



WORKING TOWARDS A CLIMATE-ROBUST CITY

GHENT CLIMATE ADAPTATION PLAN
2016-2019



FOREWORD



Ghent signs the *European Covenant of Mayors Initiative on Adaptation to Climate Change*, 16 October 2014

Our climate is changing. Weather records are being routinely broken. Extremes in temperature, rainfall, and wind are being recorded around the globe. The city of Ghent is going to great lengths to drive down energy consumption and greenhouse gas emissions, making a contribution to the mitigation of climate change. At the same time, we must adapt our cities - including Ghent - to the effects of climate change. This is called climate adaptation, and ensures that in the future our city will remain a nice and liveable place to live and work.

Heat waves, prolonged bouts of winter precipitation, extreme summer storms, or simply extended drought periods entail risks. Climate change hits cities even harder. The considerable infrastructure of cities, such as buildings, pavements, streets and squares, ... store heat. In summer this may lead to uncomfortably warm nights. This is known as the urban heat island effect. Because of this, downtown Ghent is on average 3°C warmer than surrounding areas. On hot days this difference may even grow to 8°C. But there is more. For instance, extreme rainshowers are becoming more frequent. This causes problems for our sewers which struggle to cope with the vast quantities of rainwater washing off infrastructure. Time to seek solutions in this area as well.

On 16 October 2014, Ghent was one of the first cities in Flanders to sign the European Covenant of Mayors 'Mayors Adapt'. This initiative seeks to motivate cities to develop a local climate adaptation strategy and action plan, containing local measures for the adaptation of the urban environment to climate change. In doing so, the City of Ghent is working on the development of a climate-robust city, and contributing to the European objectives for the creation of a climate-resistant Europe.

The efforts towards making the city climate-robust should be seen as a major part of future planning. Adaptation takes place by focusing on green and water within the city, by eliminating hardened surfaces, retaining water, and allowing it to infiltrate. These are all measures that not only secure a better future, but also create a pleasant, liveable, healthy, and safe city today for our residents and our businesses.

The Ghent Climate Adaptation Plan 2016-2019 before you lays out the Ghent approach. An abundance of actions and measures aimed at readying Ghent for the future.

On behalf of the entire city administration

Tine Heyse

Deputy Mayor of the Environment, Climate, Energy and North-South

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1.1. International and Flemish contexts

GLOBAL CONTEXT

The world is seeing new heat records being set year after year. 2015 was the warmest year on earth since measurements began¹, breaking the 2014 record. 15 of the 16 warmest years were recorded in the 21st century. Statisticians at among others Stanford University demonstrated that these heat records are no coincidence. The cause: never before has the atmosphere contained this level of greenhouse gases. In the spring of 2015, the three-monthly average CO₂ concentration exceeded the 400 ppm² limit for the first time.

At the local, national, and international levels efforts are underway to limit the further increase in greenhouse gases in the atmosphere. However, there is no way we can turn back the clock. The increase in greenhouse gases is already causing a rise in temperature. The 1°C temperature increase mark compared to the pre-industrial era (the average between 1850 and 1900) was exceeded for the first time in 2015³. This means that the earth is halfway towards a 2°C temperature increase, the pivotal point that is expected to dramatically affect climate change. The goal behind all climate-related efforts agreed to at the Paris global climate conference in December 2015 is to keep the temperature increase below 2°C. If we simply continue conducting our business as usual, a 5 to 6°C increase is projected.

This global warming has dire consequences, including a rising sea level, extreme weather conditions, groundwater depletion, changes in biodiversity, altered food production, spreading of diseases, climate-induced migration, ...

The cities (will) primarily suffer the consequences of climate change. Cities form important centres of population, infrastructure, and services. Today, half of the world's population lives in cities. In Europe, this figure is 7 out of 10. By 2050 7 out of 10 people will live in cities, in Europe 8 out of 10⁴. The significant density of functions and users, the large proportion of at-risk population groups, and the presence of major economic hubs make cities particularly vulnerable to extreme weather conditions and other effects of climate change.

¹ The Met Office in Great Britain, NASA, the NOAA in the US, and the UN World Meteorological Organization (WMO) have all confirmed that 2015 was the warmest year globally since measurements began at the end of the nineteenth century (1880).

² Latest report from the UN World Meteorological Organization (WMO).

³ British Meteorological Institute MetOffice

⁴ UN 2014

One focal point is the global scale of the (indirect) consequences resulting from climate change. In our globalized world, floods and drought in other continents may influence our food systems. Water shortages could give rise to grave geopolitical conflicts, and for instance spark new waves of migration. The global economic system will be increasingly affected by climate change, in turn impacting energy prices, monetary systems, and so on. Naturally, it is impossible to predict the effects of these possible global shockwaves on cities in general and Ghent in particular. Yet it is still wise to boost resilience and limit dependence on global (vulnerable) systems.

EUROPEAN CONTEXT

The European Commission is conscious of the vulnerability of cities, and seeks to enhance the resilience of European cities in order to cope with the consequences of climate change, today and in the future. Analogously to the Covenant of Mayors for climate mitigation, the European Commission⁵ also launched a Covenant of Mayors for climate adaptation in March 2014, the ‘Covenant of Mayors Initiative on Climate Change Adaptation’, or in short ‘*Mayors Adapt*’ (<http://mayors-adapt.eu/>). This is a voluntary but formal commitment made by cities to develop local climate adaptation strategies.

With this, the European Commission acknowledges the role of local authorities in improving the climate-proofing of cities, supporting city policy and local actions regarding the adaptation of cities to climate change. Both knowledge building at the local level and political commitment form the basis for the Covenant of Mayors. *Mayors Adapt* helps raise public awareness on climate adaptation and the necessary measures. In addition, *Mayors Adapt* wants to provide a platform to a network of cities working on climate adaptation.

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Mayors Adapt asks that the following step-by-step approach be followed:

- Step 1: Preparing the basis for working on climate adaptation by ensuring the necessary support and organizing management
- Step 2: Pinpointing risks and vulnerabilities regarding climate change, as a basis for prioritizing adaptation actions
- Step 3: Identifying adaptation options
- Step 4: Assessing, testing, and selecting adaptation options
- Step 5: Implementing the options
- Step 6: Monitoring and regularly evaluating the accomplished progress and redirecting local adaptation strategy, based on results

Climate-ADAPT is the European platform set up by the European Commission and the European Environment Agency (EEA) with the goal of helping European member states adapt to climate change. It offers an *Urban Adaptation Support Tool* to help cities and municipalities go through the steps towards drawing up an adaptation plan⁶. It should be noted however that, in practice, the steps are typically not carried out one by one, but in random order, or parallel to one another. Activities such as involving citizens and businesses may play a part in all of the steps.

⁵ Directorate-General for Climate Action (DG-CLIMA)

⁶ <http://climate-adapt.eea.europa.eu/tools/urban-ast/step-0-0>

In the run-up to the Climate Summit in Paris, 15 October 2015 saw the European launch of the new and integrated Covenant of Mayors for climate and energy. The new Covenant of Mayors is an integrated agreement in which measures for the reduction of greenhouse gas emissions (climate mitigation) are tied to actions aimed at enhancing the resilience of cities and municipalities in coping with the effects of climate change within their territories (climate adaptation). In this context, Europe is putting forth new goals for climate mitigation: cities and municipalities must reduce CO₂ emissions within their territories by at least 40% by 2030.

BELGIAN CONTEXT

In 2010, Belgium defined its national adaptation strategy⁷ (NAS) and is currently working on a national adaptation plan 2015-2020 (NAP) along with the regions.

The draft federal adaptation plan⁸, drawn up in 2014, identifies 34 federal adaptation measures targeting 10 sectors: transport, economy, energy, marine, research, health, development cooperation, international security, crisis management in case of disasters, and agriculture.

FLEMISH CONTEXT

The Flemish Department of Environment, Nature, and Energy (LNE) is spearheading the Flemish climate adaptation policy. On the basis of a number of preparatory studies, including

- Building blocks towards a coherent and efficient adaptation plan for Flanders⁹
- LNE adapts¹⁰, describing how the policy domain of Environment, Nature, and Energy can address climate change
- Adapting to climate change: Global costs and practical examples

the Flemish Adaptation Plan¹¹ (VAP) was developed in 2012, and approved on 28 June 2013 as part of the Flemish Climate Plan. The key objectives are understanding the Flemish vulnerability to climate change and the improvement of Flemish defences against the effects of climate change. The 11 Flemish departments involved retain responsibility for the actions within their policy domain, and shall finance the costs of these actions using their usual financial resources.

In addition to its very own approach and action plan, the Flemish government wants to support the Flemish cities subscribing to *Mayors Adapt* in drawing up their city's climate adaptation strategy and action plan. Ghent along with Antwerp, Kortrijk, Hasselt, Leuven, Zwijndrecht, and the province of Antwerp are taking part in the pilot group where knowledge and experiences regarding climate adaptation are exchanged at the local level. In 2015, LNE had a study conducted in which the many existing instruments for drawing up and/or implementing a climate adaptation strategy were

⁷ <http://www.lne.be/themas/klimaatverandering/adaptatie/nationale-adaptatie-strategie>

⁸ http://www.klimaat.be/files/6313/9248/5036/ontwerp_federaal_plan_adaptatie.pdf

⁹ <http://www.lne.be/themas/klimaatverandering/adaptatie/vlaams-adaptatieplan>

¹⁰ <http://www.lne.be/themas/klimaatverandering/adaptatie/studies-en-onderzoek>

¹¹ <http://www.lne.be/themas/klimaatverandering/klimaattips/klimaattips/wat-doet-de-vlaamse-overheid/vlaams-klimaatbeleidsplan>

screened, with the end goal of developing an instrument fit for Flanders. The Ghent climate adaptation plan 2016-2019 was constructed using this methodology.

1.2. Ghent's ambition

On 16 October 2014, the City of Ghent was one of the first cities in Flanders to sign the European Covenant of Mayors called *Mayors Adapt*. With this move, Ghent committed to developing a climate adaptation strategy and drawing up an action plan with local measures for adapting the urban environment to climate change. This way, the City of Ghent is working on building a climate-robust city and contributing to the European objective of creating a climate-proof Europe. In November 2015, Ghent also signed the new integrated European covenant of mayors for climate and energy, of which *Mayors Adapt* is a part.

In the long term (2030), we seek to prepare and adapt Ghent to the projected effects of climate change (precipitation extremes and water nuisance, extended periods of drought and water shortage, heat stress, and rising sea levels) making **Ghent a climate-robust city**. The target year of 2030 is linked to the target year for the new spatial structure plan *Ruimte voor Gent 2030* (Room for Ghent 2030). Not only is there a close link between climate adaptation and Ghent spatial structure, planning ahead of climate change also implies a strong interwovenness with other major societal and spatial challenges such as demographics, liveability, mobility, economy that all converge in cities.

In order to turn Ghent into a climate-robust city, we wish to **develop a keenly accurate picture of projected climate changes for Ghent by 2019**: what are the effects of heat stress, precipitation extremes and water nuisance, extended periods of drought and water shortage on our city? Climate adaptation is a relatively recent theme and requires a certain level of knowledge build-up. The vulnerability analyses provide an insight into the exposure of the city to the effects of climate change, to our sensitivity, to the potential impact, and eventually also the need to tackle these issues. The objective here is to enhance our ability to adapt, in turn reducing our vulnerability.

In addition to knowledge build-up, climate adaptation should by 2019 also be integrated into the operation of the city services that manage the instruments that arm our city against the effects of climate change. In addition to the Environmental and Climate Service, policy tools are also found among others within the operation of the Parks and Public Gardens Service, the Roads, Bridges and Waterways Service, the Urban Development and Spatial Planning Service. The idea that adaptation is a future-proof investment that makes a lasting contribution to a liveable city should therefore be an integral part of the thinking on city development.

