known for reducing stress. It is therefore important to create urban green spaces and add natural elements in streets and other open spaces. The approach 'restorative environments' starting on page 72 goes much more into detail on this topic.

09. High-rise

High-rise buildings cause stress in two different ways, for people who live in them and for people who are around them. Unfortunately, it seems very unrealistic to ban all high-rise from - future - urban environments. Since the problem lies in the buildings being oppressive and in the increase of wind and temperature, the positioning and design of the buildings is very important. Creating enough space around them would already make a difference.

10. Public transport

Public transport is for some of the stressors a part the solution. It is therefore quite unfortunate that public transport in itself is also a stressor. Because travelling by trains, trams and subways is less stressful than travelling by bus, those networks should be prioritized. To prevent stress from crowding in stations, enough space should be created for commuters in and around the stations.

11. Perception of security

Stress caused by feeling unsafe can be the result of many things. In general, there are a few things that can be done to increase - the perception of - security or safety. Clear boundaries and territories in neighbourhoods lead to less anonymity and less crime (Van Dorst, 2012, p. 228). More eyes on the street and creating spaces for people to meet also helps (Van Dorst, 2012, p. 231; Gehl, 2013, p. 73). Things like good lighting and safe crossings can also help.

12. Lay-out of architecture and urban design

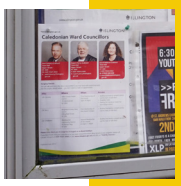
Since this stressor is so broad, it should be examined for each specific location if there is something stressful about the lay-out of the architecture and urban design. This can be done with the help of the list of stressors from chapter 4. High-rise and sharp architectural angles are examples, but as stated before, many of the stressors are related to urban design and/or the public space.

Gender inequality is often looked at from a female perspective. In this thesis, that might also be the obvious choice, since "women experience more chronic stressors then men" and find them to be more threatening (Mayor, 2015, p. 2). But since it is about equality, both men and women should be considered, here and in the public space. This could mean a public space with a combination between good nearby access and public kitchens for women (Vestbro & Horelli, 2012) and opportunities to exercise or hang out for men.

16. Gender inequality

To design against race equality is to design for diversity. According to Talen (2006), this has often been tried by mixing housing types, with quite a positive outcome. In the public space, streets are first of all important, because they literally provide a connection (Talen, 2006). Also shared spaces around private residential spaces are important, since they provide a "chance for informal, collective control as well as a sense of shared responsibility" (Talen, 2006, p. 243). Also, a "fine grain in the urban texture" like small blocks "encourage a diversity of building types and uses" (Talen, 2006, p. 243).

17. Race inequality



Social support is known as a stress reducer. Therefore, it is one of the indirect approaches of this thesis. In 'pro-social places', starting on page 68, this is further explained.

20. Lack of social support networks

Since sunshine and daylight "play a role in the global defensive response to stress" (Amir, Brown & Amit, 1979, p. 77) and have been labelled as a stressor by Zipjet (2017), it is important to let enough sunlight into the city. Sunlight is often blocked by trees and high-rise. Low-rise would therefore help to get more sunlight on street level. However, creating more or enough open space around trees and high buildings would also make a difference.

21. Sunshine hours

It is almost impossible to imagine a city without air pollution. It is therefore a difficult stressor to tackle. As mentioned at other stressors, making the city less car dependent and focussing on a good public transport network should be the first priority.
In the public space, some efforts can be made as well. Trees for example, partly remove the air pollution from the city (Nowak, Crane & Stevens, 2006).

22. Air pollution

Noise has a bigger effect on human stress than one might think. It is therefore important to reduce noise as much as possible. Apart from trying to prevent noise pollution, noise can be blocked by noise barriers (Moudon, 2009). These barriers can be walls, but also natural elements such as trees and hedges.

23. Noise pollution

24. Light pollution

Light pollution is of course a stressor that mainly occurs at night and it can be caused by many different light sources. Examples are lights in empty office buildings and lights to show buildings or billboards (Chepesiuk, 2009). Changing this is more related to policies than to public space. In public space however, lamppost can be used that do not emit light above horizontal plane (Chepesiuk, 2009) and light can be blocked by walls, trees, etc. (Moudon, 2009).

31. Physical health

Many things have an influence on our physical health. Within the focus of this thesis, stress in general, but also air, light and noise pollution and a lack of exercise can have a negative influence on mental health and thereby on our physical health. Part of the solution therefore lies in reducing those stressors. Another part lies in physical activity, which is part of the indirect approach 'restorative environments', starting on page 72.

37. Lack of exercise

Physical exercise is one way to restore from stress. It is therefore included in the indirect approach 'restorative environments', starting on page 72. There it is explained why physical exercise is beneficial and how this can be supported by the design of public spaces.

12. THE INDIRECT APPROACH

Reducing stress in cities can be done in various indirect ways. The indirect approach focusses on altering the effect or the perception of the stressor, so that less stress is experienced or so that stress is relieved or restored.
Within this indirect approach, there are 3 sub-approaches, focused on finding ways to indirectly reduce stress through urban design in the public space. They are: perceived control, pro-social places and restorative environments. For each of these sub-approaches, a text is written containing an explanation about the definition and importance of the approach, what can be done to achieve improvement and what kind of design criteria follow from this. The text about the design criteria is supported by small images.
The information described for each sub-approach is mainly based on literature. Sometimes common sense, experience or the results from street conversations (see part 04, page 91) have been used.

PERCEIVED CONTROL

12.1 Perceived control

Perception is the process of attaining awareness and the understanding of sensory information (Grahn & Stigsdotter, 2010 p. 264). It is important for people to have a perception of control, because when they experience a lack of control it often results in stress (Epstein, 1981). Also, people "have better mental health when they can control their surroundings" and when they do not, helplessness can occur (Evans, 2003, p. 544). A lack of control and helplessness can be caused by different environmental stimuli. In general, a lack of control can occur when someone is in a situation where he or she can not complete their goal and it seems as if there is no escape from this environment (Epstein, 1981, p. 127-128). More related to urbanism, a lack of control can be caused by crowding and excessive unwanted social interaction (Epstein, 1981). Busy city streets are an obvious example of places where crowding can occur, but uncontrollable social interaction can also occur in high-rise buildings and poor-quality housing (Evans, 2003).
Helplessness can also be caused by crowding, and by other uncontrollable stimuli such as noise and urban smells - air pollution (Evans, 2003).
It seems as if not much more has been written about the relation between perceived control and urban design or the public space. It might therefore be necessary to make some well-thought-out assumptions. What is mentioned however is that the influence of choice is important. When you choose to be in a certain - stressful - situation or environment, the negative effect is not as bad and it does not lead to a lack of control (Epstein, 1981; Perlmuter, 1980). What also helps is the feeling that you can get away from a certain situation or environment (Epstein, 1981).

Translating this knowledge on perceived control into the field of urbanism, it might be assumed that in order to achieve perceived control in urban environments, things as readability, clarity, predictability and maybe even safety play a role. Readability, clarity and predictability of the urban environment allow people to know where they are, where they are going, what their options are and what can be expected around the next corner. When this is not the case, it is likely that people feel a certain lack of control.
Evans and Cohen (1987) also mentioned the relation between predictability and control and between predictability and stress. It is likely that safety is also related to predictability.

Urban design criteria:

- *Gradient private to public*
  Provide a range of social spaces varying from more private to more public, this is associated with more perceived control and comfort (Evans, 2003, p. 544).
- *Privacy zones*
  Create clear privacy zones and make sure local people do not have to share their space with passers-by (Qu & Van Dorst, 2014, p. 7).

- *Control and intervene*
  Provide the possibility for people to control their interaction with the social environment and maybe even to intervene with the physical environment (Qu & Van Dorst, 2014, p. 10).
- *Enough space for pedestrians*
  Create enough space for pedestrians, to decrease the chances of crowding. See also stressor 2 in the direct approach chapter.
- *Provide enough options*
  Provide enough options, for example routes, public transport stops, etc., so that people have a choice.
- *Low-rise*
  Build low-rise where possible, because high-rise is related to uncontrollable social interaction (Evans, 2003).
- *Avoid air and noise pollution*
  Try to avoid air and noise pollution. When it can not be prevented, trees can be used to solve part of the air pollution and block some of the noise. Also, noise can be blocked for example by noise barriers such as walls, hedges, etc.
- *Clear and readable urban design*
  Create a clear and readable urban design network, using familiar, recognizable and similar urban design elements, think of furniture and material use.
- *Clear and predictable*
  Design areas in a clear way so that the organisation is understandable and predictable for residents and visitors of the area. Think about the design of streets and their hierarchy and about the design of corners for example.

Relation to specific urban stressors and the direct approach

02. Crowding
09. High-rise
11. Perception of security
12. Lay-out of architecture and urban design
22. Air pollution
23. Noise pollution

gradient private
to public

privacy zones

control and
intervene

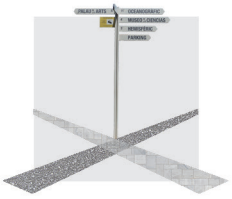
enough space
for pedestrians

provide enough
options

low-rise

avoid air and
noise pollution

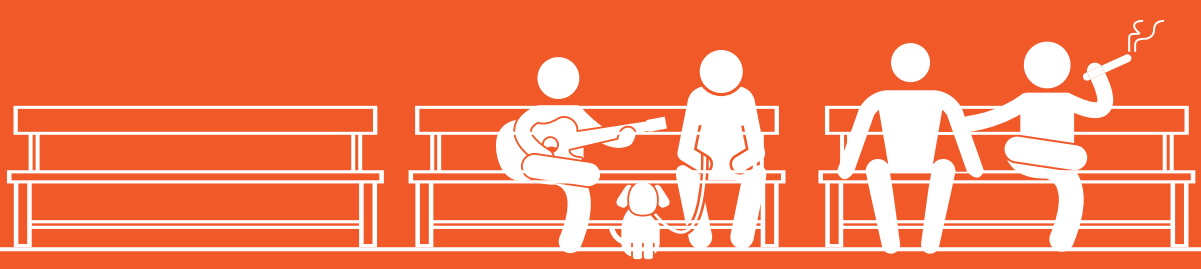
clear and readable
urban design



clear and
predictable

Image 3: Design criteria for Perceived Control

PRO-SOCIAL PLACES



12.2 Pro-social places

According to Evans (2003), social support has a positive effect on mental health. It is considered to be one of the ways to cope with stress (Thoits, 1995). Coping with stress means that one is dealing with the stressful situation, whereas restoration - also frequently mentioned in this thesis - can almost be explained as the healing of mental health after it has been diminished by stress.
It is not strange that social support is associated with the reduction of stress, since the lack of social support networks has already been established as an urban stressor in part 01 (Burton, 1990). It might not really matter whether people actually receive social support, as long as they believe that emotional support is available (Thoits, 1995). It is assumed that one of the ways social support helps in the coping process is by helping to re-evaluate or reinterpret the situation (Thoits, 1995). It might also lead to higher self-esteem, which is positively related to mental health (Barton & Pretty, 2010). Another relation between stress and social support can be found in sharing the negative effects of a certain stressor, this "seems to create empathy for the other person" (Evans & Cohen, 1987, p. 594), which can then possibly lead to a social connection and support.

There are a few things related to urban design and the public space that can have a negative impact on social support. They are very much related to the urban stressors found in part 01. The first is crowding, because crowding causes social retreat, which is the opposite of what is needed for social support (Evans, 2003; Montgomery, 2014). Again, this is worse in high-rise buildings (Evans, 2003).
Another one is busy streets. Apparently, people who live on busy streets, are more socially withdrawn than people living on streets with less traffic (Evans, 2003, p. 545). Related to this, noise also has a negative effect on social behaviour. It does not only make it more difficult to communicate, it also makes people "less likely to help others" and it can lead to irritability and even aggression in some situations (Evans, 2003, p. 545).

Besides supporting the coping process, social support also has other stress related *benefits*. One example is that supportive social environments promote physical exercise benefits, which is part of the restorative process - see 12.3 restorative environments (Bodin & Hartig, 2003).

Urban design criteria:

- *High density*
  Although it might contradict other statements made in this thesis, in this case high density is beneficial, especially for women and elderly. A higher density increases the opportunity to "move around and have an active social life" (Melis, Gelormino, Marra, Ferracin & Costa, 2015, p. 14899). A good public transport network also supports this (Melis, Gelormino, Marra, Ferracin &

Costa, 2015).

- *Green environment*
  Create a green environment. This relates very much to the next approach, but also in the social context this is important. Montgomery (2014) namely states that green spaces make us "more trusting and generous towards other people" (p. 160-161).
- *High quality public spaces*
  Create high quality public spaces. When the public space is just an open space, it will most likely only be used for necessary activities, while high quality public spaces "accommodate a range of optional (e.g., recreational) and social activities" (Francis, Wood, Knuiman & Giles-Corti, 2012, p. 1571).
- *Pro-social furniture*
  Arrange furniture in a pro-social way. Benches for example can be placed in a way in which they encourage social interaction (Evans, 2003).
- *Make connections*
  Connect residential buildings to pedestrian paths or meeting places (Evans, 2003, p. 545).
- *Nearby & focal points*
  Create places that are close to people (buildings) and that have focal points. These focal points should be neutral and provide visual prospect, which means that people "can see what is happening in the space prior to making a behavioral commitment to the space" (Evans, 2003, p. 545).
- *Combine public functions*
  Add other public functions in the plinth around the public open spaces, cafés for example.
- *Projects for Public Spaces*
  Projects for Public Spaces have also dedicated a large part of their 'What Makes a Great Place' approach to social places. Their criteria can be found in image 4.

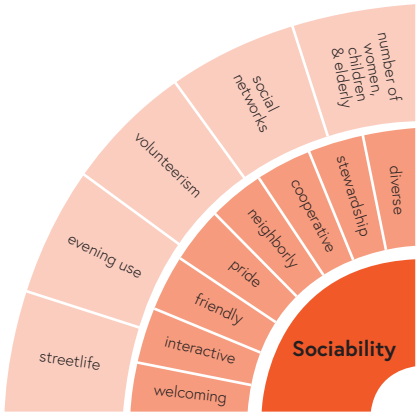
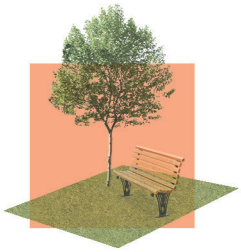


Image 4: Sociability according to Project for Public Spaces. By author, based fully on What makes a great place? from Project for Public Spaces, n.d. (https://uploads-ssl.webflow.com/581110f944272e4a11871c01/5acfa7910b1c9faf752f2229_greatplace-detail-PPS.jpg)

Relation to specific urban stressors and the direct approach

02. Crowding
06. Traffic (jams)
07. Parking problems
08. Accessibility & availability of green
09. High-rise
11. Perception of security
12. Lay-out of architecture and urban design
16. Gender inequality
17. Race inequality
20. Lack of social support network
23. Noise pollution

high density

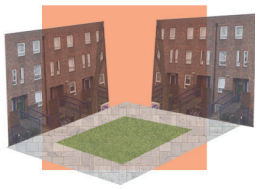


green
environment

high quality
public spaces

pro-social
furniture

make connections



nearby &
focal points

combine public
functions

projects for
public spaces

Image 5: Design criteria for Pro-Social Places

RESTORATIVE ENVIRONMENTS

12.3 Restorative environments

Hartig (2007) describes restoration as a "process of recovering physiological, psychological and social resources that have become diminished in efforts to meet the demands of everyday life" (p.164). Stress can be seen as one of the factors that causes the depletion of psychological, and perhaps even physiological and social, resources. Both Ulrich and Kaplan have formulated a theory about restoration. The first, by Ulrich et al. (1991) is the psycho-evolutionary theory - also referred to as the stress reduction theory. The second, by Kaplan (1995), is called attention restoration theory. The psycho-evolutionary theory suggests that restoration is related to sustained attention, where the attention restoration theory suggests it is related to involuntary attention (Ulrich et al. 1991; Kaplan, 1995). This will become more clear in the section about nature.

Both Ulrich and Kaplan agree on the restorative effects, for stress or mental health, of nature. However, there are two more things that have a restorative or positive effect on mental health, which can also be influenced by the urban design of the public space, they are sleep and physical activity. These three things that support restoration are described below, accompanied by urban design criteria.

Nature

It is widely known that nature has a positive effect on health in general. This is also true - to some extent - for urban green (Grahn & Stigsdotter, 2010). As said before, Ulrich and Kaplan can both explain this according to their theories. Ulrich et al. (1991) state that nature has a restorative influence because it causes a "shift in feelings towards a more positively-toned emotional state, positive changes in activity levels in different physiological systems" (p.224). This should both lead to certain levels of sustained attention, which is seen as an important positive factor (see also Ulrich, 1983). Kaplan (1995) however, also emphasises that natural elements are very well suited for restorative experiences, but he has a different opinion on how this works. Where Ulrich writes about sustained attention, Kaplan believes that exposure to nature results in "involuntary attention" (p. 172). This form of attention is effortless and is the opposite of voluntary attention or directed attention, which is the attention or focus that one gives to work on a project or complete a task. Involuntary attention should not deplete ones psychological resources and even provides time to rest or restore.

Although Ulrich and Kaplan might not completely agree on how nature is exactly beneficial for our mental health, they do agree that it is beneficial, and so do many others. According to Barton and Pretty (2010) for example, exposure to nature varying from viewing it through a window to exercising in natural environments, can have a positive effect on people's mental health. A few concrete benefits that affect our health and are related to green spaces

are "air quality, physical activity, social cohesion and stress reduction" (Hartig, Mitchell, De Vries & Frumkin, 2014, p. 212). This also nicely shows how restoration and nature are related to the urban stressors central to this project. Although there is more written about the benefits of nature on mental health, many researchers refer back to Hartig, Ulrich and Kaplan, so this text already gives a good summary of the existing knowledge and theories.

Urban design criteria:

General

According to Kaplan (1995), there are four components of restorative environments that are required (p. 174; see also Kaplan, 1992). Green spaces are one of the most likely places in cities where these requirements can be met. They are:

- *Being away* - to feel like you are in a different environment, away from your usual surroundings. Distance is not a very important factor here.
- *Fascination* - this is closely related to involuntary attention. There should be things one can see and wonder about without any effort or necessity, so one does not think about other things.
- *Extent* - in urban areas, extensive green spaces are difficult to realize. Extent is however more about the perception than the actual size. This is closely related to 'being away'.
- *Compatibility* - the space should provide the context for the purpose of someone's visit.

These components can be translated into urban design based on the specific context and the designers experience. Examples of this can be seen in part 04.

Specific

- *More green & add water*
  A combination of green spaces with water has a more positive influence on mental health (Barton and Pretty, 2010; WHO, 2016). They can be seen as safe havens, also from a evolutionary point of view (Bratman, Hamilton & Daily, 2012).
- *Serene scenery*
  Create a serene and natural scenery. This means an undisturbed environment, which is silent and without too many people (Grahn & Stigsdotter, 2010).
- *Places to stay*
  Place enough benches in the green spaces so people have the opportunity to rest and enjoy their environment (source: street conversations).
- *Accessibility*
  The green spaces should be accessible, well-maintained, clean and safe (WHO, 2016).
- *Alternative green & close by*
  Design green (spaces) spread throughout the city. Green spaces should be within walking distance of people's homes, a maximum of 5 minutes (Litman, 2017; WHO, 2016). Include green also in dense areas. If there is not enough open space available, green can be brought into the city using rooftop gardens or street landscaping (Litman,

2017).