Also, the realization of a climate-robust city is already being demonstrated by means of a **number of example projects**. These example projects make climate adaptation more concrete, have an inspirational effect, and generate a learning-by-doing effect to build knowledge and experience with climate adaptation measures at the local level.

Lastly, focus is placed on **communication to and awareness-raising among different target groups**, both internally and externally, in order to enhance the knowledge of and the support base for climate adaptation measures.

Climate adaptation constitutes the second pillar of the Ghent Climate Policy, in addition to climate mitigation. Holding back climate change (mitigation) remains the basis for our climate policy. We as local authorities must do everything in our power to reduce our CO₂ emissions as much as possible. Our ambition is to be climate neutral by 2050. The Ghent Climate Plan 2014-2019¹² describes our actions towards the first step in the direction of this ambition, namely -20% CO₂ by 2019. Meanwhile, Ghent also commits to reducing CO₂ emissions by 40% by 2030. CO₂ emissions and the related climate change however is a global issue, and as a local authority we alone cannot stave off climate change. Climate change can be partly felt today already, and its effects will only increase over the coming years. This is why it is important that we as a city focus on climate adaptation and strengthen our city in the face of climate change.

it is important to establish connections between climate adaptation and climate mitigation, and to search for win-win scenarios whereby mitigation and adaptation mutually benefit from one another. An emphasis on green roofs is a good example of a win-win measure: a green roof lowers a building's energy consumption, mainly in lowering cooling efforts in hot weather, while at the same time contributing to water buffering and a greener city. A choice for green roofs does not need to present an obstacle for solar panels. Often the slanting part of the roof can be reserved for solar panels and rainwater recuperation, with the flat roof being eligible for a green roof. Wherever necessary, a combination of green roofs and solar panels is possible. Thanks to the cooler surface beneath them, solar panels on green roofs even have a higher yield than those placed atop conventional roof coverings. Likewise, the residence renovation programme, which focuses on more energy-efficient homes, contributes to the enhancement of our resilience by emphasizing quality ventilation, countering the risk of overheating of homes and heat stress.

We must also ensure that climate adaptation and mitigation do not clash. One example is the use of air conditioning units which may cool off buildings on hot days, but which have high rates of energy consumption and also emit heat outside of the buildings, making them part of the problem rather than a solution.

1.3 The Ghent climate adaptation strategy

Ghent was among the first European cities to pick up on the climate adaptation theme and realize the importance thereof. In 2012, Ghent was selected as one of the 21 pilot cities for the European project *Cities Adapt*. Our climate adaptation strategy was outlined under the impulse of this project. These outlines form the pillars on which climate-robust Ghent rests, and are the basis for the action plan in chapter 4.

¹² https://klimaat.stad.gent/sites/default/files/klimaatplan_2014-2019.pdf

The pillars of the Ghent climate adaptation strategy:

1. Political support base and broadening within the city organization
2. Knowledge build-up regarding climate scenarios, impact, and vulnerability of Ghent
3. Knowledge build-up regarding possible measures at the local level
4. Integration into city policy plans, instruments, and processes
5. Implementation by means of example projects
6. Targeted communication and awareness-raising
7. Partnerships and multi-stakeholder approach
8. Monitoring and evaluation

This climate adaptation strategy is further developed in the following chapters. Chapter 2 forms our **vulnerability analysis**. This involves researching the effects of climate change to which Ghent is exposed and the impact thereof. Such an analysis forms the basis for the future strategy and a vetting framework for the choice and prioritization of measures. Chapter 3 provides the **principles** which a **climate-robust city** must meet, both in the public domain and in private developments. Chapter 4 explains in greater detail for each of the afore-mentioned pillars of our climate adaptation strategy what the strategy and current approach is, and also attaches an **action plan for the further legislature (2016-2019)**. One important note on this topic is that the action plan is a living document that can be further refined and specified where needed, based on the results of the vulnerability analysis or in light of opportunities.

The present climate adaptation strategy and the action plan commit to preventing and reducing the negative effects of climate change, with a focus on spatial structural measures and instruments. This constitutes step 3 of what we may call the “**climate ladder**”:

- 1) Prevent further climate change (meaning: always prioritize mitigation);
- 2) Deal with uncertainty by incorporating flexibility in case of unforeseen scenarios;
- 3) Prevent or reduce the negative effects of climate change and utilize positive effects;
- 4) Prevent or reduce damage when negative effects do occur;
- 5) Incorporate conditions for smooth recovery from negative effects.

Steps 4 and 5 are important elements in the construction of a climate-robust city. This includes the communicative and the social side of climate adaptation, whereby focus is placed on

- information and awareness-raising in order to enhance awareness and the support base;
- enhancing the population’s adaptability and resilience, with a particular focus on vulnerable groups (*accessible drinking water, cool spaces, medical follow-up*);
- contingency planning in case of calamities (*heat planning for heat waves, disaster planning in case of water nuisance, crisis management, flexible transportation management, programming modified activities*);
- a smooth recovery from adverse effects for instance by means of financial buffers such as insurances and funds.

Information and awareness-raising is part of the communication strategy as included in pillar 4.7.

The other steps are not yet explicitly part of the scope of the present climate adaptation plan. In practice however, attention is given to this:

- As for heat stress, the social dimension is naturally already taken into account. Indeed, the City of Ghent has a heat and ozone peak plan, and the care sector is prepared to address the extra needs in case of heat waves.
- The social dimension behind green management is also taken into account already (e.g. collective of co-management of public green spaces). In addition, it may be noted that a strong focus placed on public green provision, among others in the purview of climate adaptation, also constitutes a pre-eminently social policy (e.g. additional parks for people without gardens) that is already taken into account.
- In the purview of the City of Ghent's climate goals, a vast amount of efforts are being made to the benefit of vulnerable groups. For these target groups, emphasis is placed on specific unburdening plans, premiums, free advice, low-cost loans, ... In this respect, climate mitigation and adaptation are not regarded as detached entities. Indeed, a well-insulated home provides improved summer comfort. In addition, specific advice will be given on green roofs, rainwater recuperation and infiltration, lightly-coloured materials, and sun protection.

Consequently, the social dimension behind climate adaptation will at a later stage be further developed within the strategy and the action plan.

Likewise, the enhancement of our local resilience in light of possible indirect effects of worldwide climate change on global systems (food production, energy, drinking water, transport, financial system) is important, but not within the scope of the present climate adaptation plan.

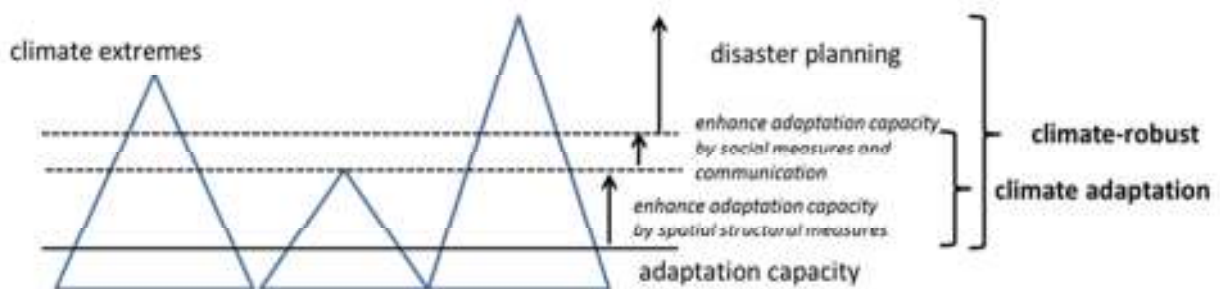


Figure 1. Building a climate-robust city

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WHAT DOES CLIMATE CHANGE MEAN TO GHENT?

How vulnerable is Ghent to climate change? This chapter provides a state of affairs on observed and future climate change for Flanders based on the MIRA Climate Report 2015. Subsequently, the focus is placed specifically on Ghent: to what effects of climate change are we exposed, and to what extent are we susceptible to them? This allows us to chart the possible impact of climate change on our city. Our vulnerability to heat stress and water nuisance is viewed in greater detail in 2.3 and 2.4. These aspects form the most direct apparent effects of climate change on Ghent¹³, and studies at the Ghent city level have therefore already been conducted on this matter.

2.1 MIRA Climate Report 2015

In September 2015, the Flemish Environment Agency (VMM) released its latest climate report.¹⁴ In it, a response is given to the questions ‘To what extent is climate change already apparent in Flanders?’ and ‘What are the expectations for the future?’.

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CURRENT SITUATION: ALREADY OBSERVED CLIMATE CHANGE IN FLANDERS

Regardless of significant natural fluctuations, the effects of climate change are already apparent in a number of indicators. The figure below provides an overview.

¹³ The 2015 MIRA Climate Report also primarily emphasizes the consequences for water management and public health, through heat wave victims and the influence on air quality.

¹⁴ Brouwers J. *et al* (2015) 2015 MIRA Climate Report, on observed and future climate changes. Vlaamse Milieumaatschappij (Flemish Environment Agency) in collaboration with KU Leuven, VITO and KMI. Aalst, Belgium, 147 p.

The publication can be downloaded from www.milieurapport.be. English version:

<http://www.milieurapport.be/en/publications/topic-reports/mira-climate-report-2015-about-observed-and-future-climate-changes-in-flanders-and-belgium/>

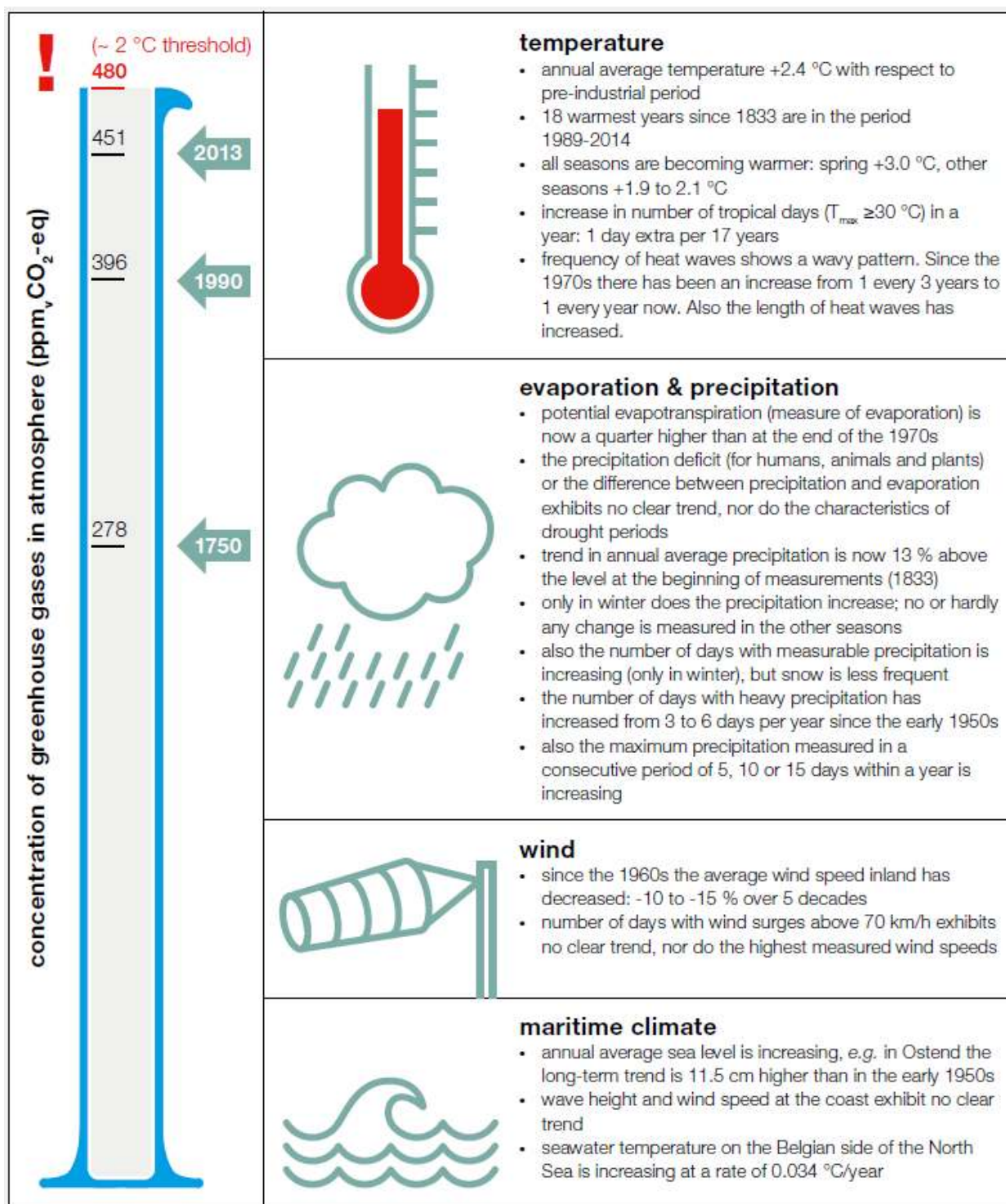


Figure 2. Climate trends detected in Belgium until 2014 (Source MIRA Climate Report 2015)