Sleep

According to Kaplan (1995), sleep is one way to recovery and in general, it is necessary for good health (WHO, 2011). However, Kaplan (1995) also states that sleep alone is insufficient for restoration (p. 142), which means that the other themes in this chapter and this thesis in general are still relevant.
Both noise and light can disturb sleeping patterns (Gruebner, 2017; WHO, 2011). Sleep disturbance is not only a problem because it interrupts the restoration process, but it also related to mental health in general (Gruebner, 2017; Anderson & Bradley, 2013). Although this is true for both urban and rural areas, increased density often results in increased noise and light pollution, making it a more relevant issue in cities (Litman, 2017). Noise pollution is often caused by road traffic, but also for example by sirens, construction and alarms (Litman, 2017; WHO, 2011). Modest health effects already arise from noise exposure of 30dB(A) (WHO, 2011). Light pollution is described by Chepesiuk (2009) as when "artificial outdoor lighting becomes inefficient, annoying, and unnecessary" (p. A21). Examples are lights in empty office buildings and lights to show buildings or billboards (Chepesiuk, 2009).

Urban design criteria:

- *Down-facing lighting*
  Use street lighting where no light is emitted above the horizontal plane (Chepesiuk, 2009).
- *Distance*
  Create distance between people - residential areas - and noise sources (Moudon, 2009, p. 170). For example: place primary roads and busy city centre functions outside residential areas.
- *Block light & noise*
  Block light and noise pollution using urban design elements in the public space. Think of noise barriers (Moudon, 2009), trees, walls, hedges, etc. Trees also help to reduce the air pollution (Nowak, Crane & Stevens, 2006).

Physical activity

It is still unclear whether physical activity should be mentioned under restoration. However, it is known amongst other things for having a positive effect on mental health, which is what is important in this thesis, so therefore it is included in this theme (Barton & Pretty, 2010; Hartig et al., 2014; Bodin & Hartig, 2003). It is assumed that "the "time out" from daily stressors in and of itself contributes to enhanced psychological well-being" (Bodin & Hartig, 2003, p. 142; see also Bahrke & Morgan, 1978). This implies that it is beneficial for people to exercise in a different environment than one is used to during their daily hassles.
According to Bodin and Hartig (2003), there is not much know about the relation between the benefits of exercise and the environment that this exercise is done in. However, Barton and Pretty (2010) have found that exercising in natural environments has a positive effect on mood

and self-esteem, which is related to good mental health and coping with stress. Also, exercising in nature is preferred by people, and the perceived positive effects are higher (Bodin & Hartig, 2003). This, together with other findings, leads to 6 design criteria.

Urban design criteria:

- *Natural environments*
  Create exercise opportunities in natural environments. Not only are the - perceived - benefits in natural environments higher (Barton & Pretty, 2010; Bodin & Hartig, 2002; Van den Berg, 2007), the availability of urban green is also related to higher levels of physical activity (Schipperijn et al., 2013). When the green is combined with water, this has a positive effect on both the degree of physical activity and the mental health benefits (Hansmann et al., 2007; Barton & Pretty, 2010).
- *Facilities*
  Prioritize certain facilities in parks. According to Kaczynski et al. (2008) park facilities such as a paved trail, water area, and playground are more important for physical activity than for example a drinking fountain, picnic area, or restroom; paved trails in particular were strongly associated with physical activity (p. 1452; see also WHO, 2016). However, Schipperijn et al. (2013) found that physical activity was "positively related to features such as walking/ cycling routes, wooded areas, water features, lights, pleasant views, a bike rack, and a parking lot" (p. 109).
- *Playgrounds*
  Create playgrounds for children. Outdoor spaces are associated with more physical activity of youth and playgrounds are associated with the highest level of physical activity (Oreskovic et al., 2015).
- *Walking & cycling routes*
  Design the city for physical activity. Integrate physical activity in city life by providing good walking and cycling conditions (Litman, 2017, p.42).
- *Public transport*
  Foresee in a good public transport network. Usually, transit travel is combined with walking or cycling (Litman, 2017), making a good public transport network important for supporting daily activity.
- *Mixed neighbourhoods*
  Create mixed neighbourhoods. When a mixed neighbourhood has enough different facilities within walking distance, it will be more doable en inviting to walk to your destination (Litman, 2017).

Relation to specific urban stressors and the direct approach

08. Accessibility & availability of green
10. Public transport
12. Lay-out of architecture and urban design
23. Noise pollution
24. Light pollution
31. Physical health
37. Lack of exercise

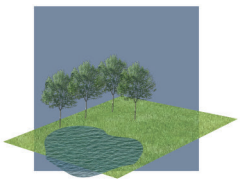
being away

fascination

extent

NATURE

compatibility



more green &
add water

serene scenery

places to stay

accessibility

alternative green
& close by

SLEEP

down-facing lighting

distance

block light
& noise

PHYSICAL ACTIVITY

natural
environments

facilities

playgrounds

walking &
cycling routes

public transport

mixed
neighbourhoods

Image 6: Design criteria for Restorative Environments

PART 04

PART 04
DESIGN

In this part, the project location - Caledonian, London - is introduced. Showing how urban stress can be reduced through urban design the main focus of this part of the thesis and therefore different designs are presented.

PART 04

13. INTRODUCTION TO LOCATION AND DESIGN

Since this thesis is a part of the Master Urbanism, it is only natural that it includes a specific project location where there can be focussed on spatial planning or design. In the case of this thesis, a location has to be found where multiple designs can be made for the public space. It has been explained before that this thesis is built around a topic instead of a location. The location merely functions as a test area to find the relation between the theory and the built environment and to see if the outcome of the research is applicable in the design of real urban areas. This is the reason that the location of this project is introduced only now.
The city that has been chosen is London. The specific project area is Caledonian, a ward in the borough Islington. This part of the thesis, part 04, introduces the location and explains why it has been chosen.

Observations and analyses of the location have led to a general strategy that aims to reduce stress within this area. One part of this strategy, a route through the area, is further zoomed in on. A design is made on the scale of this entire route and smaller and more detailed designs are made for smaller areas on or close to this route. In all these designs, the knowledge and the design criteria from the previous parts are used. This is shown in coloured labels connected to the maps of each location. Sections and impressions are used to show in more detail what has been altered in the space and how this effects the atmosphere in terms of stress.

14. LONDON

In the process of choosing a location, there were first a few personal interests that led to some personal criteria. I wanted the location of the project to be in a large, high density, Western European city, that everyone would know. The reason for this is that there is a high probability of stress in such a location and people can hopefully easily relate to the project when it is about a location they know. A large, high density city was not only personal preference, but a metropolitan area is also important considering the main research question.
After focussing on the criteria above, the decision is based on the stressful city ranking of Zipjet (2017) and the relevance of stress in different cities according to different newspapers and other media.

Urban stress in London
As seen on page 82, London was only ranked #81 of the world in terms of being a stressful city. When looking only at Europe, London is ranked #17. However, even though some other Western European cities scored worse on some of the stressors, most of them also scored better on some of the stressors. It was striking that London scores averagely bad on most stressors. This implies that there is much improvement possible, but also that the city is not completely hopeless when it comes to stress.
This observation has then been combined with a simple, not so scientific, google search on stress in different cities. For London, there were many hits of newspapers, blogs, etc. that had written about all kinds of stressful situations that go hand in hand with living in London. For other Western European cities, not as much attention was given to the topic of stress, which made it seem not as relevant as in London.
So the combination of the observations about the Zipjet ranking and the apparent relevancy have led to London as the city for this project.

			CITY						POLLUTION			FINANCE				PEOPLE				
#	CITY	COUNTRY																		TOTAL
81	London	United Kingdom	6.68	3.60	2.93	6.86	6.50	9.40	3.48	5.05	8.43	5.29	5.05	3.90	3.36	5.47	7.43	2.87	2.99	4.95

Legend

- Density
- Green Spaces
- Public Transport
- Traffic
- Perception of Security
- Sunshine Hours (av./year)
- Air Pollution
- Noise Pollution
- Light Pollution
- Unemployment
- Debt per Capita
- Social Security
- Family Purchase Power
- Mental Health
- Physical Health
- Gender Equality
- Race Equality

Image 7: London in stressful city ranking Zipjet (Zipjet, 2017)

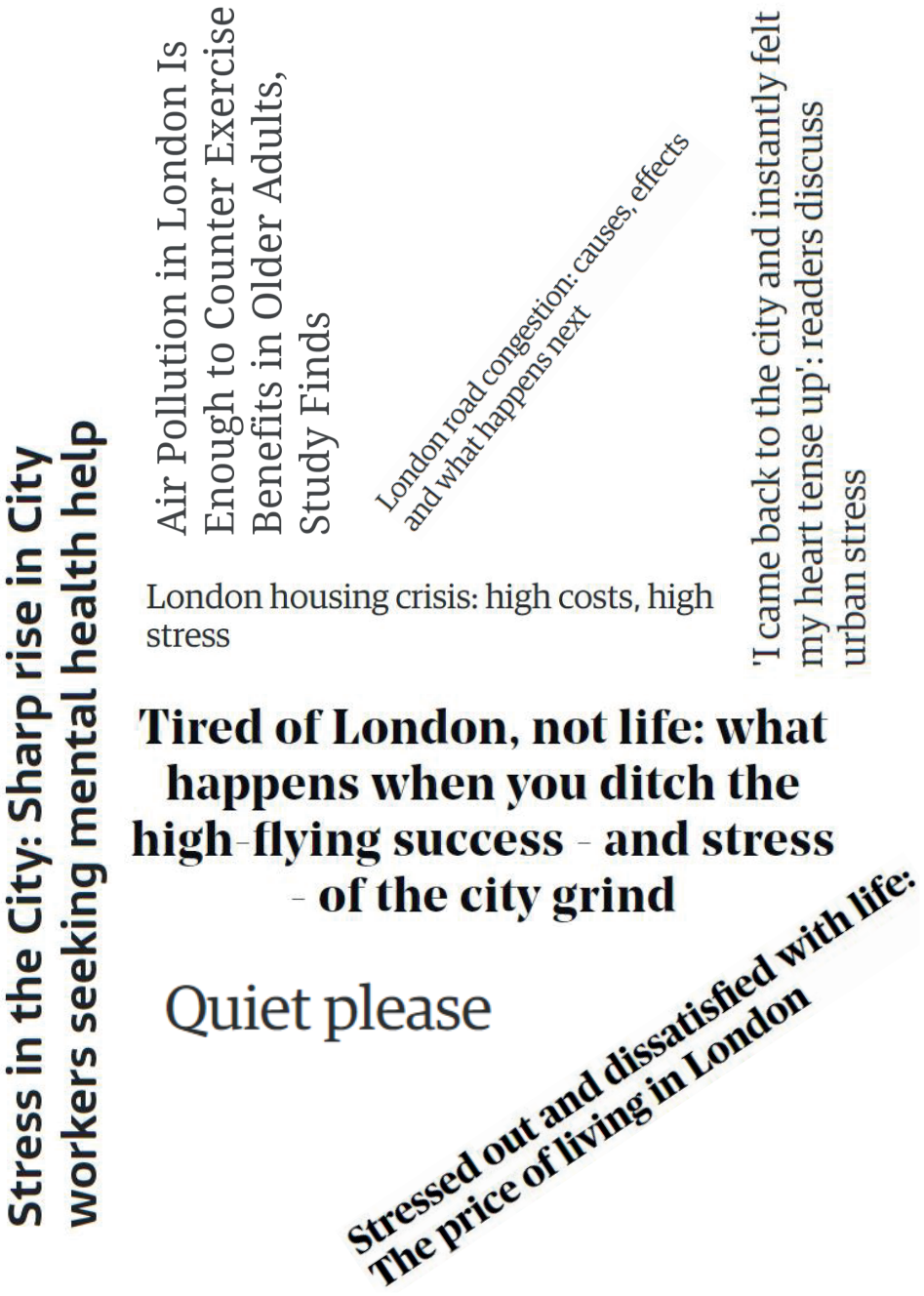


Image 8: Collage of headlines about stress in London (by author, based on unknown, 2012; Perry, 2015; Russell, 2016; Hill, 2013; Henriques, 2017; Hill, 2016; Hardy, 2008 & unknown, 2017)

15. CALEDONIAN

The entire city of London is much too big to cover in this graduation project. Besides, only a smaller urban area is needed to be able to make the link between urban stressors and urban design.

When choosing the specific location, there was first looked at the bigger scale of the London boroughs. A first selection, based on personal preferences (the feeling that you are still in the inner city and the chance that people will know the area) led to a selection of 13 boroughs, see map 1. In order to get a smaller selection, these boroughs were cross-referenced against population density and well-being scores. When comparing maps 2 and 3, this leads to 6 boroughs:

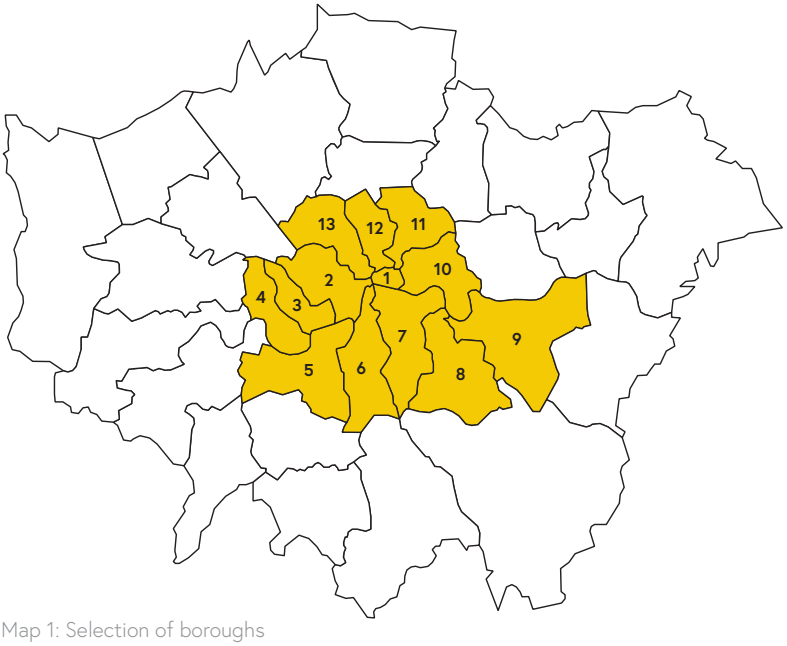
- 2. Westminster
- 6. Lambeth
- 10. Tower Hamlets
- 11. Hackney
- 12. Islington
- 13. Camden

On page 86, the land-use division of these boroughs is shown, consisting of domestic buildings, non-domestic buildings, roads and rail, domestic gardens, paths, greenspace and water. For this map, it is assumed that domestic buildings, non-domestic buildings, roads and rail can cause stress and that domestic gardens, paths, greenspace and water can help reduce stress.
The two boroughs with a bigger percentage of 'negative land-uses' than 'positive land-uses' are Westminster and Islington. Looking back at map 3, Islington has a worse well-being score, so therefore an area in Islington is chosen as a specific location for this project.

Islington is divided into 16 wards and the size of a ward is a fitting area size for this project. The choice for Caledonian (ward 6 on map 5) has been made quite bluntly. Only the southern wards still make you feel as if you are in London, of those 4 score quite bad in terms of well-being:

- 3. St. Peter's
- 4. St. Mary's
- 5. Barnsburry
- 6. Caledonian

The ward Caledonian is right next to the national and international train stations King's Cross and St. Pancras. This might mean higher levels of stress or a higher amount of stressors and makes it easier for people to identify the area. Therefore, Caledonian is chosen as the location for this project.

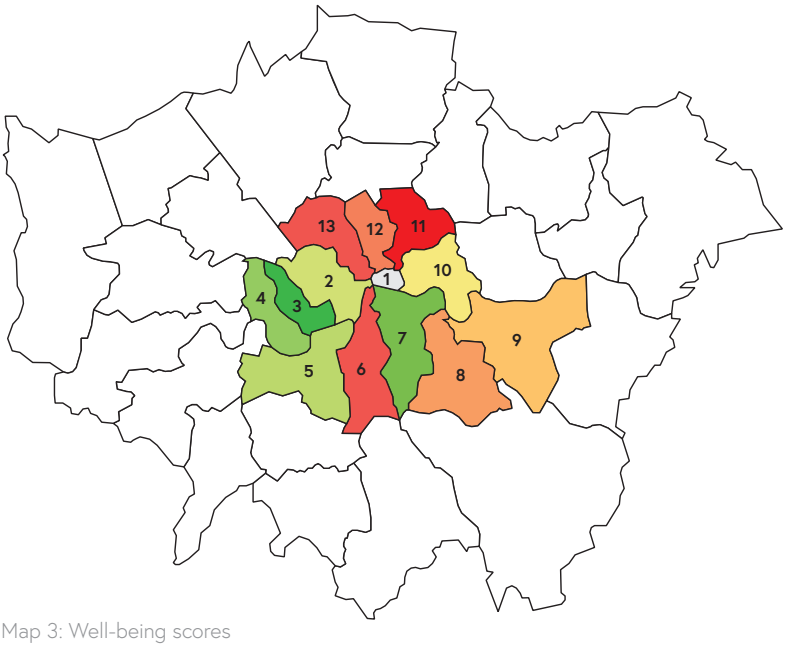


1. City of London
2. Westminster
3. Kensington and Chelsea
4. Hammersmith and Fullham
5. Wandsworth
6. Lambeth
7. Southwark
8. Lewisham
9. Greenwich
10. Tower Hamlets
11. Hackney
12. Islington
13. Camden

Map 1: Selection of boroughs

10.000 +
75000
5000
2500
0 (people per sq km)

Map 2: Population density



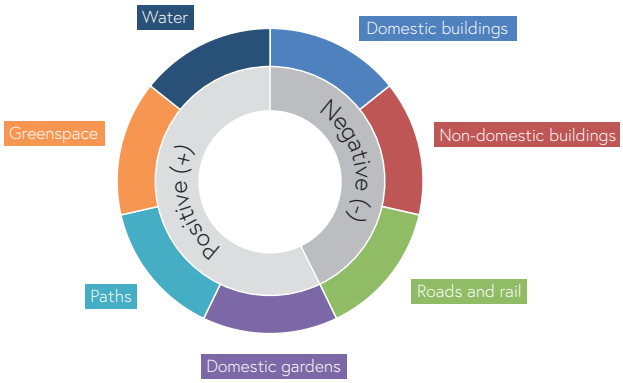
Lowest well-being score

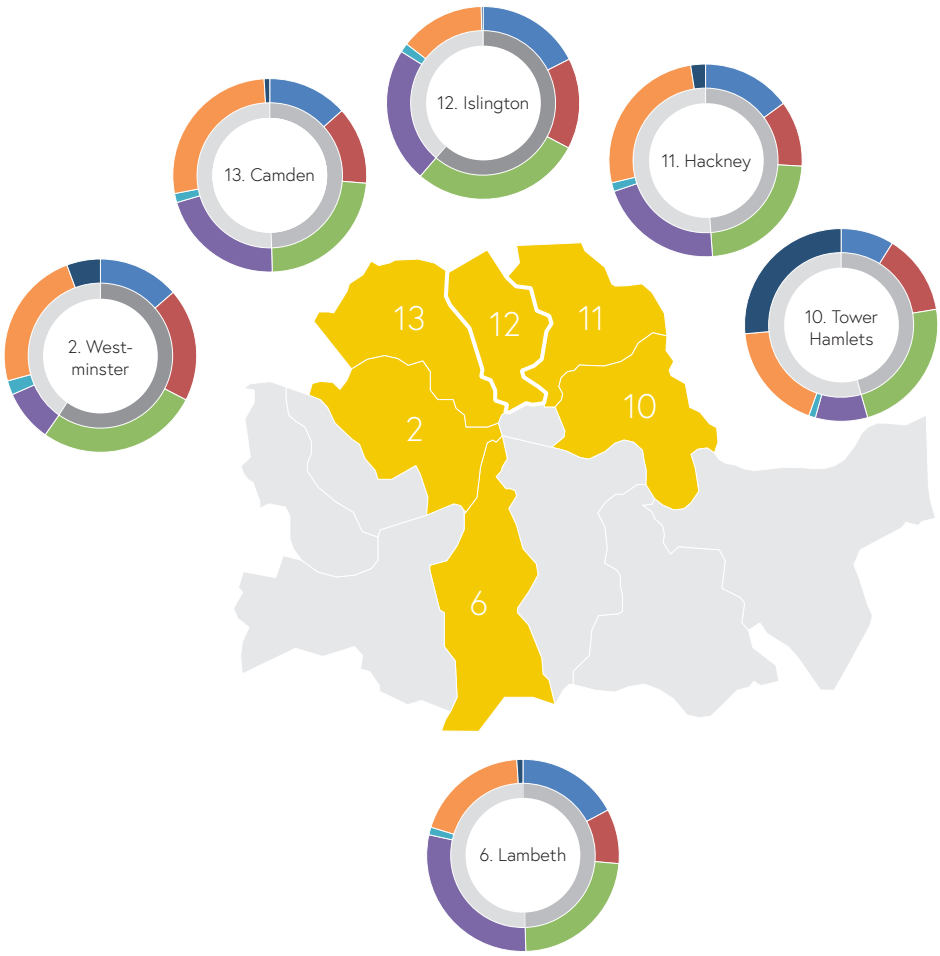
Highest well-being score

No data

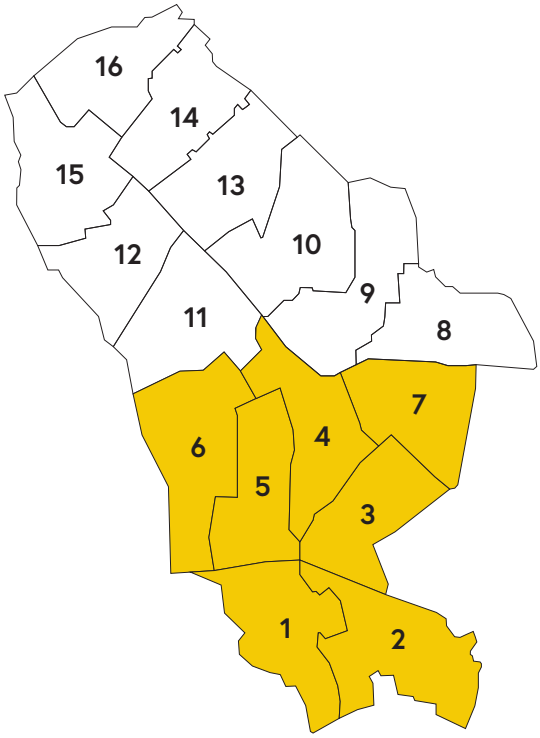
Map 3: Well-being scores

Map 2-3 (by author, based on Office for National Statistics, 2010; Office for National Statistics, 2015)