WHAT DOES THE FUTURE HOLD: CLIMATE SCENARIOS

Based on some 200 global climate model simulations, the MIRA Climate Report 2015 presents future climate change for Flanders by means of three climate scenarios: low, medium, and high. These

three scenarios are used to chart the scope of possible change¹⁵. The table below provides an overview of the key climatological parameters over 30, 50, and 100 years according to these three climate scenarios.

¹⁵ The low and high climate scenarios are based on the top and bottom limits of the 95% confidence interval calculated on the basis of the full range of newly available climate model projections for Belgium. The low and high climate scenarios thus seek to represent for each (climate) parameter the band width of possible climate change facing Flanders and Belgium over the coming decades and towards the end of this century. The medium climate scenario corresponds with the median of all climate model projections, but is not by definition the most likely scenario.

change for	over number of years	climate scenario			additional info
		low	medium	high	
annual average temperature	30	+0.2 °C	+1.1 °C	+2.2 °C	The coast has a mitigating effect on warming, but the effect is small with respect to the expected climate change.
	50	+0.3 °C	+1.8 °C	+3.6 °C	
	100	+0.7 °C	+3.7 °C	+7.2 °C	
average number of extremely hot days per year	30	0	+5	+19	The number of extremely hot days increases the most in the centre of Belgium.
	50	0	+8	+32	
	100	0	+16	+64	
average number of extremely cold days per year	30	0	-2	-10	The number of extremely cold days decreases the most in the Ardennes.
	50	-1	-4	-17	
	100	-1	-7	-33	
total winter precipitation	30	-0.4 %	+3 %	+11 %	Winter precipitation increases more along the coast.
	50	-0.6 %	+6 %	+19 %	
	100	-1 %	+12 %	+38 %	
total summer precipitation	30	-16 %	-4 %	+5 %	Extreme summer precipitation intensities may increase significantly. Spatially, a north-south pattern is emerging with greater desiccation in the south of the country.
	50	-26 %	-7 %	+9 %	
	100	-52 %	-15 %	+18 %	
number of wet days in winter	30	-1 %	+0.5 %	+2 %	
	50	-2 %	+0.8 %	+4 %	
	100	-5 %	+1.5 %	+8 %	
number of wet days in summer	30	-12 %	-5 %	+1 %	
	50	-21 %	-8 %	+2 %	
	100	-41 %	-15 %	+4 %	
total potential evapotranspiration in winter	30	+0.5 %	+3 %	+11 %	
	50	+1 %	+6 %	+18 %	
	100	+2 %	+12 %	+35 %	
total potential evapotranspiration in summer	30	+0.5 %	+5 %	+14 %	
	50	+1 %	+8 %	+23 %	
	100	+2 %	+17 %	+47 %	
daily average wind speed in winter	30	-8 %	0 %	+3 %	
	50	-14 %	-0.5 %	+6 %	
	100	-28 %	-1 %	+11 %	

Figure 3. Overview of possible climate change for Flanders and Belgium, according to the low, medium, and high climate scenario over 30, 50, and 100 years (Source MIRA Climate Report 2015)

In summary we may expect the following effects:

- A **rise in average temperature** (both in summer and in winter), which will only increase as one moves from the low to the high scenario.

- An **increase in the number of heat waves during summer**: this is tied in with the increase in average temperature. The number of extremely warm days increases dramatically in the high scenario, and this increase is the most pronounced in the centre of the country. The intensity of heat waves will also increase. A rise in temperature and number of heat waves combined with city infill and sprawl will ensure that within the city centres the number of heat wave days is going to increase by a factor between 1.7 and 17.2, depending on the accepted climate scenario.
- A **reduction of precipitation in summer** (except in case of the high scenario) but an **increase in the intensity of rainshowers in summer** (summer storms). Only in case of the low scenario would this increase not occur, with the expectation being a reduction rather.
- An **increase in the dryness of summer**: this is caused by a combination of a reduction in precipitation and a marked increase in potential evapotranspiration (which in turn is tied in with the rise in temperature). The importance of the dryness increases significantly from low across medium to the high scenario, despite the fact that the precipitation reduction rate is lower in the mid and high scenarios than in the low scenario.
- An **increase in precipitation in winter** (except in case of the low scenario). This appears to be less related to an increase in the number of wet days, but rather to the increase of precipitation volume per day.
- As for the **average wind speeds**, both in winter and in summer, no significant changes are projected, although wind speed in winter during the most powerful storms will likely increase by 0 to 30%.

Many still often have a positive outlook on climate “warming” in Flanders, expecting a southern climate in our region shortly. But this is not what projections are showing.

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- Our climate is getting warmer, but not necessarily sunnier
- The following **seasonal trends** are expected:
 - Fewer cold winters, but wetter winters
 - Warmer and drier summers
The expectation is that extreme European summers such as the summer of 2003¹⁶ would become average summers by the middle of this century, and at the same time more intense summers will occur.
 - The intermediate seasons will be warmer but greyer.
- As for **climate extremes** we expect
 - More periods of sudden, intense rainfall, both in winter and summer. Rainshowers that used to occur once every 100 years are expected to occur once every 10 years by the end of this century
 - Multiple heat waves¹⁷ annually that are more intense (8 to 9°C warmer on hottest days) lasting a combined total of 1 month
 - Periods of serious desiccation and water shortage

¹⁶ In Europe, the summer of 2003 was likely the hottest since the year 1500. At that time, our country was undergoing a significant heat wave that lasted fourteen days, and another warm period lasting thirteen days. Excess mortality for these periods was 1,230 persons. Considering the entire summer (the months of June through September) of 2003, excess mortality even amounted to 2,052 persons. The extreme temperatures also exacerbated exposure to harmful substances, such as tropospheric ozone and fine dust.

¹⁷ The Federal Public Service for Public Health utilizes the following definition of a heat wave: a period of at least three consecutive days with an average minimum temperature (average over three days and not per day) higher than 18.2°C and an average maximum temperature higher than 29.6°C.

Climate adaptation first and foremost means preparing for climate extremes.

DEALING WITH UNCERTAINTY

The scope of the climate scenarios in all likelihood covers the future reality. However, a great deal of uncertainty lingers. For instance, there are known processes and mechanisms that have not yet been explicitly taken into account (e.g. the crossing of *tipping points*¹⁸). There are also uncertain elements that are not even known to exist yet. However, what is already clear is that the recent global emission of greenhouse gases almost seamlessly overlaps the evolution of the most extreme scenario. Even if we assume that we can limit global warming to no more than 2°C as agreed at the 2015 Paris climate summit, this still means that the high scenario is very likely for Flanders.

The effects of climate scenarios can be put in numbers, however. If the consequences of a certain scenario are significant, it is important to take this into account during policy-making and management. The possibility should be built in to make adjustments - at minimal cost - as climate knowledge is enhanced.

Because the effects of climate change are uncertain and partly unknown, and because the circumstances under which they occur are changing, climate adaptation is not a static concept, but one that will also require flexibility and adaptability. This includes both the ability to display flexibility in addressing changing threats, and the ability and playroom to utilize new opportunities.

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2.2. Consequences of climate change for Ghent

Just like most cities, Ghent is susceptible to the effects of climate change. Ghent is home to a vast group of residents (258,000 inhabitants, 1,650 inhabitants/km²), including at-risk populations such as the elderly, small children, the disadvantaged. Ghent is also home to major functions such as care institutions, childcare centres, ... In addition, Ghent houses a great deal of economic activity, as well as major economic hubs such as the Ghent seaport.

Ghent is about 50 km from the coastline, at an average elevation of 8m above sea level. Along the Sea Scheldt, the city experiences the tidal effect of the North Sea. Ghent is also linked to the North Sea via canals and locks.

¹⁸ When certain thresholds are crossed (tipping points), (self-reinforcing) mechanisms are activated that lead to abrupt changes in the climate system. They may have significant consequences that are not yet incorporated into the climate scenarios.

One prominent example of a self-reinforcing mechanism is the ice-albedo effect: an initial warming of snow or ice mass induces regional melting. The melting of snow or ice uncovers dark surfaces, specifically brown land or blue ocean. These dark surfaces reflect less sunlight, resulting among others in increased regional warming and additional melting.

Ghent is thoroughly covered with hardened surfaces, an average of 46% of our soil is covered with buildings or pavings. At the heart of the city, the surface hardening rate even exceeds 80%.

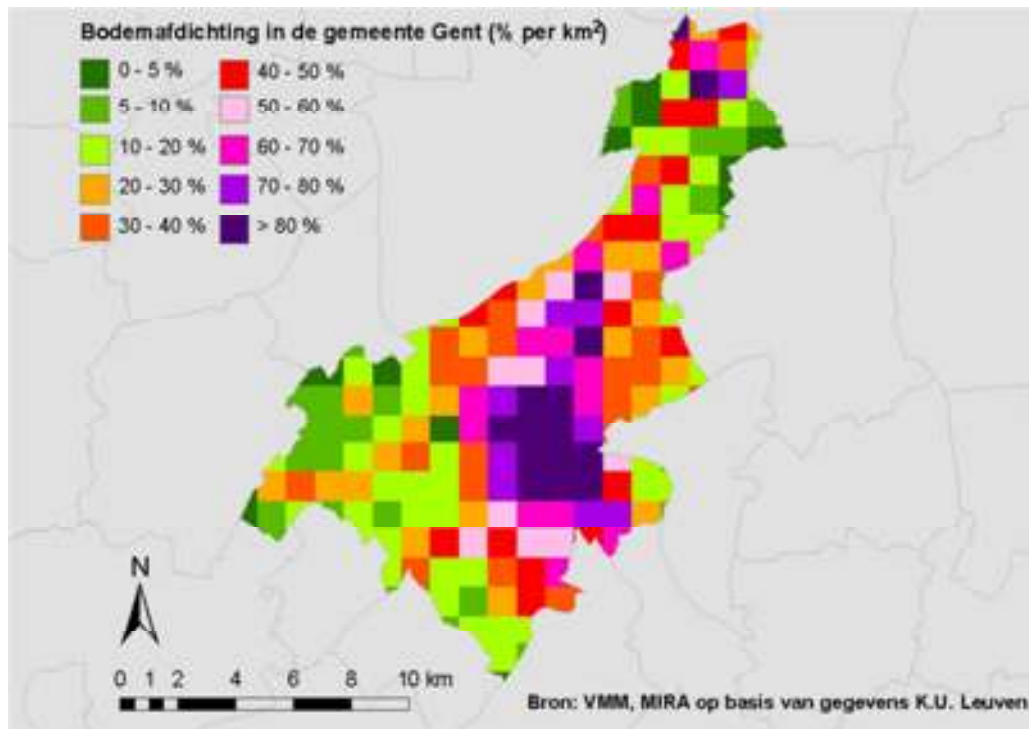


Figure 4. Sealed soil in Ghent

This typical urban structure with little greenery and plenty of infrastructure ensures that the primary effects of climate change (high temperatures, more and longer heat waves, extreme precipitation, drought, ...) lead to problems. These are known as the secondary effects of climate change, such as heat stress, water nuisance, water shortage.