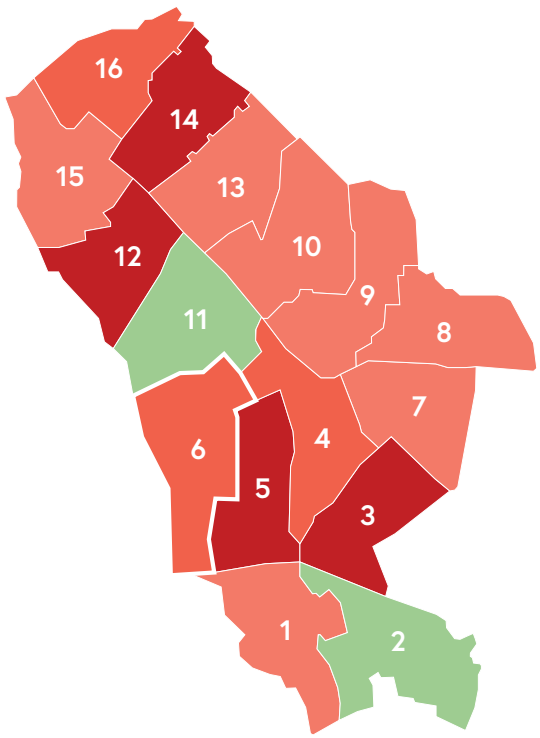


Map 4: Land-use of selected boroughs (by author, based on Office for National Statistics, 2007)



Map 5: Islington wards

1. Clerkenwell
2. Bunhill
3. St. Peter's
4. St. Mary's
5. Barnsburry
6. Caledonian
7. Canonbury
8. Mildmay
9. Highbury East
10. Highbury West
11. Holloway
12. St. George's
13. Finsbury Park
14. Tollington
15. Junction
16. Hillrise



Map 6: Islington ward scores

Ward score based on:

- Safety
- Accessibility of public transport
- Accessibility of green spaces
- Well-being

Lowest score

Highest score

Map 6 (by author, based on London Datastore, 2015)

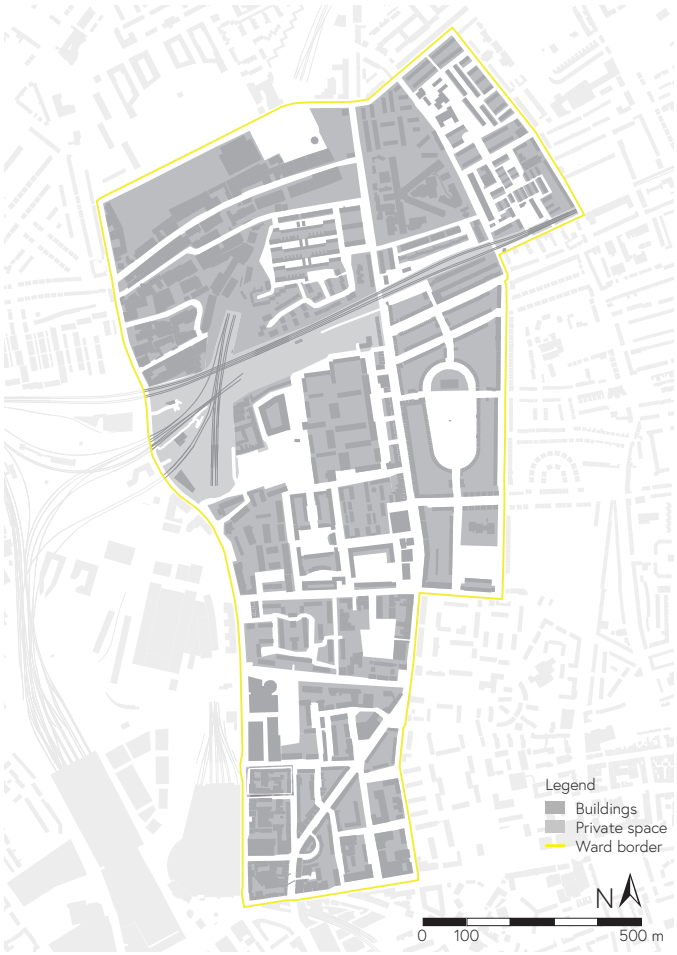
About Caledonian

Caledonian is a ward in Islington, London and has about 14.000 inhabitants (Islington, 2014). It is located at the northeast of the well-known stations St. Pancras and King's Cross. The area is divided in three parts (see map 9 and 10). This division is made by the Regent's Canal in the south and by the railway in the north.

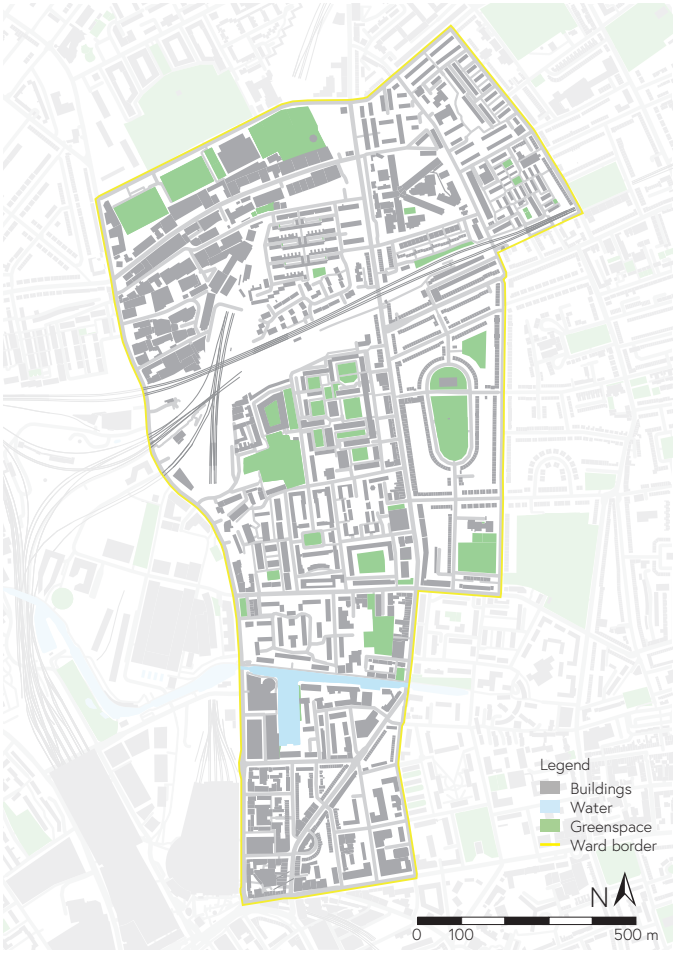
When looking just at the built space (map 7) it seems as if there is much open/public space left in this ward. However, when adding the layer of private space (map 8) it becomes clear that this is not the case. It is remarkable that a big part of this open space is either water or greenspace. This is however unfairly spread over the area, because in the north(east) and in the south of the area, there is clearly a lot less green present.

In terms of functions, the south part, close to the stations, is mainly a retail and business area. The middle part is mainly residential and the north part consists of both a business and a residential area. The blue circle on map 10 shows the location of a prison, which is located in the middle of a residential area.

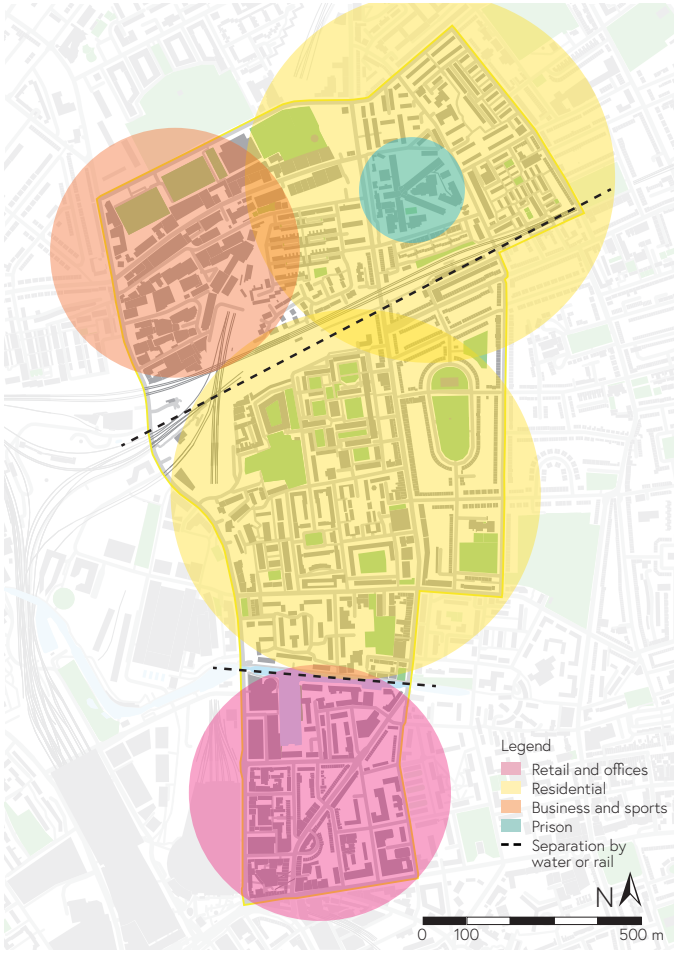
Map 7: Buildings Caledonian



Map 8: Private space Caledonian



Map 9: Water and green Caledonian



Map 10: Areas by function, Caledonian

16. FIELD TRIP

Observations
After getting to know Caledonian through Google Maps using satellite images and street view, it was very interesting to finally be able to walk through the area. Because the way people experience the city is so important in this project, it became immediately clear that the still images of Google Maps were not sufficient to get a good overview of the area and how it is being used. It was good to see what places were used and by how many people and what kind of places weren't used, even though you might think that they would be. It was also good to experience how I perceived the public space, keeping the earlier found stressors in mind. The times I felt stressed in the project area, were mainly caused by fear (safety - crime/robbery), people (human behaviour and crowding), the lack of usable green, traffic, lack of space for pedestrians and the atmosphere.
It was also striking that people often choose to use primary streets, which is where generally most urban stressors occur in this area.

Survey
The prepared survey consisted of several questions related to two pictures showing more or less stressful urban situations (according to literature study and translation to urban design thinking) and some open questions. However, the questions that were based on pictures were difficult for people to answer, because they didn't see a strong relation between the pictures and urban stress or because the differences between the pictures were too subtle. This meant a change in approach, focussing only on the open questions later on.
From these questions, it became clear that people (both crowding and human behaviour) are the most obvious stressor for people in the city. The next page shows the most important indicative outcomes of the qualitative street conversations that were held.

Interview with expert
Talking to someone who works on the same topic is always very nice. However, the expert unfortunately couldn't tell me much about the urban design aspect of her work and couldn't tell me much more than what I had already read on their website.

YES

NO

Experience urban stress?

HUMAN BEHAVIOUR

CROWDING

BUSY

TUBE

SAFETY

HARD TO GET AROUND

PEOPLE LOOKING AT SMARTPHONE

LOT OF TRAFFIC

YOUTH

RUSHING

BUILT ENVIRONMENT

LACK OF SPACE

WORK

NOISE

SMELLS

ATMOSPHERE

SUGGESTIONS

MORE GREEN

MORE SPACE FOR PEDESTRIANS

LESS CARS

MORE OPEN SPACE

MORE SAFETY

MORE BENCHES

BETTER CONDITIONS

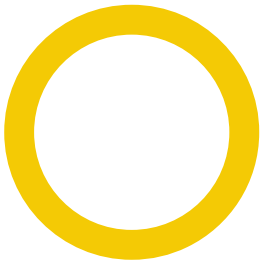
MORE LOW RISE

CAR FREE STREETS

DESIGN ON HUMAN SCALE

BETTER WAYS TO CROSS THE STREET

YES



Avoid urban stress?

TAKE A QUIETER ROUTE

TRAVEL OUTSIDE RUSH HOUR

SPORTS

TRY TO IGNORE PEOPLE

AVOID THE TUBE

STAYS OFF SMALL STREETS AND OUT OF PARKS IN THE DARK

AVOID YOUTH

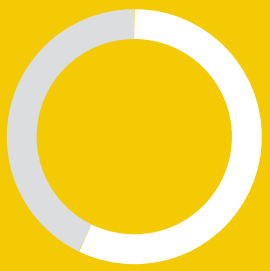
AVOID THE BUS

STAY IN FAMILIAR PLACES OR GET FAMILIAR WITH THEM

AVOID NOISE WITH HEADPHONES

GO INTO PARKS

NO



YES

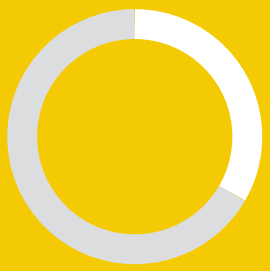
Experience urban stress?

I'M JUST NOT A VERY STRESSFUL PERSON

BECAUSE I'VE LIVED HERE ALL MY LIFE

I'VE LIVED HERE FOR 20 YEARS, SO I KNOW IT LIKE THE BACK OF MY HAND

NO



YES

Avoid urban stress?

I AVOID BOYS ON BIKES OR MOPEDS

TAKE QUIETER ROUTES

Conclusion

The amount of people and their behaviour (also linked to safety - crime) is the most mentioned stressor by the interviewed people. In the conversations, it became clear that stress is often experienced during their travel through the city, so while moving around. It also became clear that safety is an issue in a specific area of Caledonian.

17. STRATEGY

After trying to start designing to reduce urban stress and after visiting the project location, it became clear that a more general strategy was needed first on the scale of the entire ward. From observations and street talks, it became clear that a lot of stress is experienced while travelling through the city. This suggests that routes/streets are a priority. At the same time, it is also important to have places for restoration, either for people that live in this area, or for people that have some extra time while travelling.
Therefore, this strategy focusses on places to stay and places to move. Those two combined, should ensure a less stressful, calmer Caledonian.

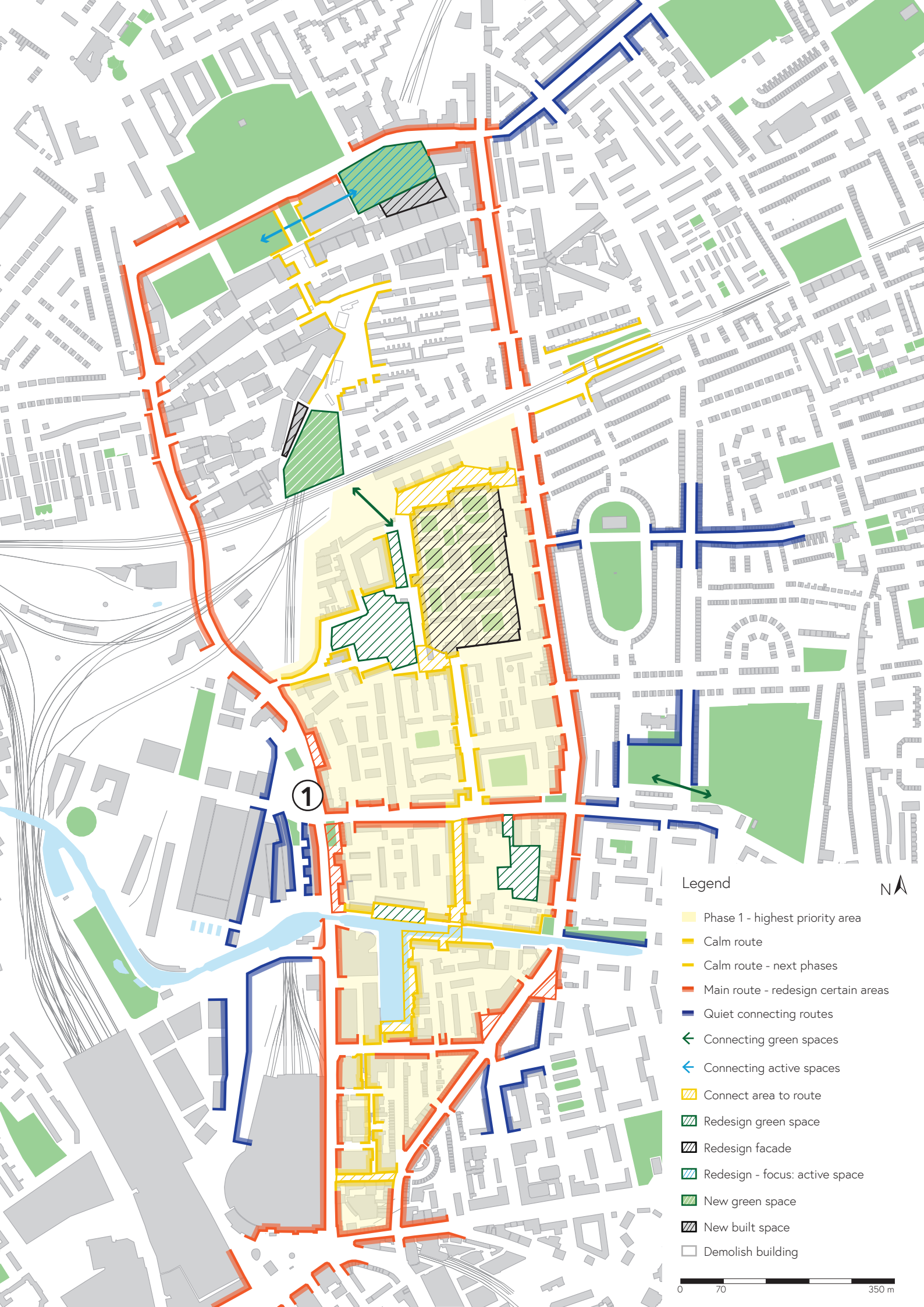
The first step is creating a peaceful route, away from the main roads. This route is drawn in yellow (see the map on page 94). Along this route, a number of small to medium-sized interventions are made to support the stress free experience. From the street conversations in the area and from observations, it became clear that the area marked in light yellow has the highest priority to address first.
The yellow routes however, drawn without an inner glowing 'shadow' are suggestions for the next phase.