HEAT STRESS

The temperature in cities is generally higher than in surrounding rural areas. This effect is known as urban heat island, chiefly caused by urban areas with dense infrastructure, where natural surfaces such as vegetation and water are replaced with impermeable and warm surfaces, usually constructed out of concrete and asphalt (buildings, roads, car parks, industrial and commercial areas, ...). Less vegetation (and thus less cooling through evaporation) and more infrastructure, the catching of radiation between buildings, the relatively limited heat exchange between the city and the atmosphere, the high thermal inertia of urban materials, and the heat released during the heating and cooling of buildings and traffic all contribute to elevated city temperatures.

This urban heat island effect can be observed today, with higher temperatures in the city centre compared to rural areas. Because of this, urban populations will have to deal with heat stress more quickly during heat waves, with a sense of unease and discomfort. The rise in average temperatures

and the increased frequency of heat waves will further enhance this urban heat island effect, leading to more heat stress. The sick, the elderly (> 65 years old), and young children are highly sensitive to this effect. This may lead to heat-related issues and illnesses such as cramps, faintness, and strokes. In extreme cases this even leads to untimely death. For instance, during the heat wave of 2003 Belgium suffered 2,052 victims, and 2006 saw 940 victims (excess mortality). But heat waves affect everyone's comfort (loss of sleep, difficult working conditions, ...), as well as employment and productivity. Moreover, heat negatively impacts air quality and causes the formation of more smog in the city. Furthermore, energy consumption (air conditioning) is also affected, and transportation infrastructure may suffer failures (damage among others to railway tracks, road surfaces).

WATER NUISANCE

Sealed surfaces may cause local water nuisance in case of more frequent extreme rainshowers. A distinction is hereby made between

- water nuisance from sewers after extreme summer showers (pluvial flood)
- water nuisance from waterways after extended precipitation, a phenomenon more typical of winter (fluvial flood)

VMM and W&Z are mainly responsible for the control of water nuisance from waterways. As a City we must mainly gain an insight into possible bottlenecks in Ghent and their impact under changing climate conditions. Knowledge build-up regarding the impact of climate change on our sewer system and the manner in which we drain rainwater is carried out in conjunction with sewage management company Farys.

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DESICCATION AND WATER SHORTAGE

This may sound contradictory to the afore-mentioned issue of water nuisance, but there are indications that drought and water shortage will become one of the the most noticeable effects of climate change in Flanders. Water availability in Flanders is already at a striking low, with fewer than 2,000 m³/inhabitant per year¹⁹. When water availability drops below 1,700 m³/inhabitant per year, there is water shortage. The causes for this low water availability are among others a high population density, and thus great demand for water, and a limited supply of surface and groundwater. In addition, the vast rate of hardened surfaces leads to less water infiltration, so groundwater is being replenished less and less.

Ghent too is susceptible to drought due to the high demand for water, both drinking water and water for agriculture and industry (process water, cooling water, ...). More frequent droughts

¹⁹ Depending on the method, it is apparent that, on average, there is an annual availability in Flanders and Brussels between 1100 and 2000 m³ of water per person. Internationally, this is viewed as "very little". Only a few Western nations have even less water per resident (Italy and the Czech Republic). Even in countries such as Spain, Portugal, and Greece, water availability per resident is greater than in Flanders and Brussels. These figures again show why it is important, also in Flanders, to use the available water sparingly and efficiently.

See '[MIRA indicator: waterbeschikbaarheid in Vlaanderen](#)'.

negatively impact both the availability and the quality of the water. Drought also shows in lower water levels in the canals of Ghent, compromising the transportation function of our waterways.

CONSEQUENCES OF RISING SEA LEVELS

All climate scenarios for Flanders project a rise in the sea level; increasing from the low, through the medium, to the high scenarios respectively by +60 cm, +80 cm, and +130 cm for the period 2071-2100. In Europe, Belgium is second only to the Netherlands in vulnerability to flooding due to a rising sea level: in Flanders, 15% of the surface is fewer than 5 metres above the average sea level. Consequently, in the long term (2100?) we are projecting an impact of rising sea levels on Ghent as well, among others the Ghent drainage system, water quality (salinisation), and flooding hazards.

OTHER CONSEQUENCES OF CLIMATE CHANGE

In addition to the afore-mentioned, more spatial consequences, climate change will also among others affect the following:

- biodiversity, as native plants and wildlife come under pressure and new species thrive sometimes at massive rates and at the expense of native species.
- health with possibly new illnesses and plagues spreading to our regions.
- food supply, by local and global changes in yield and food safety. Self-sufficiency will become even more important.

Climate change may also produce a number of positive effects, such as an increase in tourism or milder winters leading to a reduction of the demand for energy. But these matters do not outweigh the need for us to prepare for the less desirable effects of a changing and more extreme climate.

2.3. Vulnerability analysis on heat stress

In 2014, VITO charted the urban heat island effect for Flanders using satellite imagery²⁰. Compared with the countryside, night temperatures are particularly higher in cities. For Flanders, this difference amounts to a few degrees, with peaks of 7 to 8 °C and more. A strong connection is apparent between the infrastructural surface rate of a city and the intensity of the heat island effect. Ghent is second only to Antwerp in having the strongest heat island effect out of all Flemish cities.

²⁰ De Ridder K., Maiheu B., Wouters H. & van Lipzig N. (2015), Indicators of the urban heat island in Flanders, study commissioned by VMM, MIRA, MIRA/2015/05, VITO.

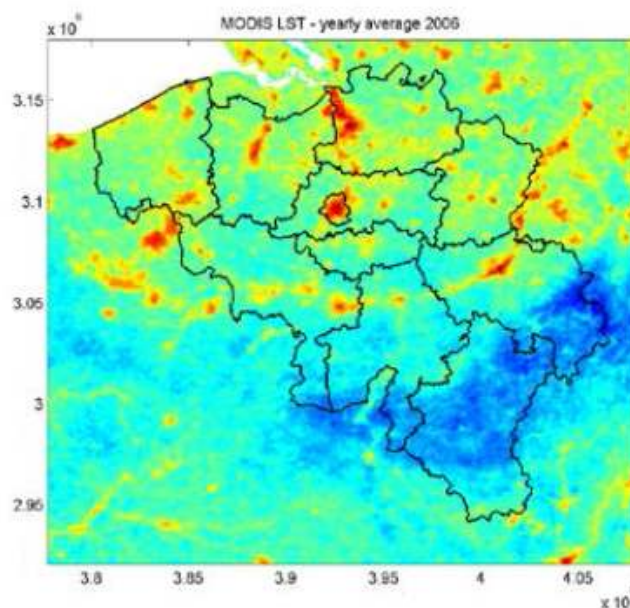


Figure 5. Image of the annual average surface temperature (MODIS LST) for Belgium for 2006

rang	overdag	's nachts
1	Antwerpen (14)	Antwerpen (15)
2	Gent (29)	Gent (21)
3	Kortrijk (40)	Brugge (36)
4	Roeselare (54)	Mechelen (48)
5	Sint-Niklaas (60)	Kortrijk (70)
6	Mechelen (77)	Roeselare (79)
7	Aalst (92)	Turnhout (85)
8	Brugge (101)	Leuven (94)
9	Leuven (116)	Gent (117)
10	Turnhout (132)	Hasselt (130)
11	Ieper (135)	Aalst (133)
12	Tienen (136)	Ieper (144)
13	Geel (137)	Sint-Truiden (160)
14	Hasselt (170)	Tienen (160)
15	Aarschot (176)	Sint-Niklaas (163)
16	Gent (157)	Aarschot (185)
17	Sint-Truiden (200)	Geel (187)
18	Lier (203)	Lier (215)
19	Diest (221)	Diest (228)

Figure 6. Explicit ranking of cities according to intensity of the heat island effect based on surface temperatures (SUHI) during summer (April – September) for the period 2002 – 2013. The lower the figure, the stronger the SUHI compared to the other cities. Cities with a strong SUHI are indicated in red.

ANALYSIS OF THE URBAN HEAT ISLAND EFFECT FOR GHENT

In order to gain a more detailed view of our vulnerability to heat stress, an instruction was given in 2012 to Flemish research organization VITO and the Department of Mobility and Spatial Planning of the University of Ghent.²¹

Creating heat maps:

During the summer of 2012 (20 July - 20 September), VITO researchers conducted a measurement campaign with a number of fixed temperature and humidity sensors spread out across the city (Vrijdagsmarkt, Botanical Garden UGent, and city garden in Ledeborg) and the surrounding countryside (test farm Melle). A number of existing measurements were also used in the study. Furthermore, in the late evening of 18 August 2012 (the second warmest night ever since the

²¹ Maiheu B. *et al*, (2013), Creation of a heat map and analysis of the urban heat island effect for Ghent. The complete heat study can be downloaded from <http://www.gentklimaatstad.be/study/hitte-eilandeffect-centrum-gent-gemiddeld-3-c-warmer-0>

beginning of observations) VITO conducted a number of mobile temperature measurements (car and bicycle) in and around Ghent.

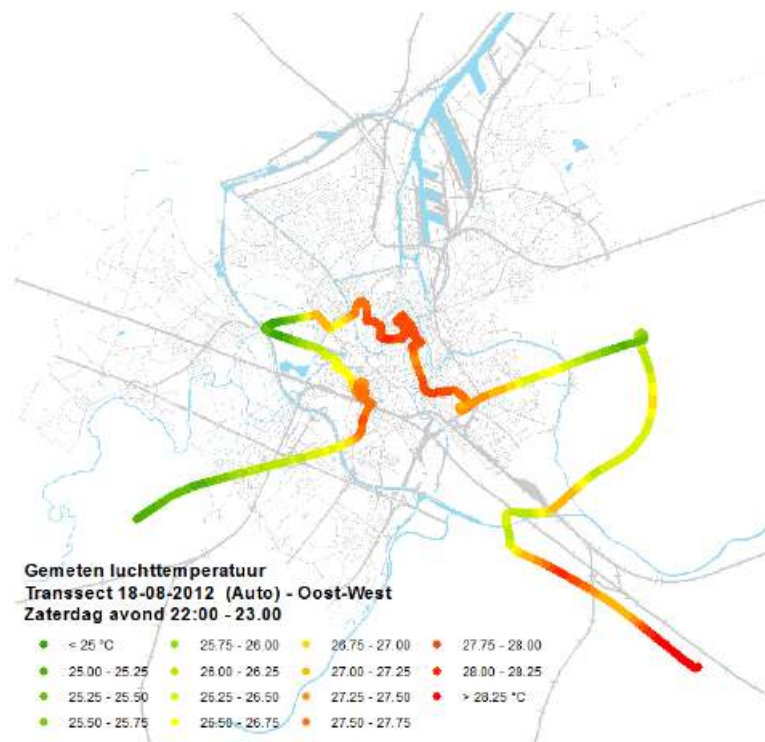


Figure 7. Measured air temperature utilizing mobile transect on Saturday night 18-08-2012 between 10 p.m. and 11 p.m.

These temperature observations were supplemented using urban model calculations and infrared satellite imagery to chart the occurrence and gravity of the urban heat island effect in Ghent.

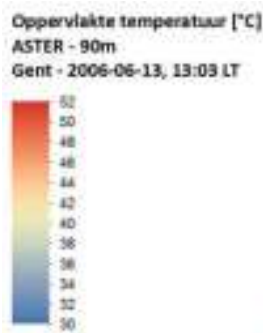


Figure 8. Satellite-based surface temperature on 13 June 2006



Figure 9. Modelled urban heat island effect (air temperature) on 19 August 2012 at midnight

The results both from measurements and models show that the Ghent city centre is on average some 3 degrees warmer, with peaks of up to 8°C on hot evenings and nights with clear, open skies and typically very low wind speeds. The urban heat island effect is strongest after sunset. Indeed, the average daily profile shows that the heat island effect reaches its maximum of about 3°C around midnight. The effect wanes as morning approaches, and reaches its minimum intensity before noon around 10 a.m. There is a slow but relatively insignificant increase of 0.5°C until early evening around 6 p.m., when the heat island effect once again fully takes hold.

Derivative map materials furthermore show that in summer, the city centre has up to 8 additional warm nights compared to the countryside, when temperatures likewise fail to drop below 18°C at night. Such elevated nightly temperatures cause sleep impairment and other issues.

Typical hotspots shown on heat maps are densely built-up neighbourhoods such as the city centre, Ledeborg, the railway station area, the area around Strop, Brugse Poort, Dampoort, and parts of Sint-Amandsberg. Furthermore, a number of hotspots showed up in the port area (e.g. the Volvo Cars and Honda areas, the Volvo Trucks areas along the R4, the Arcelor Mittal areas). These port locations are typically characterized by large, open industrial areas paved with asphalt (or crushed stone/coal). Such industrial sites do heat up quickly, but are also able to cool down quickly at night. However, the higher surface temperatures may give rise to elevated radiation load and thus heat stress during the day.

The study also charted the future evolution of the heat island effect, both due to changing land use (urbanization) by 2030 and due to climate change. The projections for Ghent as a result of climate change are an increase in the average intensity of the urban heat island effect by 0.4 to 0.8°C, some 5 additional days with a minimum nightly temperature of over 18°C, and a clear increase in the peaks and intensity of the urban heat island effect. Because of growing urbanization, an increase in the urban heat island effect is furthermore expected mainly in the city's periphery, and not so much in the city centre. This development mainly indicates that the heat sensitivity of the entire city is further enhanced, and with it the necessity to develop (policy) measures.

Heat map analysis:

During a second phase of the assignment, the analysis phase, the map materials were used to

- determine the causes of the urban heat island effect in Ghent
- chart vulnerability due to heat stress in the various Ghent city neighbourhoods.

The analysis results demonstrate that in Ghent, the main contributor to the urban heat island effect is the petrification of surfaces. In this respect, asphalt produces a stronger heating effect than concrete. Also the proportion and density (many narrow streets, few open spaces) of infrastructure has a significant influence. A possible cooling effect may be obtained primarily through vegetation (chiefly vertical green). Moreover, trees are able to provide shading during the day (leading to a diminished heating of the air at night). Another interesting aspect for Ghent was the potentially cooling effect of a combination of water elements with vertical greenery along the banks.

The table below provides an overview of the influences of the different parameters on the heat island effect in Ghent (strong heating effect (+++), heating (++) , slight heating effect (+), no influence (0), slight cooling effect (-), cooling (- -), strong cooling effect (- - -)):

Variable	Additional explanation	Influence	
		spring	autumn
Hardened surface fraction	<i>The degree to which the surface is covered. The greater this fraction, the higher the air and surface temperature.</i>	+++	+++
Water fraction	<i>The extent to which the surface consists of water. The more water, the lower the surface temperature.</i>	- - -	- -
Sky View Factor	<i>The extent to which the sky is visible. The smaller the proportion of infrastructure and the wider the streets, the more the sky is visible, the lower the air and surface temperature.</i>	- -	- -
Vegetation fraction	<i>The density of present vegetation. The denser the vegetation, the lower the air and surface temperature.</i>	- -	- - -
Asphalt fraction	<i>The extent to which the public space is covered by asphalt. The greater this fraction, the higher the surface temperature.</i>	+++	+++
Concrete fraction	<i>The extent to which the public space is covered by concrete. The greater this fraction, the higher the surface temperature.</i>	++	++

Causes of the urban heat island effect



Solutions to the urban heat island effect



Figure 10. Causes of and solutions to the urban heat island effect

The City Centre, Muide-Meulestede-Afrikalaan, Dampoort, Sluizen-Tolhuis-Ham, and Ledeborg areas have the highest sensitivity to the heat island effect based on demographics (age, population density, singles, and non-Belgian/Belgian proportions), socioeconomic factors (below average income

and unemployed jobseekers), and vulnerable functions (nursery schools, playgrounds, childcare centres, hospitals, service apartments, retirement and care homes, and public events).

ADDITIONAL ANALYSES BY VITO AND UGENT

Impact of heat on living and working in Ghent city and port

Flemish think tank Klimaatadaptatie instructed VITO's *Urban Climate Service Center* to conduct a follow-up on the afore-mentioned heat study. Particular focus was given to the assessment of the influence urban greenery has on local heat stress, and of the loss of productivity (loss of working hours) due to heat stress in the port area, using the data from the exceedingly hot summer of 2003.

2.4. Vulnerability analysis on water nuisance

In 2015, the City of Ghent conducted an initial analysis of the Ghent water system and our vulnerability to water nuisance.

WATER MANAGEMENT IN GHEENT

The Ghent canal basin is characterized by human manipulation of the water system. Different canals and locks ensure that the water level in the centre of the city can be kept at an artificially fixed level. The Lys and upper Scheldt rivers provide a large proportion of the water. The Ringvaart canal distributes the water flow from these rivers across the outflowing axes. These outflowing axes are the Ghent-Ostend Canal, the Ghent-Terneuzen Canal, the Schipdonk Canal, and the lower Scheldt or Sea Scheldt. Near Deinze, two thirds of the water flow from the Lys river is diverted away from Ghent via the Lys diverting canal, one third of the water flow goes directly towards the Ringvaart. Figure 11 shows the inflowing and outflowing axes and the matching flow rates under normal circumstances.

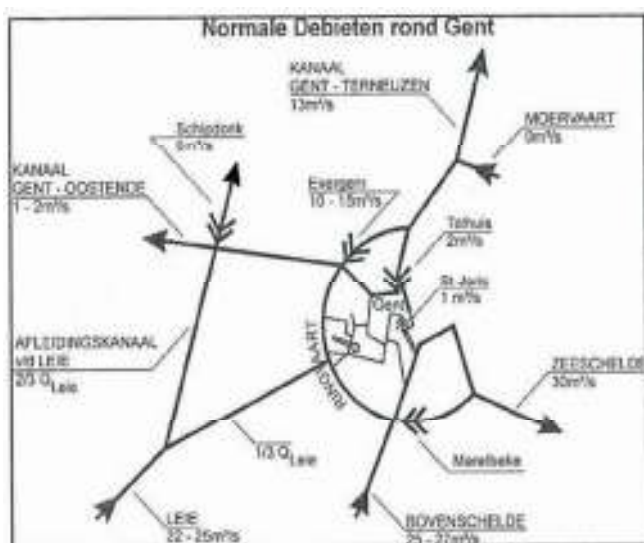


Figure 11. Water management in Ghent under normal circumstances.

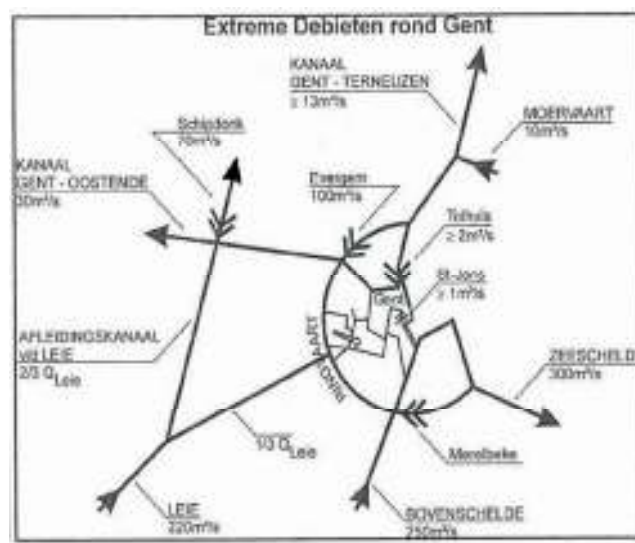


Figure 12. Water management in Ghent in case of extreme rises in water level of the Lys and upper Scheldt

The water flow of the Lys and upper Scheldt rivers is primarily determined by precipitation in Northern France. Drainage capabilities can be considerably enhanced in case of extreme rises in water level of the Lys and upper Scheldt rivers (figure 12). The water is diverted around the city, for now keeping the city centre entirely safe from flooding virtually at all times. Elevated water levels do cause flooding from the Lys and upper Scheldt rivers in parts of the city outside of the Ringvaart canal. Water levels and water flows in the largest rivers and canals can be monitored constantly at www.waterinfo.be.

Lastly, figure 13 shows water distribution in case of low outflow.

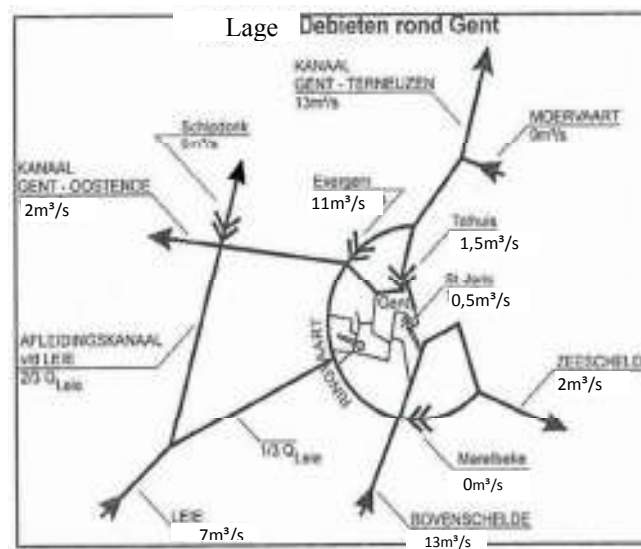


Figure 13. Water management in Ghent in case of low outflow

WATER NUISANCE FROM THE WATERWAYS

Current situation:

A number of maps are available for the assessment of the current vulnerability to flooding from the waterways: the water assessment map, the recently flooded areas, the high-risk areas, and the flood hazard and risk maps. All of these maps can be viewed at www.waterinfo.be. Based on the available map materials, supplemented by the knowledge of the terrain of the City, the water managers, and sewage manager, the following picture may be drawn regarding the current situation.

Ghent city centre appears to be well-protected against high water levels in the Lys and Scheldt rivers. This high level of protection of the inner city is owed to the complex system of canals in and around Ghent as described above. Excess water can be diverted according to preference to a combination of these different outflow waterways to safeguard the area within the Ringvaart canal.