The red routes are the existing main routes, with a lot of stressors. Even though there will be a new - yellow - route, these routes will most likely also still be used regularly. Therefore, a new street design is also necessary here at some places.

The blue routes are quite peaceful routes in the current situation, that connect the project area to the surrounding areas and even to the rest of the city. They can be used together with the new calm route.

The areas that have green lines, are existing or new green spaces that either have to be designed or redesigned. Some of them, often smaller in size, are mostly meant as 'places to stay', others are to support the routes that are alongside them.

When an area is marked with black lines, it concerns buildings. Either the facade or plinth changes, to create a more safe or aesthetic street environment or a built area is demolished or there is a new area available for buildings, to create enough space for the routes.


1
Legend
N
Phase 1 - highest priority area
Calm route
Calm route - next phases
Main route - redesign certain areas
Quiet connecting routes
Connecting green spaces
Connecting active spaces
Connect area to route
Redesign green space
Redesign facade
Redesign - focus: active space
New green space
New built space
Demolish building
0
70
350 m

The strategy is not just a plan for the larger scale, it is also an important scale to look at some of the stressors and stress reducing approaches. The routes for example, are not only a response to observations and interviews, they also support physical activity as there is more space to walk and cycle. It also connects many of the 'places to stay' which improves their accessibility. This is also true for the stations, which together with the improved walkability, helps support a less car dependent city.

The yellow route within the priority area has been chosen to further elaborate on, this is done in chapter 18.

NOTE: on the east road, marked in red (see number 1 on the map), a Cycle Superhighway is designed into the street. Cycle Superhighways are designed throughout the entire city to support cycling. One of these routes is also planned in this area, but this has not been made specific yet. To encourage physical activity and connect to a larger scale and the plans of the city, this Cycle Superhighway is included in this strategy.

18. CALM ROUTE DESIGN

18.1 Design on route scale

The calm route through a large part of Caledonian is designed on two levels. The first is on the scale of the entire route, the second are smaller scale designs presented at the end of this chapter. It was important to make also a more general design on this larger scale, because it is better suited for some of the design criteria that followed from the indirect approaches.

There are mainly two things important on this scale. The first is that the route is connected to places to stay, this does not only connect the route to the strategy, it also makes the route more suited for restoration.

The second thing is that the route should be clear. This is very much related to the indirect approach perceived control. The route is therefore guided in a subtle way by using the same material for easy identification and gates of trees or pocket parks are designed on places where the flow of the route is more difficult to recognise.

Moreover, some streets have gotten a new prioritisation, giving pedestrians and/or cyclist a higher priority. This is done by a new division of the space or by creating (semi) shared spaces.

Some other stress reducing interventions are shown in the yellow labels.

More 'green walking'

Being away & scenery

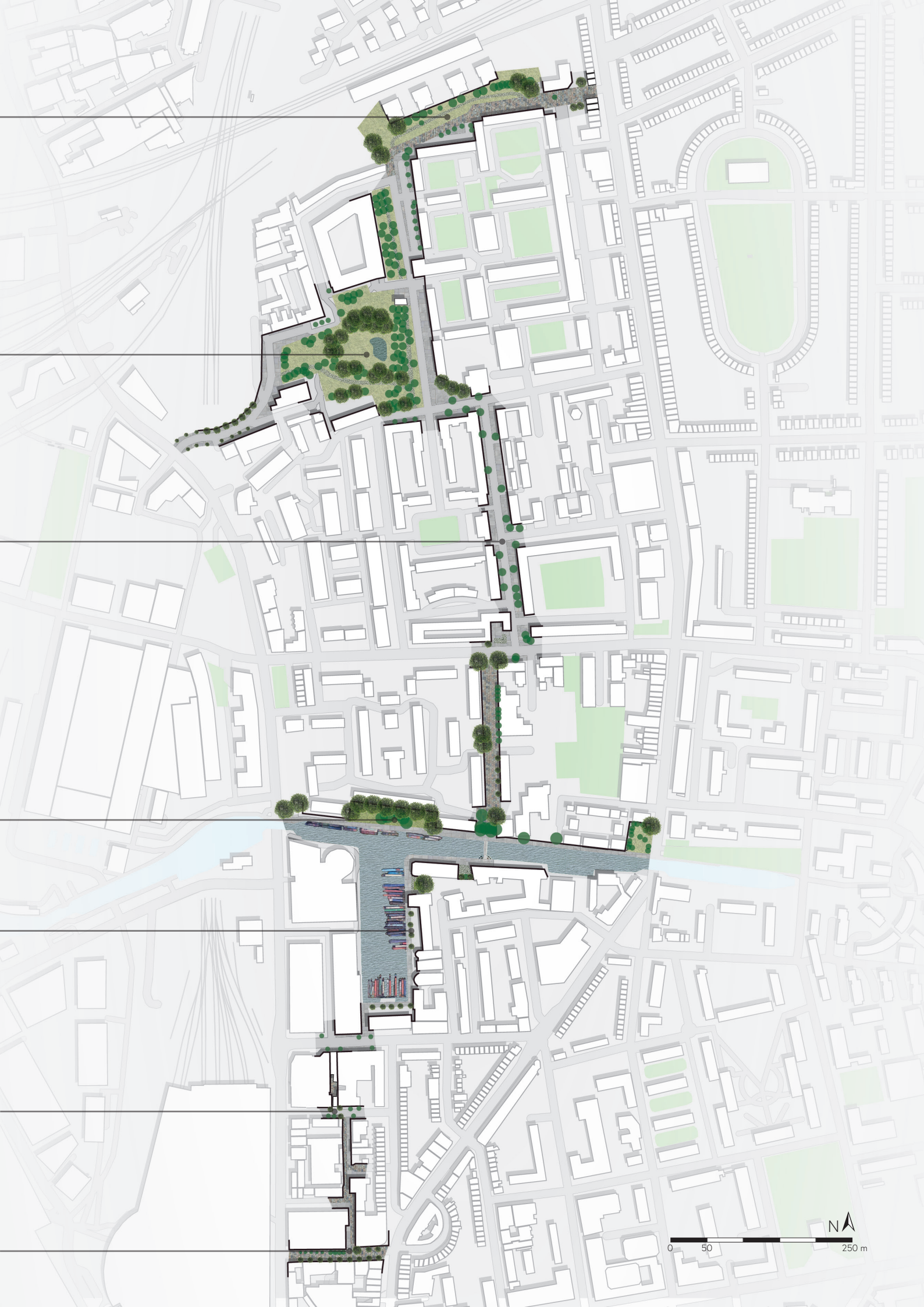
Identifiable paving

More open space & places to stay

Being away & green

'Tree gates'

Shared space & identifiable paving


N
0
50
250 m

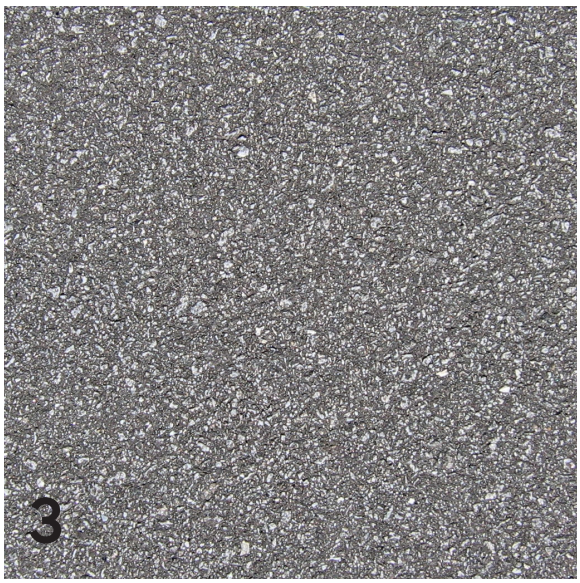
18.2 Recognizability and material use

It has just been explained that in order to achieve a higher perception of control, the same materials are used throughout the route. They are shown on the next page.
The first paving material is used when the space is just meant for walking or sometimes cycling. This is often the case when there is also a part of the street available for motorized vehicles, which can be recognized by asphalt (material 3).
When the space for pedestrians is in some way connected to the space for other traffic, in a street with (semi) shared space for example, the second paving material is used.
The fourth material is used in 'places to stay' that are connected to the route. This material is a little less easy to walk on and comes closer to the natural atmosphere that many of the places to stay have.

The first two pavements are inspired by the materials found in the area around the canal, in between the harbour style buildings. This means that they are not random, but connect to the area and therefore to some extent to the city of London as well.


1


2


3


4

18.3 Design locations

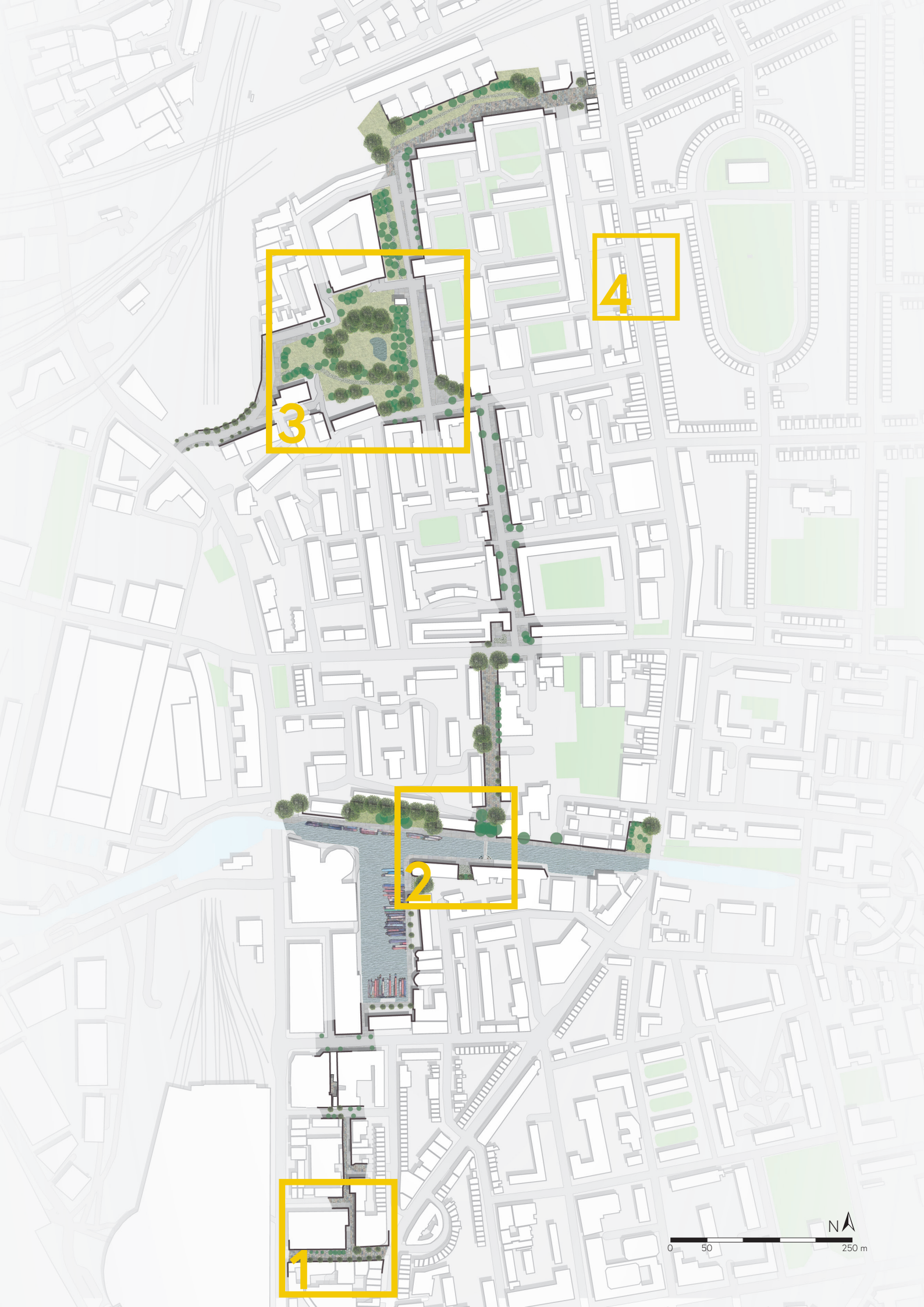
To be able to really connect the stress reducing approaches to the design of the public space, several small scale designs have been made for areas along the calm route. This does not only test the applicability of the design criteria, it has also helped formulate them using the interaction between research and design. For a complete set of spaces, each with different characteristics, a design has been made for 4 different locations (see page 101):

1 = Caledonia Street (18.3.1)
2 = Regent's Canal (18.3.2)
3 = Bingfield Park (18.3.3)
4 = Caledonian Road (18.3.4)

They are presented in the next sub-chapters. For each of the designs, a small introduction is given of the location first and it is shown which urban stressors are most dominant. Then a map shows the new design. Connected to this map, there are labels in up to four different colours. They represent the design criteria from part 03, matching the colour of each of the four different approaches. These labels show in what way the design is improved in terms of stress reduction. This is then made more clear by sections and impressions, each supported with a small text.

NOTE 1: For each of the designs, it is being explained how they are related to the direct and the indirect approach. Sometimes, an intervention can support multiple approaches as well as be a direct answer to a stressor. In that case, the most important one is chosen and put in the label next to the map. Often, it is then explained in the text how this intervention also relates to other approaches.

NOTE 2: *Flash forward*. A separate booklet (chapter 22) has been made about the urban stressors, conclusions given in chapter 19 and the stress reducing approaches. The layout of this booklet is already used for the analyses of urban stress in the 4 different locations.


3
4
2
1
N
0
50
250 m

18.3.1 CALEDONIA STREET

Caledonia Street is the first project location shown on the map on page 101. It is a one way street at the south of the project area and at the south of the calm route. It actually marks the first part of the route when approaching it from the busy stations and city centre. It can be seen as a tertiary road, with a low amount of traffic and no parking spaces. The street surface is however still quite wide in comparison to the sidewalks and therefore dominant in the scene of the street.
About halfway down the street, the sidewalk is connected to an alley, that leads north through the project area and is also part of the calm route. This alley is surrounded by very nice buildings in sort of a harbour style, which are now mainly used as offices.


Mon - Fri
8.30 am - 6.30 pm
Saturday
8.30 am - 1.30 pm

1. Building density

2. Crowding

8. Accessibility & availability of green

6. Traffic (jams)

9. High-rise

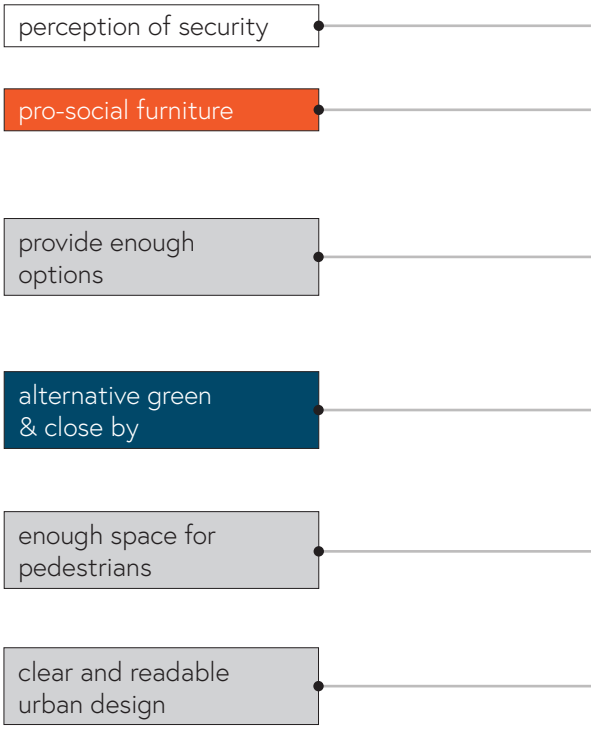
12. Architecture and urban design

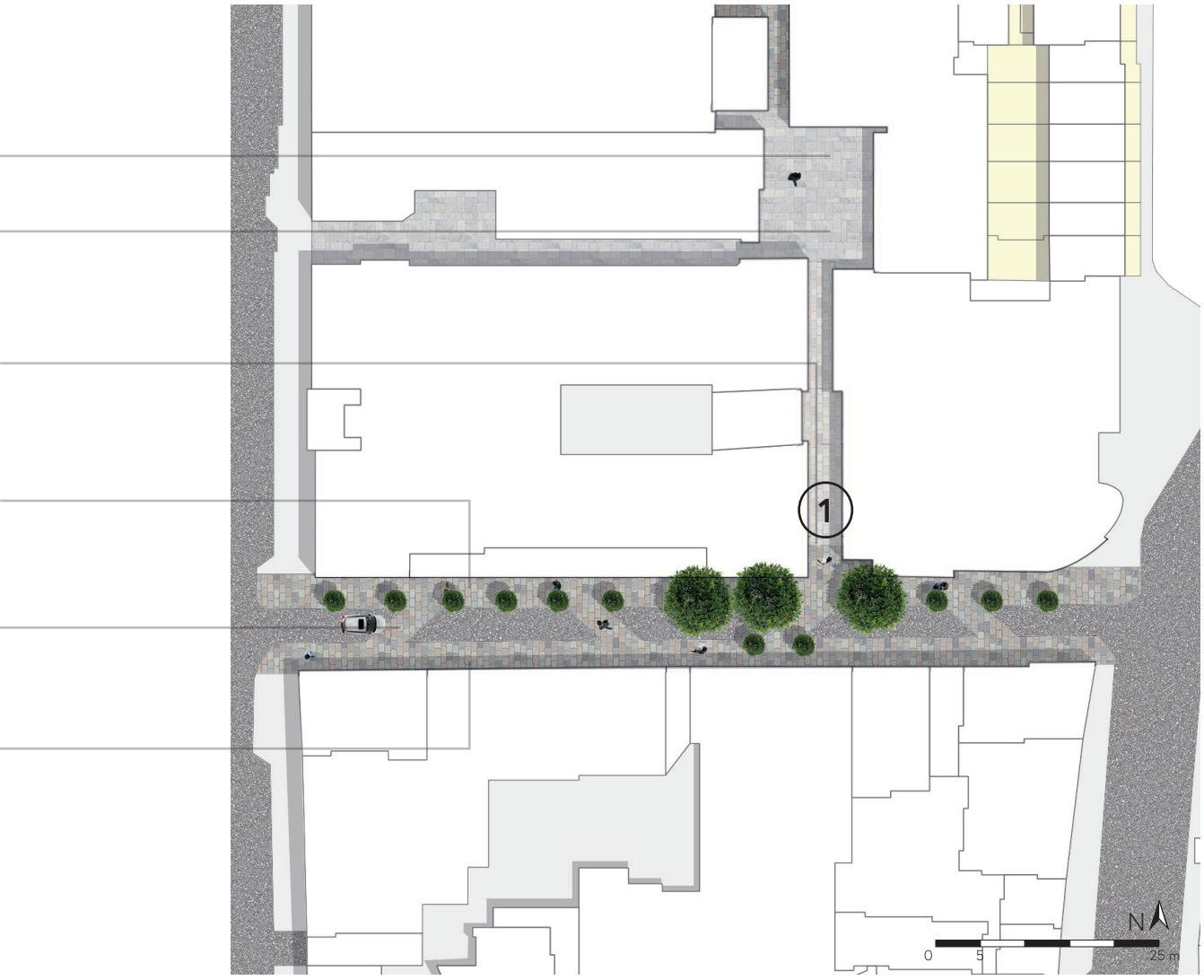
22. Air pollution

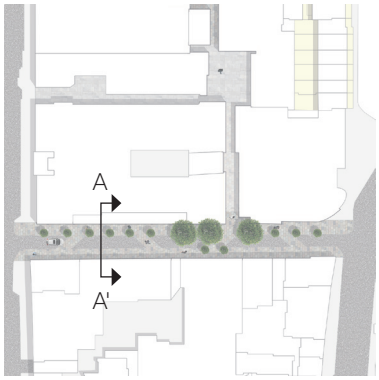
23. Noise pollution

Image 9: Satellite image of Caledonia Street (Google Maps)

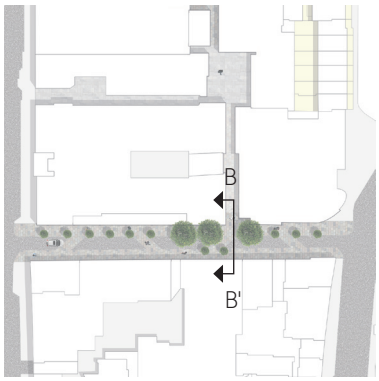
The most important change in this street is the widening and repaving of the sidewalks. This gives pedestrians more space to support walking and prevent crowding. The paving supports the perception of control, because it is used as a subtle guiding throughout the entire calm route, when there is shared or semi-shared space. Speaking of which, the same pavement is used on the part of the street that is meant for traffic. Where this was just asphalt at first, it is now a combination between asphalt and the sidewalk paving, prioritising the pedestrians and making it easier for them to cross the street.
Moreover, more trees are added in the street, making it more green. This does not only support restoration, but is also important in the other indirect approaches as well as a direct answer to stressor 08. accessibility & availability of green.
Making the alley (1) more accessible and connected to the street, does not only provide an extra option for pedestrians, it also provides access to this very quiet part of the calm route. Along this route, there is a small patio, transformed into a 'place to stay'. Social interaction is promoted here by using pro-social furniture and more artificial lights have been added for a higher perception of security, especially after dark (see page 111).