Outside of the Ringvaart canal, the risk of water nuisance must be taken into account.

- along the touristic section of the Lys and the upper Scheldt, considerable areas of **Zwijnaarde, Sint-Denijs-Westrem, and Afsnee** may suffer flooding. In the recent past (as of 1988), these areas have indeed seen a number of floods.
- the Ringvaart influences the drainage of the Scheidbeek and Leebeek in **Sint-Denijs-Westrem**, among others also impacting the connecting sewer system. Rising water levels in the Ringvaart cause flooding in a significant proportion of buffering meadows as well as a number of residential areas. A model study for the drainage basin identified areas that qualify as flooding areas.
- **Gentbrugge** too must take water nuisance into account. Gentbrugge has also seen a number of floods recently. The municipality is susceptible to flooding due to the proximity of the Sea Scheldt.
- The area comprising **Drongen, Mariakerke, and Wondelgem** is likewise susceptible to water nuisance, albeit to a lesser extent than the area directly surrounding the Lys and upper Scheldt. In the past, flooding has occurred in Bourgoyen and to the northwest of Drongen.
- To the north of Ghent, the **area around the Moervaart** is susceptible to flooding. Minor flooding has occurred here over the past few years as well, at times when the water from the Moervaart had nowhere to go due to high water levels in the Ghent-Terneuzen canal.

When flooding occurs in Ghent, it is likely to take place in areas intended for flooding or where flooding causes less damage. Indeed, the flood risk map shows that, in critical situations, mainly meadows, natural areas, and fields along the Lys and Scheldt will flood. The economic damage to these areas is smaller than the damage that occurs when residential or industrial areas flood. Moreover, there are sufficient infiltration options. Exceptionally, residential areas may flood in Afsnee and Sint-Denijs-Westrem. Due to flooding in the late 1990s, investments were made to ramp up protection for residential areas (including the Assels residential centres) and reduce the risk of flooding.

Future situation under climate change

One important question is according to what extreme future scenarios Ghent will suffer more from water nuisance.

In application of the European Floods Directive, water authorities (W&Z, VMM) are at the moment drawing up flood risk management plans (ORBP) that do take into account climate change and a time horizon up to 2050. The additional protective measures included in the flood risk management plans are based on an average climate scenario and flooding with a return period of 100 years. The provisional flood risk management plan shows that the city centre does contain areas that may be considered vulnerable. In case of a water level that recurs once every 100 years for instance, issues will occur with the drainage of the Lieve. Over the coming years, during which project studies will be conducted and the definitive flood risk management plans will be published in addition to the regional studies, it will become apparent what these flood risk management plans will entail for Ghent. We as the City closely monitor this progress.

For the further creation of Ghent's own vulnerability analysis (see chapter 4.2), consideration should certainly be given to a high return period, e.g. a rainshower that at the moment occurs once every 1,000 years and may grow more frequent in a changing climate. Possible floodings in Ghent will be extreme occurrences by definition. Sound prevention measures can only be taken if the effect of such situations is known.

WATER NUISANCE FROM SEWERS

The most frequent form of water nuisance in the city is water flowing onto the streets. In certain cases, sewers are unable to cope with precipitation as the intensity of the showers is too great. This is a typical summer phenomenon: a vast amount of precipitation in a short amount of time. The Code for Good Practices²² prescribes that no water may enter the street in case of a shower that statistically occurs once every twenty years (T20). True bottlenecks are still defined by the sewer lines that cause issues during a two-yearly or five-yearly shower. Here, back pressure will cause water to flow from the sewer covers. These problems are more structural, not related to climate change.

Current situation:

The existing 1D sewer model²³ can be used to generate 'Water on the street' maps. This shows that a large portion of sewer covers flood in case of a T20 rainshower. Ledeborg, Gentbrugge, Sint-Amandsberg, and Oostakker are the most sensitive to water on the street. In Sint-Amandsberg/Oostakker, 44% of sewer covers will flood in case of a T20 rainshower.

The high percentages must be regarded with a critical mindset and the requisite expertise. After all, this value is the result of the applied calculation model and the utilized parameters/assumptions. Moreover, modelling is based on a shower covering all of Ghent, which is almost never going to occur in reality. A comparison to the more sophisticated 1D/2D model developed in the purview of Plurisk²⁴ (whereby the more complex topography of the city and the infiltration sensitivity of different areas are taken into account to also gain a view of the drainage of the water coming from the sewer covers) shows that the 1D model provides a significant overestimation of the number of flooded sewer covers.

Model simulations do allow for the areas vulnerable to water on the street in the city to be identified. In order to systematically tackle the simulated water nuisance, FARYS created so-called rainwater drainage (RWD) visions for the following areas.

- Wondelgem / Mariakerke – area above the Brugse Vaart
- Sint-Amandsberg / Oostakker, below the R4
- Gentbrugge and Ledeborg
- Certain areas of Ghent city centre
- Sint-Denijs-Westrem / Zwijnaarde

²² <http://www.integraalwaterbeleid.be/nl/publicaties/code-goede-praktijk-rioleringssystemen>

²³ The 1D sewer model calculates the 1-dimensional drainage into sewer lines and outflow via sewer covers into the street

²⁴ The European Plurisk project aims to identify flood hazard areas and develop a warning system for floods during summer rainshowers. The City of Ghent is involved in this project through Farys.

- Drogen

These stormwater drainage visions for the areas in question are based on fully separated systems, with the rainwater system maximally loaded. The intention is to draw up a region-wide stormwater drainage vision.

FARYS is also working on a stormwater drainage vision for Ghent city centre, in collaboration with Aquafin, and attuned to the different waterway managers. To this end, negotiations began on the creation of a collaboration agreement with Aquafin in the spring of 2016.

In case of road and sewer projects, the new sewers are always designed in accordance with the Code for Good Practices, and taking into account the created rainwater drainage vision for the area in question. Thus, the simulated water nuisance is tackled area by area, taking into account future drainage and the connection of the new rainwater system.

Planned works and the rainwater drainage vision will have a positive effect on water on the street. In Sint-Amandsberg/Oostakker, where simulations show a great deal of water nuisance at the moment, a large number of works have been planned. The simulation of the model for Sint-Amandsberg/Oostakker, adapted according to the expected situation in 2020, indicates that 'water on the street' will diminish. In 2020, 33% of sewer covers will still flood in case of a T20 rainshower. The simulation is already operating under the assumption that rainwater drainage will be completely disconnected, which is the worst-case scenario.

Likewise, the following works (non-exhaustive, a maximum of 2 projects mentioned per area) will considerably enhance the drainage in the areas in question:

- road and sewer projects in Ghent city centre; in the Bagattenstraat, Savaanstraat, and Burggravenlaan
- comprehensive road and sewer works in Gentbrugge in the Braemstraat and Jules De Saint-Genoisstraat / Peter Benoitlaan which will have a positive impact on drainage in the Schooldreef area
- creation of a separated system and a new rainwater drainage line in the Groenestaakstraat, between the tram track near the Botestraat and the Brugsevaart, as a major step towards the creation of the stormwater drainage vision in this area of Mariakerke / Wondelgem
- creation of a separated system and new rainwater drainage axis in the Evergemsesteenweg with connection to the Oude Lieve, as a step towards the creation of the stormwater drainage vision in this area of Wondelgem
- creation of a separated system and rainwater drainage line in the Spitaalpoortstraat and Serafijnstraat in Sint-Amandsberg
- major rainwater drainage axis in the N70 (Land van Waaslaan - Victor Braeckmanlaan) in Sint-Amandsberg
- Slotendries (in progress) and Gentstraat in Oostakker
- Hilarius Bertolfstraat / Van den heckestraat and Frans De Coninckstraat / Hundelgemsesteenweg in Ledeborg

- The projects Luchthavenlaan and Louis Delebecquelaan (in conjunction with AQF and AWW) in Sint-Denijs-Westrem will considerably enhance drainage in this part of Sint-Denijs-Westrem.
- Beekstraat and Keuzekouter-Zuid in Drongen
- Bollebergen in Zwijnaarde

Future situation under climate change

Climate forecasts indicate that intense summer rainshowers will become ever more frequent. A rainshower that currently occurs once every 20 years, will in the future occur perhaps once every 5 or 2 years. Current climate change has been included in the creation of composite showers because precipitation from the 1977-2007²⁵ period is used as a basis. However, forecasts are not included in the precipitation series.

The models also do not take into account slowing measures such as disconnection, reusage, infiltration, buffering; meaning that the models do indeed represent a worst-case situation. Nevertheless, these aspects are strongly emphasized by comprehensive water management, through the regional regulations on rainwater, the local building regulations of the City of Ghent, and the Farys allotment directive.

²⁵ [Informatie documenten\Deel5 Ontwerpneerslag_10_2012.pdf](#)

The Ghent climate adaptation policy is intended to arm Ghent against climate change. Emphasis hereby lies with

- the city climate, with heat stress as the focal point
- the urban water system, with as the focal points water nuisance, desiccation, and water shortage²⁶.

Spatial structural measures have a significant part to play in the practical approach. It is hereby important to connect these two challenges with which Ghent is faced. After all, many measures have a double effect: they contribute to the reduction of urban heat stress, and they can cause us to better handle water nuisance and desiccation. The City of Ghent wishes to primarily focus on these win-win measures, and is chiefly interested in reducing hardened surfaces in favour of more greenery and space for water. In this chapter we present the principles to which we will adhere in the further development of our city.

Priority is given to hot spots, i.e. places that are under the greatest threat of being affected first, and where the social impact is going to be the most severe. In addition, we primarily focus on the public domain and the exemplary function thereof. Furthermore, we also indicate the direction in which we wish to point public and private development in order to contribute to a climate-robust city. Lastly, we also use our city-owned real estate as examples.

A next phase in the climate adaptation plan will seek to broaden the principles to *Groep Gent*.

It is of vital importance that we act now. Acting now ensures that the measures may be taken in time and at a reduced cost. Because the buildings, roads, utilities, sewer systems being built today will need to last decades, and are very costly to replace. Infrastructure adapted to coming climate change will in time generate lower costs and higher efficiency.

3.1. Design principles for the public domain

The way in which our public domain was created is a crucial factor for our urban climate and water system. The principles of de-hardening and the introduction of greenery (including trees) have been applied for a number of years in the (re-)construction of the public domain, but all too often we still have to compete with the conventional way of shaping the public domain. In order to make Ghent more climate-robust, we seek to further shape the public domain in accordance with the following principles:

²⁶ The rise in sea level is not yet incorporated as no short-term effects are expected for Ghent.

1. Prevention of more sealed soil due to hardening of surfaces
2. 'Greening' the city
3. Maximum focus on the green-blue network
4. Creation of space for water
5. Maximization of the city's sponge effect
6. Provision of cooling infrastructure

The City assumes the part of role model, and demonstrates by de-hardening surfaces and making the public domain greener how a climate-robust city can be attractive as well as functional.

PREVENTION OF MORE SEALED SOIL DUE TO SURFACE HARDENING

Attention to the level of surface hardening of our current and future public domain is a main focal point. Indeed, the high level of infrastructure and surface hardening in cities is the chief cause of the heat island effect and of disrupted water management.

We seek to curb the level of surface hardening within the public domain. Wherever this is required most and wherever possible, we will reduce the level of surface hardening.

For the creation of new public spaces, focus lies with:

- ✓ limiting new surface hardening to the bare functional minimum
- ✓ efficient design (e.g. road surfaces)
- ✓ bundling of infrastructure
- ✓ compensation for new surface hardening wherever possible

For the restructuring of the existing public domain, we seek to reduce the surface hardening rate.

Focus lies with:

- ✓ efficient design (e.g. road surfaces)
- ✓ bundling of infrastructure
- ✓ removal of unnecessary surface hardening (excessive width, pointless infrastructure)
- ✓ 'greening'

Always taking into account the spatial and historic contexts, as well as the accessibility of the public space.

GREENING THE CITY

'Greening' the city is an essential principle of a climate-robust city. Maximum use is made of the ecosystem benefits urban greenery can deliver. Urban greenery provides both cooling (through evaporation and shade) and retention of rainwater (through evaporation or infiltration). The realization of the green structural plan (see pillar 4, Integration into urban policy plans) and tackling hot spots regarding heat and water management are key. Focus lies with:

- ❖ Realization of greenery at the macroscale
 - ✓ large surfaces of greenery (core wood and nature areas, river valleys, green hubs, green axes, neighbourhood parks, and residential green)
 - ✓ both cooling, open greenery and protective greenery that is publicly accessible

- ❖ More greenery at the microscale (close-knit green network)
 - ✓ trees in streets and squares
 - ✓ vertical green
 - ✓ façade gardens in the public domain

MAXIMUM FOCUS ON THE GREEN-BLUE NETWORK

Our waterways constitute a significant climate system for Ghent. The idea here is to turn those into veritable climate axes through the combination of water and green. These “green axes” (a number of which are combined with water) are also included in the structural vision ‘Room for Ghent’ as a particularly potent concept. Focus lies with:

- ✓ ‘greening’ the banks of waterways (respecting the cultural-historical value of the surroundings in which these banks are located)
- ✓ realization of the green-blue axes, with maximum emphasis on broad strips (at least 30 metres), alternated with narrower sections. Attention is also paid to a full-size and comfortable hiking and/or cycle path, without unnecessary additional surface hardening.
- ✓ the smaller green-blue network (e.g. streams and ditches)

CREATING SPACE FOR WATER

Within the city, water must also be taken into consideration and receive the necessary space. Measures in this area are mainly set up within the purview of water issues, but also have a positive effect on the city climate. Focus lies with:

- ✓ clever exposure of waterways
- ✓ renovation of road ditches (peripheral area) and urban ditches (urban area)
- ✓ water elements in the public domain (trenches, open or covered gutters, fountains, ...) both for the regulation and visibility of water drainage, and for their cooling effect; a win-win situation is achievable if here too water is combined with greenery
- ✓ floodable public space (locations where water on the street can be caught, e.g. with adapted street profiles, SuDS)
- ✓ proactive search for water storage areas

MAXIMIZING THE CITY’S SPONGE EFFECT

The term sponge effect refers to the local catchment, retention, reusage, infiltration or buffering, and delayed drainage of rainwater. In a climate-robust city, rainwater neutral projects must be key. This means that under normal circumstances, there is no drainage of rainwater from the project area, but that all rainwater from buildings and hardened surfaces is locally retained, used, or gradually returned to the surrounding nature via above-ground infiltration solutions. Focus lies with:

- ✓ fewer hardened surfaces
- ✓ water-permeable surface hardening for instance in car parks, driveways, residential plots, and alleys without heavy transport

- ✓ green footpaths
- ✓ infiltration solutions (ponds, SuDS, ditches, bioswales, ...), with a preference for above-ground systems as they are cheaper, more natural, are more attractive, and are more accessible for maintenance and inspection

COOLING INFRASTRUCTURE

Cooling infrastructure is necessary for pleasant usage of the public domain on hot days. Focus lies with:

- ✓ trees in streets and squares
- ✓ shadow infrastructure
- ✓ lightly-coloured materials
- ✓ cooling water elements (fountains, mist sprays)
- ✓ local access to water (lowered quays, ...)
- ✓ drinking water infrastructure

3.2. Design principles for public/private developments

For public/private developments (allotments, housing projects, ...) focus must lie with **spatially efficient, water-robust, and heat-resistant development**. The following general principles could apply here:

- ✓ as for construction, strive to:
 - enhance spatial efficiency (flexible and multifunctional use of space, interwovenness, dynamic and change-oriented construction)
 - renovate from the inside out (reusage of existing construction, hardened surfaces, uncluttering of densely built-up areas)
 - firstly prevent construction within areas prone to flooding, secondly construct in a modified manner in order to maximally safeguard the local water storage capacity.
- ✓ within new developments only provide additional surface hardening whenever functionally required, map options for de-hardening of existing hardened surfaces, and provide a maximum of alternatives. The local replacement of additional surface hardening with a water-buffering green roof, façade greenery, ... could also be considered, so there is no need to seek compensation elsewhere all the time.
- ✓ additional greenery such as trees and façade greenery (small-scale green network)
- ✓ maximum catchment and useful reusage of rainwater
- ✓ maximum buffering via green roofs
- ✓ maximum focus on infiltration, with an emergency overflow and a return period of at least 2 years
- ✓ buffering with delayed drainage, with an emergency overflow and a return period of at least 50 years
- ✓ the possibility to expand the infiltration and/or buffer capacity at a later time and a relatively limited cost; thus the safeguarding of possible future additional required space (adaptive design)

- ✓ wherever possible also the purification and reusage of grey water (for toilet flushing and/or process water)
- ✓ the creation of shadow infrastructure in vulnerable locations

Over the coming years, further focus will be given to this for public and private urban developments, among others by further specifying the afore-mentioned principles for practical implementation. Indeed, the Vision Memo ‘space for rainwater within allotments and urban renewal projects’ (in progress) specifically outlines the principles regarding rainwater neutrality (maximum catchment, reusage, infiltration, and buffering with delayed drainage) for current and future city projects with an impact on the public domain.

A key focal point is **small-scale soil sealing on private grounds**, taking the form of construction (garden sheds, carports, ...) and surface hardening (driveways, front yards, terraces, ...). These small surfaces are often exempt from building permits, making it more difficult to control this aspect. However, the combined effect is significant, and it is important to pay attention to this as well when striving for a climate-robust city. Goal principles are:

- ✓ minimal additional surface hardening, wherever possible remove existing surface hardening
- ✓ render strictly necessary surface hardening either water-permeable or provide natural infiltration (provision of a green strip of at least one third of the built-up and hardened surface, whereby rainwater flows toward this green strip and may infiltrate locally)

3.3. Exemplary function of city-owned real estate

RAINWATER MANAGEMENT FOR PROPERTY OF THE CITY OF GHENT

As a City we have an **exemplary function** to fulfil for our citizens, companies, contractors, project developers, ... In order to help realize the objective of a climate-robust city, this should be taken into account in all of our designs. Infiltration and buffering infrastructure should be amply dimensioned and adaptively designed so that future modifications due to climate change remain possible. A **catch-up process** is provided for the existing situation. In addition to its exemplary function, the City of Ghent can also focus on its **leverage function** whereby lesser-known and pioneering techniques and systems are highlighted. For instance, example projects may be set up around the recuperation of grey water, the application of the latest generation of green roofs with maximum buffer capacity, or the creation of new water-permeable surface hardening. Due to economy of scale, the City can also focus on collective systems, taking a look at the ideal combination of catchment, reusage, infiltration, and buffering in a constructionally comprehensive manner.

Concrete goal for existing buildings

The intention with existing buildings is to bring them to the level of the current principles and the proposed sizing from the regional urban planning ordinance for rainwater (GSVH) and the local building regulations. Specifically this means:

- ✓ focusing as much as possible on separating waste water and rainwater
- ✓ maximum catchment and useful reuse of rainwater, taking into account an extensive method for the sizing of the rainwater tank
- ✓ focus on infiltration
 - by prioritizing the removal of surface hardening or, if necessary, replacing it with water-permeable surface hardening or surface hardening with natural infiltration
 - by creating infiltration facilities whereby the sizing rules from the regional urban planning ordinance for rainwater (GSVH) are observed (25 l and 0.04 m² per square metre of connected (roof) surface)
- ✓ maximum buffering of rainwater, preferentially via green roofs
 - by constructing green roofs whereby the sizing rules from the regional urban planning ordinance for rainwater (GSVH) are observed (35 l/m² drainage surface)
- ✓ wherever necessary, buffering with delayed drainage, whereby the sizing rules from the regional urban planning ordinance for rainwater (GSVH) are observed (25 l per square metre of connected (roof) surface)

Concrete goal for new buildings

The intention with new buildings is to strive for water-robust development. In addition to the obligations from the prevailing regulations (VLAREM, regional urban planning ordinance for rainwater (GSVH), local building legislation (ABR)), the following additional principles are applied in keeping with the sustainability meter:

- ✓ maximum reuse of rainwater, taking into account an extensive method for the sizing of the rainwater tank
- ✓ minimal new surface hardening, strictly necessary surface hardening/construction should be water-permeable as much as possible, or have natural infiltration
- ✓ focus on green roofs with additional water-buffering capacity (50 litres per m²) with infiltration or buffering facilities attached
- ✓ focus on infiltration, whereby infiltration facilities are sized in such a way that they overflow only once every 2 years²⁷
- ✓ wherever necessary add buffering with delayed drainage, whereby buffering facilities are sized in such a way that they overflow only once every 50 years
- ✓ the possibility to expand the infiltration and/or buffer capacity at a later time and a relatively limited cost; thus the safeguarding of possible future additional required space (adaptive design)
- ✓ wherever possible also the purification and reuse of grey water (for toilet flushing and/or process water)

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The afore-mentioned realization principles and approach have been put forth in the Vision Memo "climate adaptation policy, aspect rainwater with city real estate". For new construction projects, the current legislature is already striving for a maximum application of the afore-mentioned principles. A phased plan has been included regarding the approach to existing real estate.

²⁷ This means that all showers statistically occurring once every 2 years can be caught using the infiltration facility without overflow. Only in case of showers with a return period of more than 2 years will the infiltration facility overflow, into a waterway or (separated) sewer.

MEASURES REGARDING THERMAL COMFORT

Both new construction projects and renovations should pay attention to the interior climate.

Measures are necessary to counter the heating of interior spaces on hot days or in case of bright sunlight. Some measures may also have a beneficial effect on the exterior climate and are preferred.

For lightly-coloured materials that provide enhanced sunlight reflection, it should always be verified whether this presents any nuisance for the surroundings. Focus lies with:

- ✓ green roofs
- ✓ façade greenery
- ✓ shadow elements
- ✓ outside sun shading
- ✓ lightly-coloured materials

Climate adaptation: Short and Sweet

The Ghent soil as a sponge:

- We are meticulous and deliberate in our efforts to reduce surface hardening in Ghent wherever possible by limiting such surfaces to the functional minimum, replacing them with greenery, with water-permeable surface hardening or surface hardening with natural infiltration.
- We retain rainwater as much as possible for usage or we allow it to infiltrate into the city via greenery or infiltration facilities. Sufficient space is allocated to this purpose. New projects maximize rainwater neutrality.

We use greenery to cool off Ghent:

- Every reconstruction within the public domain includes the planting of trees and/or other greenery to provide shade and cooling.
- We opt in favour of green roofs and green façades for city buildings, and stimulate the residents of Ghent to do the same. We aim to double the total green roof surface in the city by 2020 as compared to 2013.

GHENT CLIMATE ADAPTATION PLAN: PILLAR-BASED APPROACH

4.1

POLITICAL SUPPORT BASE AND BROADENING WITHIN THE CITY ORGANIZATION

Any new theme requires awareness raising. Under the first pillar we tackle awareness raising at the city administration level, as this is the basis for constructing city policy regarding climate adaptation.

POLITICAL SUPPORT BASE

In Ghent, climate ambition enjoys broad support within the city administration. Ghent seeks to be progressive, including when it comes to climate adaptation. The signing of *Mayors Adapt*, as one of the first cities in Flanders, is indicative of this ambition.