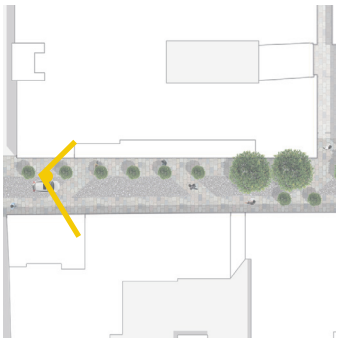

1
N
0
5
25 m



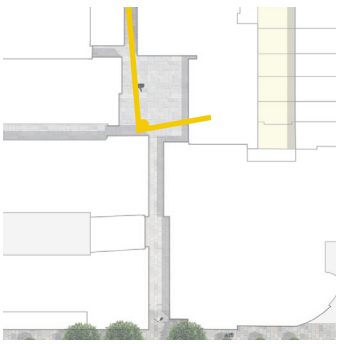
In this section, it becomes really clear that in the new situation, the pedestrians are being prioritised. Not only do they have more space than the traffic, it has also become easier to cross the street (see page 110). Although not many trees have been added, they can still have a positive influence on noise and air pollution, as well as supporting the indirect approaches of stress reduction.



Because of the removal of the gate, the continuing of the pavement around the corner of the building, the positioning of trees and a street crossing, the alley can easier be found and effortlessly be entered. The different pavings found here have been an inspiration for the pavings used throughout the entire calm route.



On this impression the new situation of the street becomes clear. Especially the combination of asphalt and sidewalk paving to prioritize pedestrians and make it easier for them to cross the street. Also the impact of the newly added trees is quite big, as well as the atmosphere created by the new pavement.



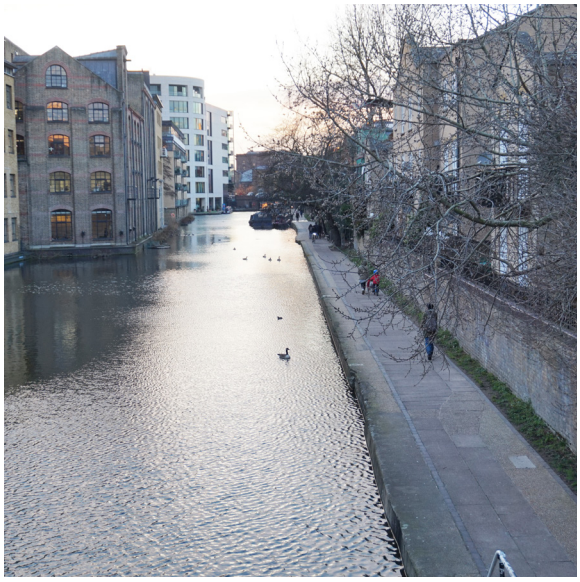
Both the flower pots and the round seat are filled with lights. Besides improving the quality of the space, they also provide the space with more light after dark, which increases the perception of security. The round seat supports social interaction, which is also accomplished by the arrangement of the other seats.

18.3.2 REGENT'S CANAL

The second design location is located around the Regent's Canal. It is a canal that was used by tow boats, pulled by horses. These days, the boats are still there, but they have been slightly modernised. They now function as a home for people who look for cheap living spaces in London.

It is a very nice and quiet area even though it is in central London, and one could really feel like being away for a short while. This is reinforced by the wall along the path, that even though it looks quite unmaintained, nicely hides the view of the neighbourhood on the north. Unfortunately, the Regent's Canal Towpath that runs along the canal, is not very well connected to its surroundings and it is therefore not an obvious option to take this path.

The canal is surrounded by very nice characteristic buildings. Between those buildings, there are quite a lot of open spaces, but unfortunately these spaces are often not reachable or not accessible.



1. Building density

2. Crowding

4. Garbage, graffiti and disrepair

8. Accessibility & availability of green

12. Architecture and urban design

18. Sense of security

23. Noise pollution

20. Lack of social support networks

Image 10: Satellite image of Regent's Canal (Google Maps)

The two most important changes in this design are the new walking path along the other side of the canal (1) and the open spaces along the paths, which are now accessible, more green and designed as social 'places to stay' (2). The new path is part of the bigger calm route and the new bridge is crucial as a new connection and thereby providing a new calm option. The combination between the added green - being trees, grass, hedges and ivy against the walls - and the water of the canal, should have an extra restorative effect. At the same time, those natural elements reduce all kinds of pollution and block some of the surrounding buildings, giving the visitors a feeling of being away.
The small open space north of the bridge has been designed as a pocket park (3), connecting the route to the street in the north and making it an easy and inviting transition. This same street (4) is now a shared space street. In this low traffic street, a lot of parking has been removed and the pedestrians and cyclist have been given the same or a higher priority than motorised vehicles. In combination with more green, this does not only make the street calmer, less polluting and more inviting to walk, cycle and socialize, it also becomes safer. This is especially important since there are two primary schools connected to this road. Again, all the materials are the same as the ones used throughout the entire route, making it recognizable and providing a feeling of control.

clear and readable urban design

make connections

enough space for pedestrians

walking & cycling routes

avoid air and noise pollution

accessibility & availability of green

being away

more green & water

pro-social furniture

places to stay

provide enough options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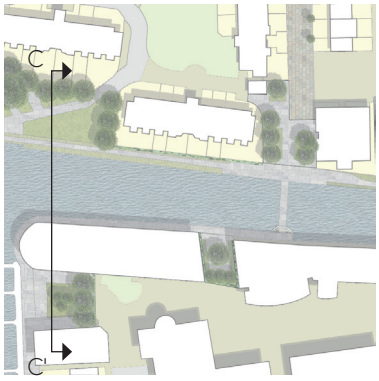
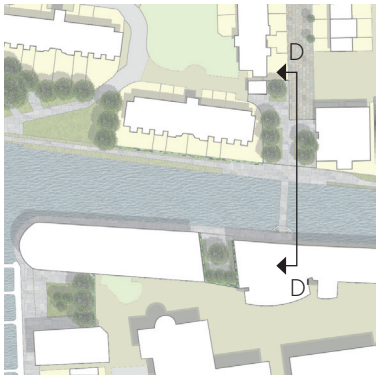
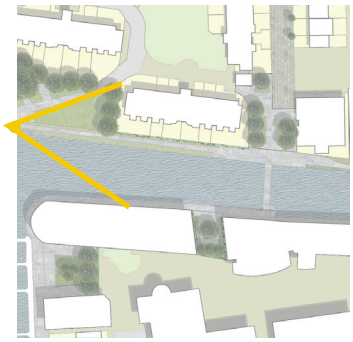


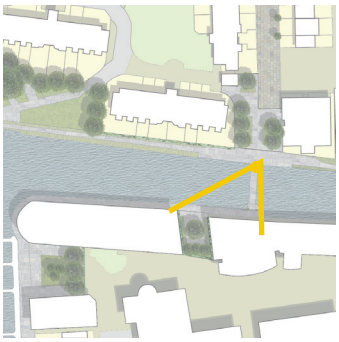
This section shows how the two previously inaccessible open spaces are now part of the calm route. It also shows how much of an impact a green wall can have on an open space and how this, in combination with trees, can hide the built space behind it (when looking at eye level). Finally, it shows how the walking space along the canal has been almost doubled by the path for this part of the canal.



This section shows the bridge and how this new path is connected to the existing street by the newly designed pocket park. This has not only become a greener space, but also a space for people to sit, meet and socialize. Again, the green wall and the trees make sure that the surroundings are hidden as much as possible, providing the people a feeling of being away.



The park on the left used to be closed off by a large gate. It is now visible and accessible from the path/calm route. This not only gives the route a more natural environment, it also creates a nice place to stay, meet people and relax. In this image it also becomes clear, especially when comparing it to other impressions, how the paving gives a feeling of familiarity and control.



The new path does not only provide more space for pedestrians and does not only provide a new connection, it also makes the open space between the buildings accessible and it brings the people even closer to the water. The open space has been made more green and pro-social, which is not only beneficial for the people who are passing by, but also for the employees working in the surrounding buildings.

18.3.3 BINGFIELD PARK

Bingfield Park is the biggest park of the chosen project area and it is connected to the calm route. Unfortunately, the park is not very well-designed. Even without considering stress, it is not very aesthetic and it seems as if not much thought has been put into the design. It also matches non of the stress reducing criteria of the indirect approach 'restorative environments'. From the east side, it is currently completely inaccessible, because it is blocked by a huge playground which is surrounded by gates. The playground looks as if it has not been used for a long time and it is very badly maintained (see the fourth picture).

8. Accessibility & availability of green

12. Architecture and urban design

18. Sense of security

23. Noise pollution

24. Light pollution

37. Lack of exercise

Image 11: Satellite image of Bingfield Park (Google Maps)

Since nature was an important part of the restorative approach, it is not strange that there are many blue labels connected to this design. In the new design, the park is divided in two main parts: the round inner area (1), and the surrounding outer area (2). The inner area is surrounded by trees and hedges and is shielded from the outside world as much as possible. In this inner area, a water element has been added. This water element does not only improve the restorative effects, but because one part is lower than the other and because there is a fountain, the falling water can drown out the urban noise coming from the surroundings (especially the main road in the west - not on visible on the map). Because of the many trees and hedges in combination with water, this area meets the 'serene', 'extent' and 'fascination' criteria of the restorative environments approach. The grass provides a place to stay, but the big round stairs also function as pro-social seating furniture.
The outer area is focussed more on moving than on staying. The path is paved - in the same pavement as used throughout the entire calm route - and therefore supports walking, running and even cycling. In the east, places to play, sport and exercise are placed, to support physical activity even more. Because this all lies in a green environment, it should be extra restorative.

walking & cycling routes

provide enough options

being away

extent

places to stay

pro-social furniture

accessibility & availability of green

compatibility

fascination

playgrounds

facilities

serene scenery

clear and readable urban design

more green & water

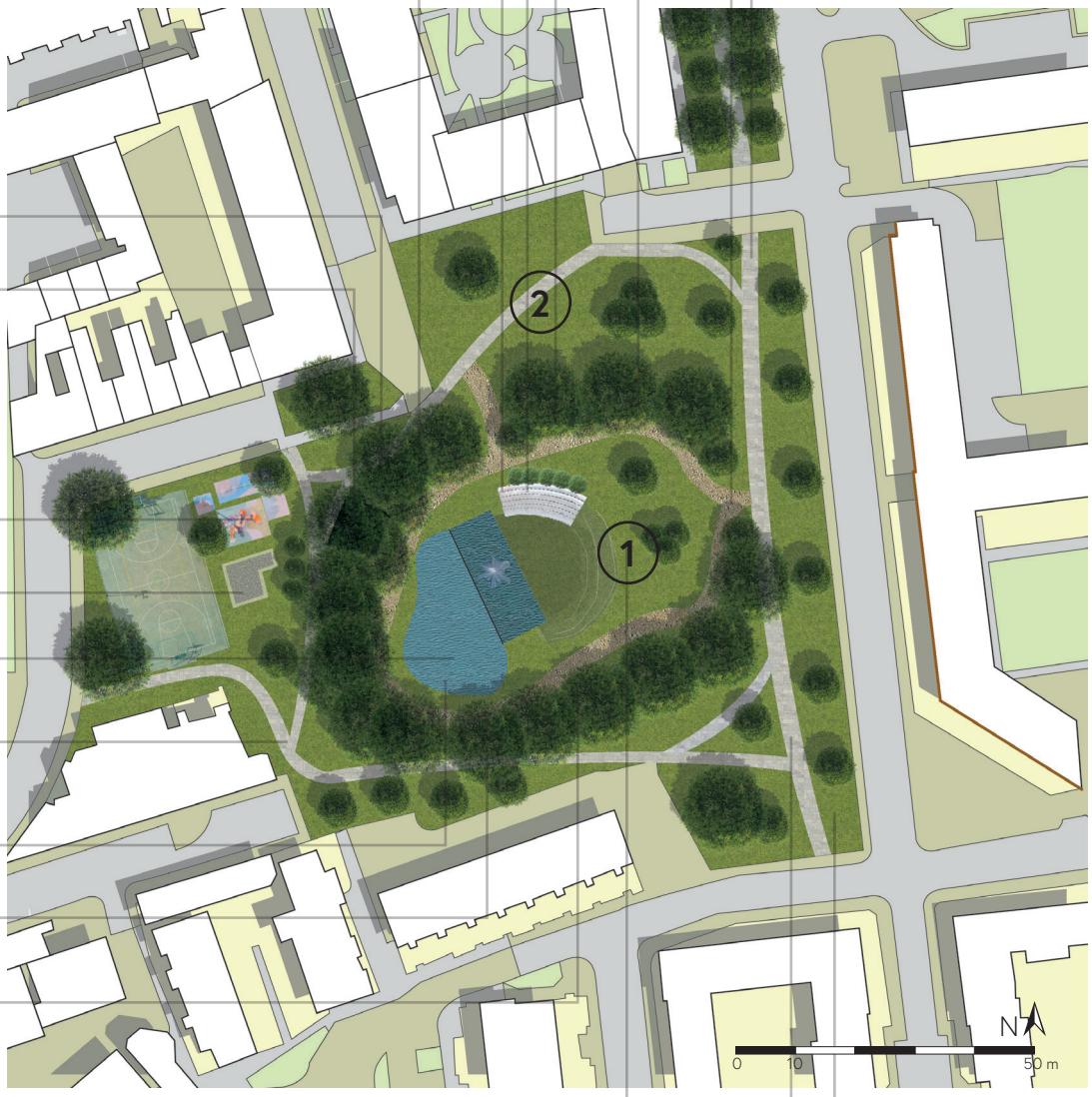
block light & noise

natural environments

high quality public spaces

down-facing lighting

accessibilty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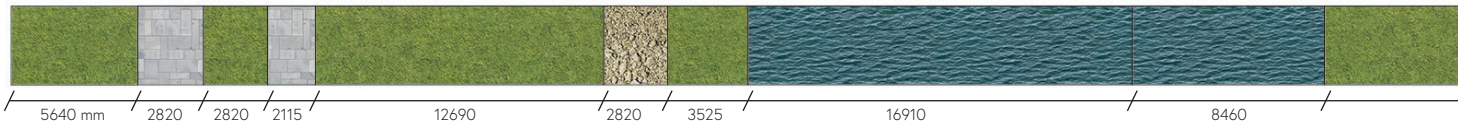
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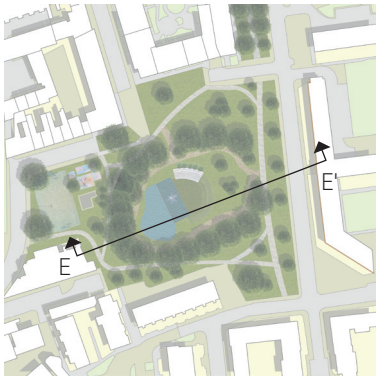
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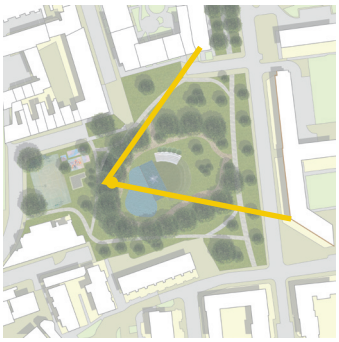
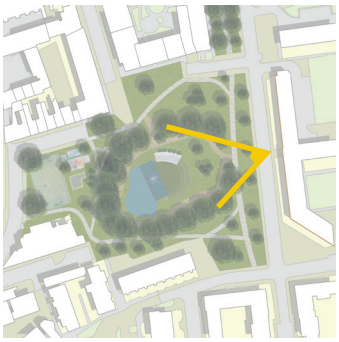
In this section it becomes clear that especially the inner area is surrounded by trees, disconnecting it from the urban environment. This is supported by the lowering of this space, which is also beneficial for the noise reduction and was necessary to create falling water along a long line.
Along the paths in the outer area, down-facing lighting is used, so the residential buildings do not experience any inconvenience from them at night.



In this impression it becomes clear that with more trees and hedges around the inner part, this park has more 'extent'. The park is also much more accessible now the gate and the playground are gone. That side of the park has been left relatively open to ensure some social control. The buildings have been given a new facade, which gives them a better appearance and the area more perceived safety.



This impression shows the view from the opposite side of the previous impression. It becomes especially clear in this impression how the accessibility of the park has been improved by removing the gates and the playground. This also gives the people living along this street the opportunity to watch the park, which can be restorative and provides social control.

18.3.4 CALEDONIAN ROAD

Caledonian Road is a long primary road running right through the project area. It is quite a busy street, especially at rush hour and therefore the traffic really dominates the street.
On both sides of the street there is a sidewalk, which is directly connected to the shops in the plinth of the buildings. Many of these shops are closed, seem closed or are very badly maintained. Above the shops, the buildings have a residential function.
This all combined makes that the street does not feel very welcoming and it causes quite some stress.

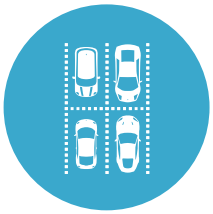

London Square


Dentalmark


Meditation Centre
myspace

6. Traffic (jams)

12. Architecture and urban design



7. Parking problems

16. Gender inequality

8. Accessibility & availability of green

17. Race inequality

18. Sense of security

22. Air pollution

19. Crime & robbery

23. Noise pollution

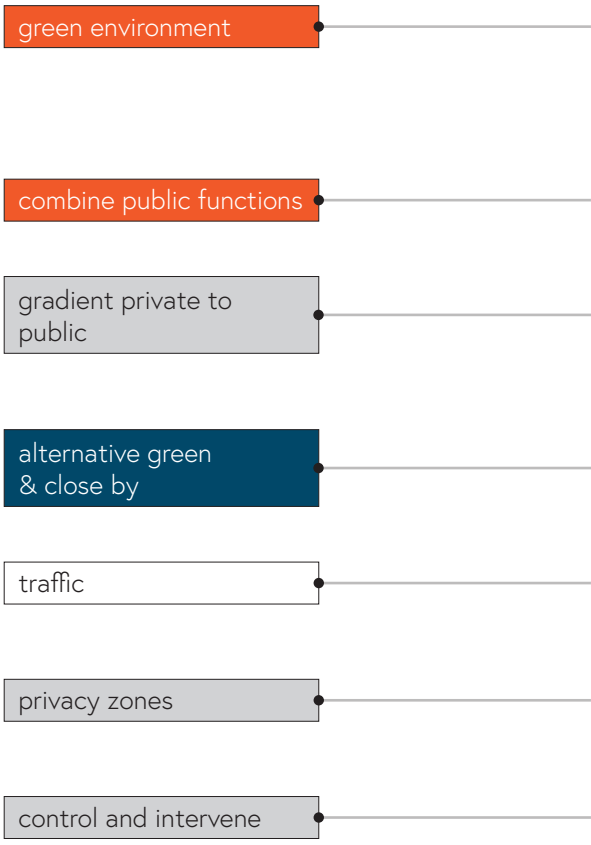
20. Lack of social support networks

Image 12: Satellite image of Caledonian Road (Google Maps)

Since this is a primary road for traffic, there is not much that can be done in this space but small interventions. Still, these interventions can make quite a difference.

Some trees and planters are added to make the street more green and to create a barrier between the sidewalk and the traffic and street parking. On the sidewalk, a small strip of different paving has been placed right in front of the buildings. This creates a small privacy zone for the residents of the buildings, which should be beneficial for them in terms of stress. On this strip, residents can feel free to personalize the space a bit, even though that might come with some risks in this area. But since perception is often more important than the reality, it might already help to have the opportunity to do this.

Some of the buildings in this street have been given a more public function that supports social interaction, for example a coffee bar. To connect them to the street as much as possible, it is important to create an open and inviting facade.

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In the section, it becomes clear how the planters and the trees do not only create a greener environment, but how they are also a buffer between the traffic and the pedestrians and buildings.

In this image, it becomes clear what a difference an open facade can make for a street. The new pavement in front of the buildings also becomes visible in this image, giving the residents a small transition from inside to outside.

PART 05

PART 05
CONCLUSION & REFLECTION

The fifth and final part of this thesis presents the most important conclusions. These conclusions are related both to the research questions of part 02 and to the reduction of urban stress through urban design in general (part 03 & 04). This part also reflects back on the process and methods of this thesis and presents some final recommendations, as well as a first step for the future.

PART 05

19. CONCLUSION

For this project, different conclusions can be drawn. Before they are explained, it is good to first look back at the main research question:

How can the urban design of public spaces contribute to the reduction, relief or prevention of urban stress in metropolitan areas?

In this main research question, three scales can be found: the metropolitan, the urban and the scale of the public space. The first conclusions can be drawn about the urban stressors, the approaches to reduce them and these three scales.
Another set of conclusions can be made about the direct and indirect approaches themselves, based on how they could be used in the different designs.
The last set of conclusions can be seen as a general outcome of this project, the most important things to consider when working on this topic in future research and design.

In this thesis, the main focus has been on the public space, located within the other scales. The most important conclusions are therefore based on that scale. However, this does not mean that some other conclusions can not be made for the other scales.

19.1 Conclusions on three scales

Metropolitan scale
Most of the stressors that have not made the selection of chapter 4 were not chosen because they had too little relation to the public space. Those stressors, especially the ones falling under the theme economic stressors are important on the large scale of the metropolis.
In general, it can be said that the metropolitan scale is the cause behind the urban stressors. The bigger the metropolitan area, the bigger the chances of more and worse urban stressors. With the current trend of urbanisation (United Nations, 2005) , which will mostly take place in already existing cities or metropolitan areas, this scale will only become more of a factor. Although traffic and public transport are still in the selection of urban stressors for this thesis, they are also related to the metropolitan scale. As mentioned in part 03, it is desirable to make the city less car dependent and to create distance between the city and the main road network. This

Metropolitan scale

1. Urban stressors that have not made the selection of chapter 4, which are more planning related.
2. Cause of urban stress is general, the bigger the area, the bigger the impact of the stressors, which will only become worse because of urbanisation.
3. Specific urban stressors:
   06. Traffic
   10. Public transport

Urban or city scale

1. Most suited scale for the direct approach.
2. Larger urban green spaces spread throughout the city.
3. The design and planning of density, high-rise and boring megascapes.

Project scale, ward - public space

1. Best suited scale for reducing stress through the indirect approach
2. The adding of natural elements, giving space to pedestrians and giving them more options, the blocking of light, noise and air pollution and creating more places to stay.

Figure 8: Three scales of the main research question

starts at the organisation of the mobility network and by investing in a extensive public transit network.

The urban scale
Where the public space has proven to be very suited to disguise some of the urban stressors, to decrease their negative effect and to reduce stress in general in an indirect way, it seems as if the cause for stress needs to be looked at on a larger scale. Directly tackling and reducing the urban stressors, where urban is already in the name, has to be done on the scale of the whole city or of large urban areas in many cases.
There are also some specific things important on the urban scale. The first is urban green. Urban green and natural environments in general have proven to be very important within the topic of urban stress. Even though it is beneficial on all scales, and it can be applied in the smaller public spaces, it is also important to create bigger natural areas spread throughout the city (Grahn & Stigsdotter, 2010). Especially for physical activity, extent, being away and a serene scenery, natural areas with a size corresponding with the urban scale are very meaningful.
Secondly, density, high-rise and boring megascapes are also urban characteristics and urban stressors to consider on the urban scale. Even though it might be possible to soften the effect of these stressors in the public space, it is good to think about them in an earlier phase and on a bigger scale first. It can then be assessed in which areas they can be beneficial or harmless, and in which they should be avoided.

The scale of the public space
As said in the previous section, the public space seems very fit to reduce urban stress in an indirect way. Particularly the adding of natural elements, giving space to pedestrians and giving them more options, the blocking of light, noise and air pollution and creating more places to stay, are things that can be created in many different urban spaces with relatively small interventions. Sub-chapter 19.2 goes deeper into the relation between the public space and the indirect approach.

Summarizing, it can be concluded that the indirect approach is most suited for stress reduction in the public space of existing areas. When aiming to remove or decrease the cause of urban stress, which is related more to the direct approach, this can better be done on a larger scale or in areas that are being newly developed or redeveloped.

19.2 Conclusions about the indirect approach

In general, one thing stands out in the indirect approach. Many of the design criteria or design solutions have something to do with trees or other natural elements. Green environments do not only support restoration, they also have a positive influence on many other stressors and stress related topics.

In the rest of this paragraph, the 3 indirect approaches are discussed separately.

Perceived control
Perceived control is easiest to understand according to the criteria about clear urban design and the availability of different options. It is not hard to imagine that someone who understands his or her surroundings and feels like he or she has a choice in what to do next or where to go next feels in control. From the designs, it seems as if the design criteria or solutions that match these concepts, can basically be applied throughout the entire city, on bigger and smaller scales in different public spaces. Some of the other criteria, related to privacy zoning, have a more indirect influence on perceived control. While designing, it has become clear that these criteria are most important in residential neighbourhoods and are more difficult to design with because they often require more space than there is available. It is therefore important to also consider privacy zones already in an early stage of the design process and not after the area has been built. It is however possible to create small privacy zones in existing built environments (see the design of Caledonian Road, 18.3.4).

Pro-social places
The conclusion of social support is a bit contradictory. On the one hand, social interaction can be supported in many different public spaces, even on a very small scale, using pro-social furniture for example and just by creating places where people can meet. On the other hand, it seems as if the design locations that were chosen in this project were not really suitable for the pro-social places approach. The design criteria 'making connections' and 'nearby and focal points', are better suited for residential streets and open spaces. And 'high density', 'combine public functions' and 'high quality public spaces' are better suited for a larger scale, or for areas with bigger squares or open spaces. Still, this is an interesting conclusion, which connects nicely to the conclusions on the different scales. Besides, it continues on the first findings of the urban stressors and the direct approach, which were also contradictory: high density is seen as an urban stressor, but high density can also support social interaction which makes it something positive.

Restorative environments
In the restorative environments approach it is again striking how important nature is. Luckily, the designing process has proven that it is something that can easily be applied in the public space, since it can be done in so many different ways, using so many different elements, in so many different sizes and on so many different scales. However, many of the specific design criteria can only be met in larger open spaces such as parks.
Physical exercise is also strongly related to nature and is supported by the feeling of being away as well. The main design assignment to support physical activity is to provide enough space and facilities, so

people have the option to exercise. This 'enough space' should be paved paths for runners and cyclists.
Sleep is something that can be improved or prevented on a larger scale, but in the public space it is much more about blocking or mediating the effect of the 'pollution' that causes a disrupted sleep. Luckily, this can often be combined with adding green or making areas less focussed on cars.

19.3 5 Guidelines for less urban stress

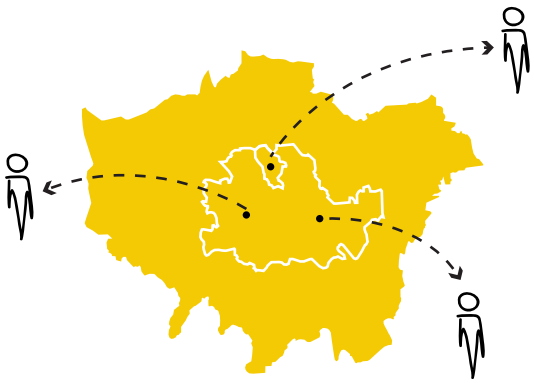
Both from literature and from designing with the design criteria from part 03, it has become clear that there are some general things important when designing against urban stress. This can either be because something has a big influence on stress, or because it decreases the stress of many urban stressors at once. This has been translated into '5 guidelines for less urban stress'. The titles of these guidelines are a bit exaggerated, but they are formulated this way to invite people to read them and use them in their research or design on this topic.

1. Green cities are good cities
In part 03, 04 and again in this conclusion it has become clear: nature is almost crucial when reducing stress. The reason is of course because of its restorative effects (Kaplan, 1995; Ulrich, et al., 1991). Green, or natural elements are beneficial on all scales and can therefore be applied in many different public spaces. Grass, trees, hedges and green walls are just some of the possibilities. It is however desirable that larger and more extensive natural areas are also designed into the city, preferably combined with water elements (Grahn & Stigsdotter, 2010; Barton & Pretty, 2010).

2. Outside the city inside the city
'Being away' is one of the general criteria of the nature part of 'restorative environments' (Kaplan, 1995). It is however also known as something that is important for restoration during physical activity (Bodin & Hartig, 2003; Bahrke & Morgan, 1978).
Since stress, and of course urban stress, occur more in cities than in rural areas or out of the city, it makes sense that having the feeling of being away for a short while helps. And not just from the city, but from ones standard environment in general. It is therefore desirable to create spaces, places or environments that are different from their - urban - surroundings.

3. Low traffic, low stress
A city without cars is impossible these days, but when looking at the stressors and the stress reducing approaches, it seems as if a car free city would be a city with far less stress. Not only does traffic and parking in itself cause stress (Levy-Leboyer, 1982; Montgomery, 2014; Zipjet, 2017), cars and roads also cause pollution (light, air and noise), they take away open space and space for pedestrians and cyclists, result in less healthy (physical) behaviour and lead

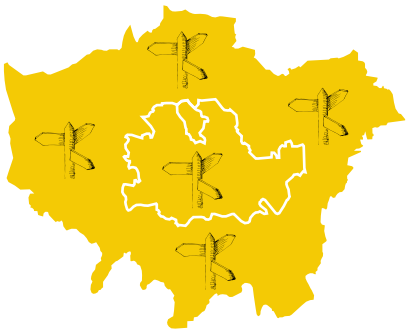
1. Green cities are good cities



2. Outside the city inside the city

3. Low traffic, low stress

4. More social, less stress



5. Clear designs are calm designs

Figure 9: 5 Guidelines for less urban stress

to accidents.
Since people still have to move around and banning the car from the city is not realistic, it is important to make the city less car dependent. This means investing in an extensive public transit network and good and safe walking and cycling routes, as well as mixed neighbourhoods. On a smaller scale, cars could be given less priority compared to pedestrians and cyclists. On secondary and tertiary roads for example, shared spaces can be introduced or pedestrians and cyclists could get more own space, separated from the road meant for motorised vehicles. Not only does this limit the stress caused by cars, it also helps in the prevention of crowding, one of the most important urban stressors.

4. More social, less stress
People are becoming less social and cities are becoming more anonymous (Perry, 2016). This while stress can be reduced by social support. The design and organisation of residential neighbourhoods play an important role in encouraging social interaction, see also the design criteria of 'pro-social places'. Social interaction can also be supported by the design of public spaces. This can be done by creating places to stay and places to meet, and designing them in such a way that they are inviting to be social (Evans, 2003). Round seating furniture or seating furniture that is facing each other would invite people more to be social than seating positioned along a straight line for example.

5. Clear designs are calm designs
People are less stressed when they feel in control of their environment. This can be achieved by creating clear, spacious urban environments. People feel in more in control when they understand their environment, have a few different options and do not feel crowded (Evans, 2003; Epstein, 1981, Perlmuter, 1980). It is therefore desirable to create environments with enough space for pedestrians and with an organisation and materialisation that is clear, familiar, understandable, readable and predictable. This can be achieved by consistency, using the same materials and design elements for example and creating focal points and avoiding blind corners.

20. REFLECTION

Relation to urbanism and urban fabrics

The title and topic of this thesis is urban stress and stress might be considered more of a graduation topic for psychology students. Yet, this thesis certainly belongs to urbanism, because it focusses on finding or establishing relations between urban stress and urban design and then formulates ways to reduce urban stress through urban design. In the reflection on the methods it is described how, even though it is an urban design project and finding spatial relations and solutions are the main goal, it is sometimes hard to not get lost in the psychological theories and forget to keep finding spatial relations and to keep or start designing.

The studio or research group that has been chosen for this project is Design of the Urban Fabric. First of all, because health and growth are two of three main themes in the Urban Fabrics research group, and they are interestingly linked in the introduced topic, that addresses the issue of the larger amount of mental health issues (like urban stress) in the increasingly urbanizing cities. Moreover, stress is a human problem, which should be dealt with on a human scale. Therefore, it has been decided to address the topic of urban stress in the public space within the urban fabric. This directly links this project to the interest and scale of the Urban Fabrics research group.

Social and scientific relevance

Social relevance

Stress is very much a social or societal problem, since in the first place it affects people. Even though for the short term stress might only be uncomfortable, it can cause major health problems, like triggering heart attacks, arrhythmias and even death. Besides that, stress that is of long duration, raises the risk of mental and physical health diseases (Krantz et al., 2013).

The research in this thesis, into the topic of urban stress from a spatial perspective, has enriched the knowledge on stress in cities and contributes to a better understanding of how to design to reduce urban stress in cities.

Scientific relevance

Stress is often researched from a social, psychological or medical perspective. Even though it has been shown that stress and

mental disorders occur more in cities, an actual spatial cause is not often given (Lederbogen et al., 2011). To have looked at this topic from a spatial (urbanist) perspective, find the relations between urban stress and urban environments and develop urban design approaches to reduce or relieve stress is an addition to the body of knowledge on this topic. It can be of great significance in trying to reduce or avoid stress rather than treat it.

Reflection on methods

Urban design using psychology theories

An important part of this thesis and one of the main methods is literature research. Because stress is often researched from a the field of psychology, it turned out that a lot of information useful for this thesis could be found in journals related to psychology. Luckily, even in literature the relation between stress or mental health and the environment has occasionally been made. Still, it was sometimes difficult to stay within the field of urbanism and it took quite a lot of effort to translate the theories into useful design approaches. To make the step from finding, understanding and writing the theory to actual design was therefore also quite difficult. However, it turns out that working on the different designs and trying to apply the theory into the space helps a lot in finding the spatial relations and seeing the theory in the perspective of the urban environments. This is where the relation between research and design has proven to be very important.

For this thesis, literature specifically related to the urban stressors of part 01 was very important. In some cases however, there was only literature available on a certain topic in relation to mental health and not to stress or urban stress. Although this is a bit of a shame, it does not mean that these things are not true or less true, because stress and mental health are so closely related.

Surveys

In the methods, it is described how surveys are one of the ways to determine urban stressors and how to reduce them. The surveys used for this thesis consisted of some open questions and some pictures that people had to compare according to a certain stressor (see Appendix 2). When in London, it turned out that people often did not understand how to answer the picture based questions. Apparently, they could not see the urban stressors in the shown environments and often answered that their experience in both environments would be the same. To not guide the people to much in their answers, the differences between the pictures were quite subtle, but without some background knowledge on urban design, these turned out to be too subtle. Urban design students were better able to answer the picture related questions than the local people in London for example.

To still get some insight in the experience of stress of the users of the public space, the survey was replaced by some open questions (see Appendix 3). This worked much better and confirmed some of the things that were

already found in the literature research, in addition to providing some ideas for the design criteria.

Interview with expert
Just before the field trip, I came across a think thank concerned about the mental health in cities and how this can be improved by urban design. This topic, as well as what was written on their website, suits very well to the topic of this thesis. The information was unfortunately not very design oriented, so it seemed very useful and interesting to meet someone of their team to ask about the design implications. As it turns out, someone from the think tank is based in London and was available during the field trip. Unfortunately, she was not able to tell me much more than what was already explained on the website, and not a lot had been done with their information in actual designs.
Later in the process it seemed less important to meet with an expert again, meaning that this method has not been very valuable to this thesis.

Research, design and conclusions
As said before, the translation of the theory into usable design criteria has been done according to literature, but also by testing it in the different designs. This is also true for the conclusions, these conclusions are an outcome of the texts of parts 01 and 03, applied in the designs of part 04. In that way it was possible to say something about the different scales and the relation to the public space and to come up with 5 guidelines.

Reflection on the communicability of the topic
It has just been explained how the picture based survey did not really work. This raises the question whether this thesis is communicable to city users and city residents. Even if this thesis might not have to be completely understandable, the designs that might follow from it have to be. In order for the designs to work to their full potential, people have to understand that some choices are more stress relieving than others and the same goes for some environments. Therefore the recommendation chapter (chapter 20) provides some examples on how to guide people, make them aware of stress and stress reduction in cities and 'promote' the idea of a calm city.

Reflection on ethics
Stress is a problem experienced by many people, for many different reasons. This project is only about urban stress and even though that is only a small part of all the types of stress, it is already impossible to find a solution for all urban stress. It should therefore be kept in mind that not everybody who is experiencing or suffering from stress is going to be helped. This project does however gather knowledge on the relation between urban stress and the built environment and uses that to create design criteria that can reduce, relieve or

prevent urban stress. If this knowledge or these criteria are used in actual urban designs, then it can help users that suffer from urban stress in those areas. When creating the design criteria or making the design, the following things have been paid attention to:

• All users should be considered, in the case of this project: the city is not only for stressed people and stress could mean something different for everyone. This should be taken into account.

• It should be investigated to what extent the designs/design criteria are applicable/ transferable to (other) urban environments and urban designs.

21. RECOMMENDATIONS

In general, it can be said that more research on this topic of urban stress should be done to enlarge the body of knowledge. After the process of this thesis however, some more detailed recommendations can also be made. The first is to look at this topic on a different scale. One of the conclusions was that the indirect approach could mainly be used on the scale of this project, but that the direct approach was less suited. It would therefore be very interesting to look at the scale of the city or even the metropolis and also to look at existing areas as well as areas that are being newly developed. This will make the knowledge much more complete.
Another aspect that should be researched is how to measure urban stress and the improvements that are made. Some stressors such as air pollution and noise pollution can be quantified, but stress in itself cannot. So how can we measure stress according to the urban stressors and how can we determine whether the interventions were successful? That last question can probably be answered by qualitative research, but it would still be interesting to investigate how to conduct such research in the best way.

Another recommendation is to focus on the perception and awareness of people. It seems as if urban stress is quite unknown, and especially what can be done to avoid or reduce it by the people themselves. It would be interesting to see if by raising awareness or making it easier or nicer for people to avoid the stressful places or take time to restore, would actually make them choose to make stress reducing decisions. Ideas are to do some 'marketing' for calm routes, using street signs, street tiles or free maps for example, or to make an app that shows the calmer routes of the city, the places where people can relax and gives advise on how to be able to live a less stressful life in the city. Hansmann et al. (2007) also discuss this: *"Public health campaigns can encourage people to visit green spaces frequently and engage in outdoor exercise, but such outreach could be more effective if the health benefits from specific natural environments and activities were better known"* (p. 223).

A last and obvious recommendation is for urban designers, researchers and policy makers to take this topic seriously. Most of the urban health issues caused by bad hygiene for example may have been mostly solved, but the city still causes other health problems. Let's tackle those as well. A first start could be to do a pilot with a municipality, to actually test the outcomes of this thesis in practice and to raise awareness at the same time. Chapter 22 focusses on this next step.

22. FROM THEORY TO PRACTICE

This thesis contains a lot of theory, but the reduction of urban stress is very much something to bring into practice. Therefore a booklet is made that summarizes the most important findings of this thesis in a very visual way. It can be seen and printed as a separate booklet.
In the recommendations the next steps for the topic of urban stress were already discussed, and this booklet can be seen as a starting point of bringing the theory into practice. It can be used by urban designers, planners and policy makers to get a first idea of how to design against urban stress. When they are interested and want to know more, they can specifically search in this thesis for an extra explanation.

DESIGNING AGAINST URBAN STRESS

42 URBAN STRESSORS

1. Building density

2. Crowding

7. Parking problems

8. Accessibility & availability of green

13. Housing conditions

14. Accidents

15. Falls

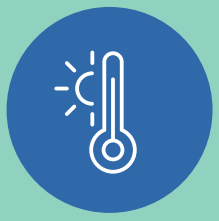
16. Gender inequality

21. Sunshine hours

22. Air pollution

23. Noise pollution

24. Light pollution



29. Heat

30. Mental health

31. Physical health

32. Exposure to germs

37. Lack of exercise

38. Obesity

39. Unemployment

40. Dept per capita

3. Boring megascapes

4. Garbage, graffiti and disrepair

5. Sharp architectural angles

6. Traffic (jams)

9. High-rise

10. Public transport

11. Perception of security

12. Architecture and urban design

17. Race inequality

18. Sense of security

19. Crime & robbery

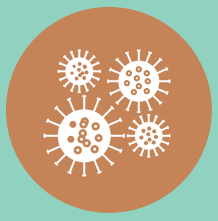
20. Lack of social support networks

25. Exposure to SO2

26. Exposure to NO2

27. Exposure to radiation

28. Climatic and geophysical hazards



33. Exposure to viruses

34. Exposure to microbes

35. Exposure to bacteria

36. Diet

41. Social security

42. Family purchase power

5 GUIDELINES TO DESIGN AGAINST URBAN STRESS

Green cities, variety of surroundings, less cars, social interaction and clear designs are 5 guidelines that are created to start designing against urban stress. Each of the guidelines can decrease multiple urban stressors and can thereby contribute to the reduction of urban stress. The guidelines are a result of a year of study into the topic of urban stress, and are a conclusion of research and design. On the next pages, the guidelines are presented in more detail.

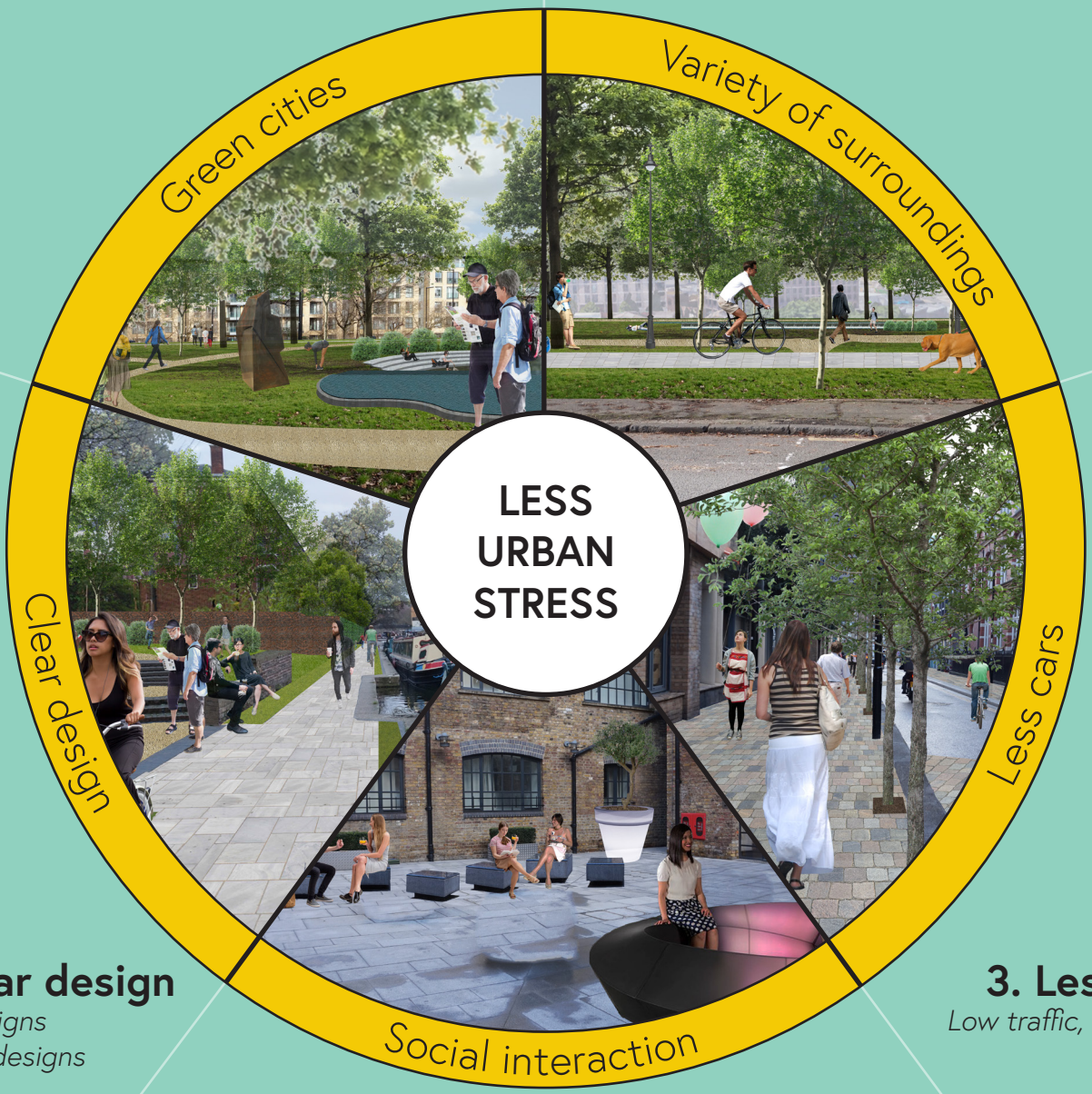
INVOLVES STRESSORS:

1. Green cities

Green cities are good cities

2. Variety of surroundings

Outside the city inside the city



5. Clear design

Clear designs
are calm designs

3. Less cars

Low traffic, low stress

4. Social interaction

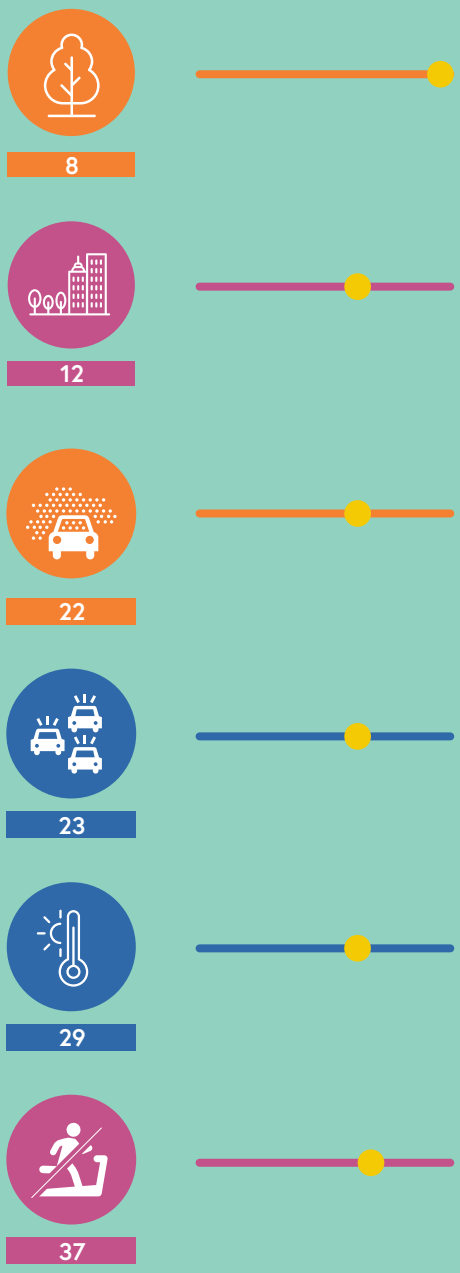
More social, less stress

1 GREEN CITIES

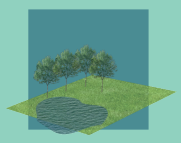
Green cities are good cities

Nature is almost crucial when reducing stress. This is because green spaces support the restoration process and therefore help to recover from stress. Green, or natural elements are beneficial on all scales and can therefore be applied in many different public spaces. Grass, trees, hedges and green walls are just some of the possibilities. It is however desirable that larger and more extensive natural areas are also designed into the city, preferably combined with water elements.

ADDRESS(ES) STRESSORS:



INCLUDES DESIGN CRITERIA:



More green & add water
A combination of water and green has a more positive influence on the restoration of stress

Being away
Give people the feeling that they are in a different environment, away from their usual surroundings

Walking & cycling routes
Integrate physical activity in city life by providing good walking and cycling conditions

Block light & noise
Use trees or other natural elements to block light and noise pollution to provide calmer environments

Extent
Design green spaces in such a way that they are percieved as extensive

Places to stay
Place enough benches in the green spaces so people can rest and enjoy their environment

Alternative green & close by
Green spaces, which can be on roofs or in streets, should be within walking distance of people's homes

Serene scenery
Create a serene and natural scenery. This means an undisturbed environment, which is silent and without too many people

Accessibility
The green spaces should be accessible, well-maintained, clean and safe

Extent

Accessibility

Block light & noise

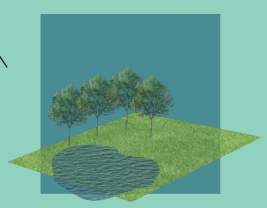
Being away

Places to stay

Walking & cycling routes

Alternative green & close by

Serene scenery



More green & add water

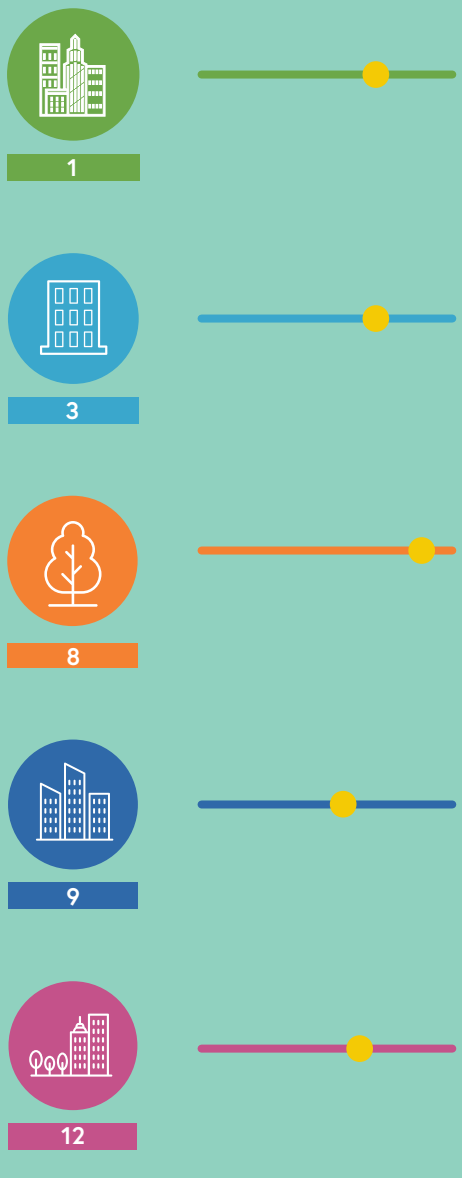
2

Outside the city, inside the city

VARIETY OF SURROUNDINGS

Having the feeling of 'being away' helps in restoring from stress. Since stress, and of course urban stress, occur more in cities than in rural areas or out of the city, it makes sense that having the feeling of being away for a short while helps. And not just from the city, but from ones standard environment in general. It is therefore desirable to create spaces, places or environments that are different from their urban surroundings.

ADDRESS(ES) STRESSORS:



INCLUDES DESIGN CRITERIA:

Provide enough options
Provide variety in areas, routes, public transport stops, etc., so that people have a choice

Being away
Give people the feeling that they are in a different environment, away from their usual surroundings

Distance
Create distance between people - residential areas - and noise sources for example

Low-rise
Build low-rise where possible, to contrast the city's high-rise

Mixed neighbourhoods
Create mixed neighbourhoods, with a variety of surroundings

Mixed neighbourhoods

Low-rise

Being away

Provide enough options

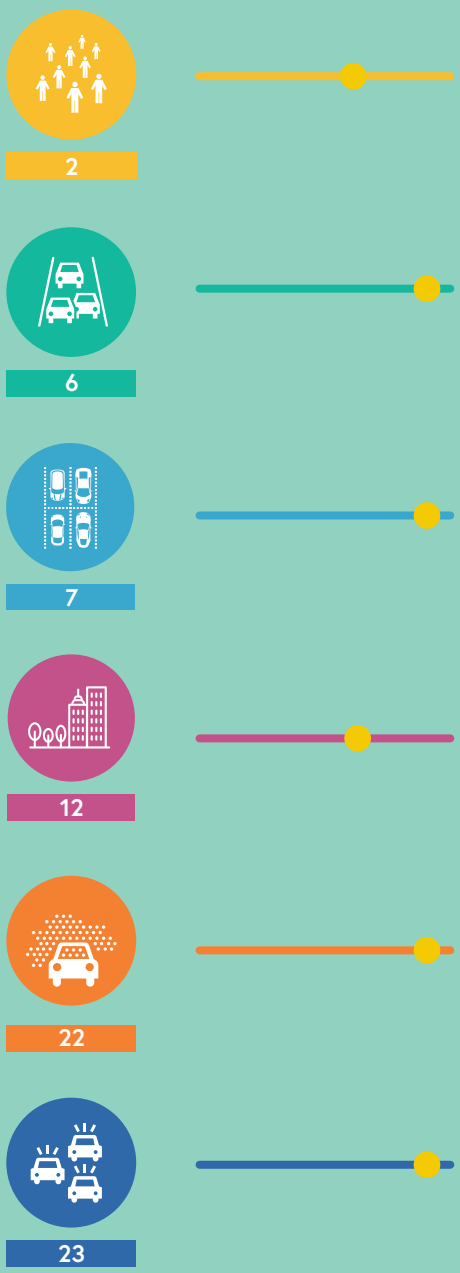
Distance

3 LESS CARS

Low traffic, low stress

A city without cars is impossible these days, but when looking at the stressors and the the ways to reduce them, it seems as if a car free city would be a city with far less stress. Not only does traffic and parking in itself cause stress, cars and roads also cause pollution (light, air and noise), they take away open space and space for pedestrians and cyclists, result in less healthy (physical) behaviour and lead to accidents. Since people still have to move around and banning the car from the city is not realistic, it is important to make the city less car dependent. This means investing in an extensive public transit network and good and safe walking and cycling routes, as well as mixed neighbourhoods.

ADDRESS(ES) STRESSORS:



INCLUDES DESIGN CRITERIA:

Mixed neighbourhoods
Create neighbourhoods with facilities within walking distance, so it is more inviting to walk to your destination

Walking & cycling routes
Provide a good walking and cycling network, so that the car is not the only option

Enough space for pedestrians
Create enough space to invite people to walk and to prevent crowding

Public transport
Foresee in a good public transport network as an alternative for car use

Provide enough options
Provide enough options, for example routes, public transport stops, etc., so that people have a choice other than the car

Provide enough options

Public transport

Mixed neighbourhoods

Enough space for pedestrians

Walking & cycling routes

4

More social, less stress

SOCIAL SUPPORT

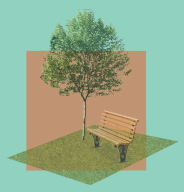
People are becoming less social and cities are becoming more anonymous. This while stress can be reduced by social support. The design and organisation of residential neighbourhoods play an important role in encouraging social interaction. Social interaction can also be supported by the design of public spaces. This can be done by creating places to stay and places to meet, and designing them in such a way that they are inviting to be social. Round seating furniture or seating furniture that is facing each other would invite people more to be social than seating positioned along a straight line for example.

ADDRESS(ES) STRESSORS:

- 2
- 8
- 16
- 17
- 18
- 20

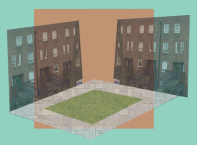
INCLUDES DESIGN CRITERIA:

Pro-social furniture
Arrange furniture in a pro-social way. Benches for example can be placed in a way in which they encourage social interaction



Green environments
Create a green environment, it makes us more trusting and generous towards other people

High density
It helps for social support to have a lot of people living nearby and to be able to easily go there



Nearby & focal points
Create places that are close to people and that have focal points, these focal points should be neutral and provide visual prospect

Make connections
Connect residential buildings to pedestrian paths or meeting places

Combine public functions
Add other public functions in the plinth around the public open spaces, cafés for example.

High quality public spaces
Create high quality public spaces, they accommodate a range of social activities

High density

Green environment

Nearby & focal points

Combine public functions

Make connections

High quality public spaces

Pro-social furniture

5 CLEAR DESIGN

Clear designs are calm designs

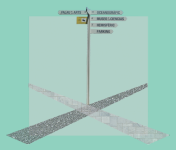
People are less stressed when they feel in control of their environment. This can be achieved by creating clear, spacious urban environments. People feel in more in control, when they understand their environment, have a few different options and do not feel crowded. It is therefore desirable to create environments with enough space for pedestrians and with an organisation and materialisation that is clear, familiar, understandable, readable and predictable. This can be achieved by consistency, using the same materials and design elements for example and creating focal points and avoiding blind corners.

ADDRESS(ES) STRESSORS:

- 1
- 2
- 12
- 14
- 15

INCLUDES DESIGN CRITERIA:

Clear and readable urban design
Create a clear and readable urban design network, using similar urban design elements, think of furniture and material use



Clear and predictable
Design areas in a clear way that so that the organisation is understandable and predictable for residents and visitors

Provide enough options
Provide enough options, for example routes, public transport stops, etc., so that people have a choice

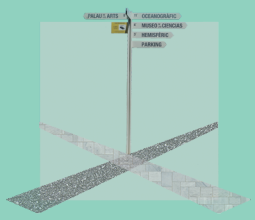
Gradient private to public
Provide a range of social spaces varying from more private to more public

Privacy zones
Create clear privacy zones and make sure local people do not have to share their space with passers-by

Enough space for pedestrians
Create enough space for pedestrians, to decrease the chances of crowding

Clear and readable urban design

Provide enough options



Clear and predictable

Privacy zones

Enough space for pedestrians

Gradient private to public

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APPENDIX 1: THEORY PAPER

An urban design perspective on urban stress

Finding spatial solutions for urban stressors

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Abstract – Stress is sometimes referred to as the disease of the 21st century. Urban stress is a type of stress and is becoming more and more important with the ongoing trend of urbanisation. However, the topic of urban stress is often researched from a sociological and psychological perspective, but not so much from the perspective of the built environment. This is a clear gap in the knowledge, because it is assumed by researchers that there is a relation between urban stressors and the urban environment. This paper therefore seeks to find spatial solutions for urban stressors from an urban design perspective, which is specifically done for urban stressors from the theme urban environment stressors. This is done by reviewing existing literature. As a result, two types of solutions are found: direct solutions and indirect solutions. This is preceded by an investigation into the different urban stressors of the specific theme, determining their relation to the urban environment and the reasons why they cause stress. In that way, the solutions are closely related to the actual urban stressors.

Key words – urban stress, urban design, coping, spatial solutions, urban environment

1 Introduction

Some refer to stress as the disease of the 21st century (Fink, 2016). Why is it, that stress levels have been increasing through the generations (American Psychological Association, 2015) and have become such an issue? Is it true that there is more stress in cities (Abbott, 2012)? How is it possible, that urban stress has been acknowledged for years (Burton, 1990; Evans & Cohen, 1987), but that there has not much research been done from the perspective of the urban environment, in comparison to the sociological and psychological perspective (Evans & Cohen, 1987, p. 571)? These questions have been the inspiration for this paper.

Research has shown that the problem of stress is more significant in cities. People who live in cities are less capable of dealing with stress than people who live in rural areas (Benedictus, 2014). Also, city living is associated with a more stressful and demanding social environment, which increases the risk of mental illness (Lederbogen et al., 2011). Moreover, those mental illnesses are found more often in cities. The risk of anxiety and mood disorders is raised by urban living with respectively 21% and 39% (Benedictus, 2014; Lederbogen et al., 2011). Adli states that this can be linked back to social density (Benedictus, 2014).

Although researchers do not yet say with certainty that there is a strong relation between stress and environmental characteristics or urban design, this is what is assumed (Evans & Cohen, 1987). The various urban stressors that are given in different resources support that assumption. The uncertainty that is still present in this topic is probably related to the submissive role of research from the built environment perspective. The research question of this paper is therefore: What kind of spatial solutions are possible for urban stress and how can they be found?

To answer this question, this paper takes a set of stressors within one theme – urban environment stressors – as an example. In the first sections, the urban stressors of the chosen theme are explored and their relation to urban design and the reasons why they are stressful are described. In the last section of this paper, suitable solutions for the urban stressors are explained.

2 Methods and material

This paper is a review paper, which means only existing literature is used to answer the question posed in the introduction. This literature is a combination of knowledge from sociological and psychological studies, where more research has been done on stress, and knowledge from built environment studies, to find the influence of the built environment on human emotions, well-being and behaviour.
There are many different stressors in many different themes. This amount is too large to tackle in this paper. Therefore, this paper focusses only on a selection of urban stressors. The selection is made by comparing two resources that present multiple urban stressors or urban stress indicators. The first is by Burton (1990), who wrote a paper about 'factors in urban stress'. The second is by Zipjet (2017), who used 17 indicators to make a ranking of the most and least stressful cities. Without going into detail on all the stressors they described, it is enough for now to conclude that five general themes can be found, 1) urban environment stressors, 2) economic stressors, 3) social stressors, 4) health stressors, and 5) stressors from urban conditions.
This paper focusses on the stressors within the theme of urban environment, because from a first look it seems that they have the most relation to urban design and are therefore best fit to use as an example in this paper.

3 Exploring the urban environment stressors

Urban environments stressors are in this paper understood as visible, tangible or noticeable elements, events or conditions that occur in urban environments. First, it is essential to know which stressors fall within this theme of urban environment stressors. As mentioned in the methods and material section, Burton (1990) and Zipjet (2017) already give a set of those urban stressors, but some more can be found when reviewing other literature. They are all given below.

Density,	(Zipjet, 2017)
Crowding,	(Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Cohen, 1987)
High-rise,	(Gifford, 2007)
Boring megascapes,	(Weintraub, 2015)
Commute by public transport,	(Montgomery, 2014; Zipjet, 2017)
Commute by car,	(Levy-Leboyer, 1982; Montgomery, 2014; Zipjet, 2017)
Parking problems,	(Levy-Leboyer, 1982)
Architecture and urban lay-out design,	(Burton, 1990)
Sharp architectural angles,	(Montgomery, 2014)
Housing conditions,	(Burton, 1990)
Frequent sight of garbage, graffiti and disrepair,	(Montgomery, 2014)
Perception of security,	(Zipjet, 2017)
Accidents,	(Burton, 1990)
Falls,	(Burton, 1990)
Accessibility of urban green spaces.	(Burton, 1990; Zipjet, 2017)

From this list, it already becomes clear that there is a lot of overlap between the different resources and that many of the stressors are strongly related. This means that again, a subdivision of different categories can be made, being: density, traffic and public transport, architectural and urban design, perception of security and the accessibility of green spaces. The rest of this paper will continue according to these categories.

4 Spatial relations and reasons for stress

To understand urban stress from a spatial perspective and to be able to find spatial solutions, it is not enough to just know the name of the stressor as described in section 3, it is necessary to know also what spatial aspects or aspects of the urban design cause this stress. Moreover, it is important to know why these spatial features cause stress and what kind of stress or emotions they raise. This section investigates this for all five urban environments stressor categories.

4.1 Density

In case of density the problem lies both in the built and the unbuilt space. Because of the ongoing trend of urbanisation (U.N., 2005), cities have to deal with an increasing amount of

people - population density. The spatial problem of density is that there is a lot of built space - building density - necessary to house and facilitate all those people. For one, this means that a lot of cities are forced to build high-rise and build up a large part of the available space.
Some researchers have found negative effects of high-rise on mental health (Gifford, 2007), both being around them and living in them can cause stress. Living in them mainly causes stress based on fear, which except for the height of the buildings, doesn't have much to do with the urban or architectural design (Gifford, 2007). Being around tall buildings can also cause stress, they can be perceived as oppressive (Gruebner, 2017) and they can increase wind speed and temperature and take away daylight (Arslan, 2014).
Building density is also a problem. A high building density means that not much open space is left. The lack of open space combined with the large amount of people in cities often results in crowding. Crowding occurs when people's need for space is bigger than the supply, whereas density is the amount of people per unit of space (Stokols, 1972). So crowding is a psychological state, in which people may feel like they are not in control of their environment. If there is no possibility to escape this environment, it leads to stress (Epstein, 1981). It is important that people have the feeling that they can achieve their goal in a certain environment (Epstein, 1981) and that they have control over social interaction – "the balance between the desired and achieved level of social interaction" (van Dorst, 2005, p. 2). So in the case of crowding, the spatial problem might lie in the lack of available open space, the unclear division of space for the different users with different goals or unclear territories (van Dorst, 2012, p. 234).

4.2 Traffic and public transport

Commuting makes people stressed and unhappy (Montgomery, 2014). According to Zipcar (2012), more than 50% of the people claim that commuting is a source of stress. Commuting by car already starts to have negative effects after only 15 minutes (Office for National Statistics, 2014). There are many reasons for stress in the car, such as traffic jams, construction, long distances (Cityclock, 2014), parking problems (Levy-Leboyer, 1982) and so on. The unpredictability, loss of control and the fact that there is no good way of communicating from the car are the reasons for stress in traffic (Cityclock, 2014).
Montgomery (2014) states that public transport also makes us stressed and unhappy. Commuting by bus is the worst, for trains, trams and subways, the negative effects only start to appear after 30 minutes of commuting (Office for National Statistics, 2014). This however, is probably mostly caused by human behaviour (Zipcar, 2012).
So commute by road is most stressful, but it is hard to say what the spatial cause of this stressor is. It is not necessarily a lack of space, because more roads do not solve congestion problems but only generate more traffic (Duranton & Turner, 2010). This means that there are also urban stressors without an obvious spatial cause, this will further be addressed in the second part of section 5.

4.3 Architectural and urban design

This paper looks at the problem of urban stress from a spatial perspective, and therefore the goal is to always link the issues to urban design. Still, a different subsection can be made of this topic, because in the other subsections it seems that something is wrong with the urban form, planning, organisation, division of functions etc. However, stress can also be caused by specific design features.
Sharp architectural angles are an example of these design features, they activate the brain's fear centres according to Montgomery (2014), which results in the release of stress hormones (p. 161). Another example is the high rise, mentioned in the subsection about density, where the shape of the buildings cause stress (Gruebner et al., 2017). For these stressors, the spatial problem is embedded in the definition of the stressor and is therefore immediately clear. It is then also clear what can be changed to improve the situation and with some extra research what the a spatial solution could be.

4.4 Perception of security

Perception of security is a very broad term, stress can be caused by unsafe events varying from climatic hazards, to crime, to traffic accidents and so on. Because this paper is about urban environment stressors, this subsection focusses on crime, which is what Zipjet (2014) means with ''perception of security'' and accidents and falls (Burton, 1990).

With crime, the stress is mainly caused by fear (Folk & Folk, 2014; Urban Age, 2011, p. 2). The fear of crime can be caused by many different environmental factors. For example in an environment with no clear boundaries or territories, residents feel no responsibility for their neighbourhood, which leads to an anonymous environment resulting in more crime and feeling unsafe (Van Dorst, 2012, p. 228). Again, high-rise can be mentioned here, because high-rise areas often create those anonymous environments (Van Dorst, 2012, p. 231). Another reason for stress or fear of crime is the sight of physical deterioration, vandalism, litter, graffiti and garbage, which can also be linked back to a lack of responsibility or care for the area (Rapoport, 1982, p. 171; Montgomery, 2014, p. 160).
Accidents and falls are of course stressful when they happen, but again the fear of accidents and falls can also cause stress. This is probably also part of the problem when experiencing stress in traffic, but it can also affect pedestrians for example. The spatial problem causing accidents and falls is in general the layout of the urban design (Urban Age, 2011, p. 18), but for accidents it is also related to vehicle speed (Ertico, 2014) and land use pattern (Ng, Hung & Wong, 2001, p. 590), which is more related to urban planning and policies.

4.5 Accessibility of urban green spaces

Both Zipjet (2017) and Burton (1990) state that – the lack of – green spaces or – the lack of – accessibility of green spaces are indicators of or factors in urban stress. However, in other resources green spaces are seen as stress reducers that calm the mind (Van den Berg, 2007; Montgomery, 2014), and not so much as stressors when they are not available. They do not only reduce stress, but also make us “more trusting an generous towards other people” (Montgomery, 2014, p. 160-161) and they have a “lasting positive effect on our well-being” (Kinver, 2014). So green spaces or natural elements are definitely related to urban stress, but might be misplaced as urban stressors.
It can simply be said that the spatial relation to this so-called stressor is the amount of green or natural elements included in the urban design. There are however different solutions for different approaches. When aiming for reducing stress directly and increasing liveability, green and nature should be nearby to provide easy contact and views (Van Dorst, 2012, p. 233; World Health Organization, 2016, p. 4). When aiming for reducing stress by physical activity (Hansmann, Hug & Seeland, 2007, p. 214), it is better to have bigger green spaces with more options for activity (World Health Organization, 2016, p. 15) – which are often further away.

5 Spatial solutions

In the previous sections the different stressors are explored and it is described what causes the stress and why. Elaborating on that information, this section focusses on solving stress caused by urban stressors by using urban design.
There are two ways to cope with stressors. The first way is to change the relation between the person and the environment, Lazarus (1993) calls this ‘’problem-focused (p. 8) and in this paper it is referred to as direct solutions. The second way is to change the effect or interpretation of what is happening, Lazarus (1993) calls this ‘’emotion-focused coping’’ (p. 8) and is this paper it is referred to as indirect solutions.
When looking at the previous section it is immediately clear for some urban stressors what the spatial cause for stress is and what spatial elements should be changed to reduce the stress. In that case, direct solutions can be used, where the actual stressor is tackled. With other stressors, these spatial causes are not as clear, and sometimes there is not a direct relation between the stressor and the urban design. In that case, indirect solutions can be used, where the perception or effect of the stressor is altered by changing something else and the stress is reduced more generally.
Examples of direct solutions and indirect solutions are given below.

5.1 Direct solutions

Direct solutions focus on making an urban design that removes the urban stressor, changes the stressor in a positive way or decreases the intensity of the stressor. An example from section 4 is crowding or density. It is not realistic to remove people from the city, but with creating a little more open public space, the perceived density and experience of crowding will be lower (Rapoport, 1982, p. 34; Stokols, 1972, p. 82). It should be kept in mind that some urban stressors can also have benefits for people and are not necessarily always negative. Density increases the opportunity to “move around and have an active social life”

especially for elderly and woman, which reduces the risk of depression (Melis, Gelormino, Marra, Ferracin & Costa, 2015, p. 14899).
Another example of an urban stressor where direct solutions can be used is crime. Designing the neighbourhood and housing in a way that there are more eyes on the street can help prevent crime (Gehl, 2013, p. 73). Creating spaces for people to meet, to create social interaction also helps (Van Dorst, 2012, 231). As mentioned in section 3 the lack of boundaries or territories is also a cause of crime. So visible boundaries can be designed, or as Perkins et al. (1990) describe, design features such as "public space dividers, greater visibility, and small and low-rise designs … encourage residents to exercise territorial control" (p. 86). Especially for traffic and public transport, it is more difficult to find direct solutions, in that case indirect solutions can reduce stress. This is explained in the next subsection.

5.2 Indirect solutions
Something that was mentioned more than one in section 4 as a reason for stress is a lack of control. So the first indirect way to improve a stressful urban environment is to give the users a perception of control. This is also described by Evans (2003) as one of three options to intercede between urban environments and human stress. An example of improving perceived control is by creating a gradient in the transition from private to public, from smaller individual spaces to small group spaces to bigger public spaces (p. 544).
The two other ways to decrease the amount of stress without changing the actual stressor are social support and restoration (Evans, 2003). Social support has an overall positive influence on mental health. The built environment can influence this for example by connecting residential areas to pedestrian areas or meeting places (Evans, 2003, p. 454). With this example it should be kept in mind that the places should not become too crowded, because crowding is one of the stressors and causes social retreat, which is the opposite of what is needed in this case (Evans, 2003; Montgomery, 2014).
Restoration is the third and last way to interfere with stress mentioned by Evans (2003). Restoration is all about recovering from experienced stress. A well-known example of a solution is exposure to natural elements (Evans, 2003; Montgomery, 2014). It also became very clear in section 4 that green spaces and natural elements are different from the other stressors and are much more about reducing stress or restoring from stress.
In another work from Evans, together with Cohen (1987), some other interesting concepts are described that have influence on the way stressors are perceived. These concepts can also be kept in mind when indirectly coping with the stressors. They are: ''they value or valance of events'', whether the stressor results in a gain or a loss; ''the degree to which a stressor is perceptually salient or easily identifiable or noticable'', this influences how much we get used to a stressor, which makes the intensity of the stressor lower; ''predictability'', which again influences how quickly we get used to a stressor; ''the necessity and importance of a stressor'', stressors that seem necessary are differently received than stressors that seem unimportant (Evans & Cohen, 1987, p. 574-575).

6 Conclusions
This paper has focussed on approaching urban stress from an urban design perspective and finding spatial solution for them, as was already specified in the introduction. To find suiting solutions, it was first of all important to investigate the relation between the stressor and the urban environment and to find out why exactly the urban stressors cause stress in people. From that it became clear that for some stressors it is very clear what their relation to the urban environment was and that for others it is more vague. It also became clear that not having the feeling of being as a in control result of an urban experience is a significant cause of urban stress. A last interesting finding from this part is that the absence of a positive urban design feature is sometimes seen as a stressor, but that is probably not correct.
The difference between urban stressors with a clear and urban stressors with an unclear relation to the urban environment, resulted in two types of spatial solutions: direct solutions and indirect solutions. Direct solutions or problem-focused coping are about changing the urban environment in such a way that it directly reduces the impact of the urban stressor. Indirect solutions or emotion-focused coping are about changing the urban environment in such a way that it reduces stress more generally or so that helps restore from stress. Three clear

ways to do this are creating perceived control, social support and restoration.

Recommendations

This paper only focussed on the urban environment stressors and completely relied on existing literature. For future research it would be very interesting to also investigate the urban stressors from the other 4 themes from an urban design perspective. Moreover, through the process of writing this paper it has become clear that when urban environments and spatial solutions are important topics, using only literature might not be sufficient. Other studies, types of research, analyses and design should also be used.

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APPENDIX 2: SURVEY FIELD TRIP

TU Delft

Survey for graduation project at TU Delft

Perception of the public space in Caledonian, Islington, London

1. Do you live in London?

☐ Yes ☐ No

2. Do you live in Caledonian or Islington?

☐ Caledonian ☐ Islington ☐ No

3. Age and gender?

☐ Male
☐ Female

☐ 0-18
☐ 18-25
☐ 25-35
☐ 35-45

☐ 45-55
☐ 55-65
☐ 65+

4. Please take a look at pictures 1 and 2. Which park would you most likely visit and why?

☐ 1 **Why?** .....
☐ 2 .....

5. Please take a look at pictures 3 and 4. Where would you prefer to walk and why?

☐ 3 **Why?** .....
☐ 4 .....

6. **Please take a look at pictures 5 and 6. Where would you prefer to walk and why?**

☐ 5 **Why?** .....

☐ 6 .....

7. **Please take a look at pictures 7 and 8. In which street would you feel more comfortable and why?**

☐ 7 **Why?** .....

☐ 8 .....

8. **Please take a look at pictures 9 and 10. On which side of the street would you rather walk and why?**

9

☐ Left **Why?** .....

☐ Right .....

10

☐ Left **Why?** .....

☐ Right .....

9. **Please take a look at pictures 11 and 12. Where would you feel more safe and why?**

☐ 11 **Why?** .....

☐ 12 .....

10. **Please look at pictures 13 and 14. Looking at the accessibility and entrances of these stations, which station would you feel more comfortable entering and why?**

☐ 13 **Why?** .....

☐ 14 .....

11. **Please take a look at pictures 15 and 16. Where would you feel more comfortable driving and parking your car and why?**

☐ 15 **Why?** .....

☐ 16 .....

12. Please look at picture 17. Would you be more comfortable being surrounded by high-rise or low-rise (or a combination) and why?

☐ High-rise **Why?** .....
☐ Low-rise .....
☐ Combination

13. Please look at picture 18. Which part of the building is more appealing to you and why?

☐ 1 **Why?** .....
☐ 2 .....

14a. When you move through the city, do you ever feel stressed?

☐ Never ☐ Sometimes ☐ Often ☐ Always

14b. If so, how often is this caused by your surroundings (urban design and planning)?

☐ Never ☐ Sometimes ☐ Often ☐ Always

15. When you move through the city, what causes you to feel stressed?

.....

.....

.....

16. Is there something you do or somewhere you go in your everyday routines, to avoid stress when you're outside? If so, please give examples.

.....

.....

.....

17. What do you think would help you to feel less stressed in the city?

.....

.....

.....

PARK

Question 4: Which park would you most likely visit and why?

NETWORK

Question 5: Where would you prefer to walk and why?

STREET 1

Question 6: Where would you prefer to walk and why?

STREET 2

Question 7: In which street would you feel more comfortable and why?

STREET 3

Question 8: On which side of the street would you rather walk and why?

SAFETY

Question 9: Where would feel more safe and why?

PUBLIC TRANSPORT

Question 10: Looking at the accessibility and entrances of these stations, which station would you feel more comfortable entering?

TRAFFIC AND PARKING

Question 11: Where would you feel more comfortable driving and parking your car and why?

ARCHITECTURE

Question 12: Would you feel more comfortable being surrounded by high-rise or low-rise and why?

ARCHITECTURE 2

Question 13: Which part of the building is more appealing to you and why?

APPENDIX 3: NEW OPEN QUESTIONS FOR SURVEY FIELD TRIP

NEW OPEN QUESTIONS FOR STREET CONVERSATIONS FIELD TRIP

1. Do you ever feel stressed while moving through the city and why?

2. Is there anything you do to avoid urban stress?

3. What do you think should be changed in the built environment for you to feel less stressed?