As the effects of climate change are being felt in a number of areas, many deputy mayors have the involvement and competence to make our city climate-robust.

Tine Heyse

Tom Balthazar

Filip Watteeuw

Martine De Regge

Deputy Mayor of the Environment, Climate, Energy and North-South

Deputy Mayor of Urban Development, Housing and Public Greenery

Deputy Mayor of Mobility and Public Works

*Deputy Mayor of Human Resources, Facility Management and
Administrative Simplification*

The city administration has chosen to earmark a specific budget for creating a policy and setting up operations regarding climate adaptation: among others in order to shape our climate adaptation strategy, conduct the vulnerability analysis, build up knowledge on measures, implement city instruments such as subsidies, show current climate-robustness by means of a number of example projects, and by enhancing understanding and the support base by means of communication and awareness raising.

Work regarding climate adaptation does not always require additional budget. For some points, a different way of working within the same budget suffices, or a shift is needed from investment cost to management cost. The idea is to utilize the existing resources in a climate-robust manner, turning the current investments into future-proof and thus climate-robust investments.

Action 1.1: Naming the ambition to be a climate-robust city in the following Ghent multi-annual plan

Even though various policy goals within the current Ghent multi-annual plan 2014-2019 (e.g. enhancement of quality of life and living conditions of the existing urban fabric, sustainable space

management, new city development projects are exemplary neighbourhoods for the 21st century, attractive, child-friendly, and usable green spaces in the city, protection of nature, lowering of environmental and health risks) do indicate various points of action that contribute to climate adaptation, climate adaptation has not yet been explicitly named. For the purpose of accomplishing our climate adaptation goals, it would be a major signal for the new multi-annual plan to explicitly focus on climate adaptation, mentioning that Ghent is not only seeking to be climate neutral (mitigation), but also climate-robust (adaptation). Consequently, the necessary actions and specific opportunities regarding this ambition need to be named, and the necessary budgets need to be earmarked in the multi-annual budget. This budget should first and foremost be integrated, and not labelled separately as 'climate adaptation' budget. After all, climate adaptation requires an integrated and city-wide approach.

One key focal point is the cost of maintenance and management. Conventional designs generally require minimal regular maintenance costs. Costs for flooding, for instance, in case of future extreme rainshowers are not taken into account however. A climate-robust set-up with more greenery, an open water system, infiltration and buffering facilities, green roofs, green façades, etc... often requires different maintenance and management. However, enhancing the city's resilience in this way will help to keep the total long-term cost within reasonable limits.

Action 1.2: Budgeting the management cost

Climate and water-robust set-ups should become integral parts of the multi-annual management and maintenance programmes with the City of Ghent. In order to realize the ambitions regarding a climate-robust city, the design process must involve budgeting for and description of the impact on management. Management agreements must be concluded, and the requisite budgets for regular management must be earmarked in order to allow the new designs to function.

BROADENING WITHIN THE CITY ORGANIZATION

It is absolutely crucial that efforts regarding climate adaptation be handled in a cross-service and cross-departmental manner. Indeed, the accomplishments in the field under the banner of climate adaptation cannot be ascribed to a single service. The realization of the entire story from design to execution and later management requires the involvement of different services and departments. This is why a **Working Group on Climate Adaptation** has been created within the City. At the moment, the Working Group on Climate Adaptation is composed of representatives of the Environmental and Climate Service, Parks and Public Gardens Service, Urban Development and Spatial Planning Service, Roads, Bridges and Waterways Service, the staff of the Department of Public Space, and the Building Projects Service within the Department of Facility Management. The cabinet of Deputy Mayor Heyse, competent for climate (adaptation), also has a seat within the Working Group. At the moment, the Environmental and Climate Service is taking on the role of director within the Working Group, coordinating, committing, facilitating, helping to clarify roles, etc.

Action 1.3: Broadening operations around climate adaptation to include sogent, Mobility Company, Farys, and OCMW-Facility Management

So far, only the most highly involved city services have a seat within the Working Group on Climate Adaptation. In addition to these city services, other city partners also have significant roles to play in the climate adaptation story. For instance, city development company sogent plays an important part in the construction of our urban environment. Many city projects are spearheaded by sogent. In the set-up of the public domain, there is a strong link with mobility and thus involvement of Mobility Company. As sewer manager, Farys is a key partner regarding rainwater policy. It is therefore of the essence that these city partners be involved in the climate adaptation policy. Collaboration with sogent, Mobility Company, and Farys is further deepened for the climate adaptation theme. This involves not only the exchange of knowledge, but also a focus on example projects (e.g. Oude Dokken). Whenever necessary, sogent, Mobility Company, and Farys are invited at the Working Group on Climate Adaptation.

OCMW-Facility Management is also involved within the purview of the exemplary function of city real estate. A subsequent phase will look into broadening towards other relevant partners within the *Groep Gent*.

The Working Group on Climate Adaptation gives shape to the climate adaptation policy, discusses the principles to be honoured, puts forth measures to be taken, proposes pilot projects, ... In other words, the Working Group on Climate Adaptation functions as the **operational apparatus for the development of the project-operational goal (POG) regarding climate adaptation** from the strategic multi-annual plan 2014-2019.

It should be noted at this point that the water theme is a very broad one: rainwater (infiltration), groundwater, waterways, space for water, ... This theme is consequently spread out over different services, which is not always beneficial to smooth operation. The water theme is in need of direction. The possibilities for the appointment of a programme director for 'water' could be further evaluated within the Working Group. A programme director (or project coordinator) for 'green axes' appears necessary as well, not simply for conceptualization and design, but also to direct the subsequent implementation.

The Working Group on Climate Adaptation furthermore should also be a **knowledge platform** from which the knowledge built up around the theme by the various services is shared within the city organization. For instance, 2015 saw the organization of broad **internal training** for more than 100 associates from the services in question for the purpose of informing them on the importance of climate adaptation, to have them see their own role therein, to inspire them by means of possible measures and positive examples, and to help them as specifically as possible to work on climate adaptation. In addition, the colleagues from the operational services such as the Parks and Public Gardens Service, Roads, Bridges and Waterways Service, Facility Management are also ambassadors to climate adaptation, who provide clarification on the what and why of planned intervention when questions are raised. Here too, internal training is important.

Action 1.4: Further development of the knowledge platform on climate adaptation

The members of the Working Group gain knowledge, each within their own area of expertise, on climate adaptation from study days, literature, personal research and pilot projects, visits to positive examples, external design assignments, ... It is important that this knowledge be shared with all the parties involved. A knowledge platform will be constructed to organize this exchange of knowledge

smoothly and structurally, both physically (e.g. a shared file on the server of the City of Ghent to which all services have access) and as to content (regular consultation on the exchange of knowledge, visits to the city's own example projects, ...).

Action 1.5: Continuation of training initiatives for the city staff members in question

As knowledge on climate adaptation (see pillars 4.2 and 4.3) is constantly expanding, it is useful to provide regular internal trainings, attuned to the needs and operation of the services involved. Specific attention will be paid to the necessary technical information.

Lastly, focus has been given to broad **internal communication** for all staff members by means of the products developed around climate adaptation such as the climate booklet, animation clip, ...

Action 1.6: Continuation of broad internal communication to all city staff members

In addition to specific service-related and technical training, awareness regarding climate adaptation must be kept alive within the city organization. Intranet, lunch discussions, staff magazine, ... will all be used to this end. Moreover, a cycling route along fine examples in Ghent will render the image of a climate-robust city more concrete and visible. This cycling route could be offered for instance as an optional activity on the sports day, and upon request as a service or team activity.

4.2

KNOWLEDGE BUILD-UP CLIMATE EFFECTS AND VULNERABILITIES

Over the past years a great deal of knowledge has been built up regarding the vulnerability of our city to climate change. By charting to what extent we are being exposed to (the consequences of) climate change, to what extent we are susceptible to this, and the adaptive capacity we currently have already, we know what impact climate change has on Ghent.

This information forms the basis for our approach regarding climate adaptation. The vulnerability analysis helps establish priorities, regarding both space and content. Sound risk assessment also helps control the damage.

Research conducted by other institutions (government, knowledge institutions) is of course closely monitored. For instance, there is the climate effect sketchbook by the Province of East Flanders (2012) and the Climate Report by the Flemish Environment Agency (2015). Under the direction of Belgian meteorological institute KMI, the federal scientific institutions (FWI) are working on a federal climate centre. VITO has an Urban Climate Service Center. And the different Flemish Universities are conducting relevant research into vulnerability to climate change at the Flemish level. Chapter 4.8. indicates to what networks and partnerships Ghent is committed in order to efficiently introduce this knowledge into city operations.

In addition, the city also undertakes its own initiatives in order to supplement and/or refine the available information at the Flemish level towards the specific Ghent situation, or to fill up knowledge gaps. In this respect, it is interesting to also follow up on innovative measurement methods for reaching microdata on weather and climate, and to address opportunities in this regard. Chapter 2 clarified the already conducted analyses with emphasis on our vulnerability to heat stress and water nuisance. This knowledge must be further developed and refined over the coming years. Additionally, the vulnerability analysis for desiccation and rising sea levels should be started up.

KNOWLEDGE BUILD-UP ON HEAT STRESS

As described in chapter 2.3, Ghent is extra vulnerable to the consequences of more frequent and more intense heat waves due to the urban heat island effect. The occurrence of the urban heat island effect in Ghent is being further examined.

Action 2.1: Development of a monitoring network for the analysis of the urban heat island effect in Ghent

Within the purview of knowledge build-up regarding the urban climate, UGent department of Physics & Astronomy in conjunction with VITO, KMI, and other partners (including observatory A. Pien) is setting up a monitoring network in Ghent in 2016, among others to analyse the urban heat island effect (<http://www.observatory.ugent.be>). In addition to a rural reference station (at the KMI measuring station in Melle), climate-measuring stations will be provided in 6 urban locations: the Provinciehuis and the Sint-Bavo school (centre), the UGent Botanical Garden (Citadel park), a private city garden (Ledeborg), an urban location in Wondelgem, and the Honda site (port area). In addition to temperature, parameters such as humidity and wind will also be measured to form as complete a picture as possible of the urban heat island. The idea is to keep this network operational in the longer term, thus forming a continuation of the temporary monitoring network set up within the framework of the heat study for Ghent. The City of Ghent is involved as a privileged partner in this research, the obtained data, communication to the general public, ...

Action 2.2: Further collection and analysis of knowledge on heat stress and mitigating measures

The general build-up of knowledge regarding heat stress and mitigating measures continues. There is certainly still a need for more knowledge on the effect of for instance climate axes and green hubs in the context of city cooling, the effect of ventilation, ... Also, knowledge build-up regarding the social and human aspects of heat stress will commence in order to expand efforts on climate adaptation into the social aspect during the next legislature.

KNOWLEDGE BUILD-UP ON WATER NUISANCE

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Our urban environment with its significant surface hardening and little space for water is sensitive to the changing conditions, including wetter winters, heavier summer storms. As for the build-up of knowledge regarding our vulnerability to water nuisance, both water nuisance from waterways and water nuisance from sewers must be taken into account.

Action 2.3: Further collection, disclosure, and analysis of available and relevant map materials pertaining to water nuisance

In 2015, the Roads, Bridges and Waterways Service and the Environmental and Climate Service collected, bundled, and disclosed available and relevant map materials pertaining to water nuisance both from waterways and from sewers within a GIS environment. This way, information already spread can be used and interpreted in a more efficient manner. The map materials require regular (e.g. annual) updates. In addition, it is important that this information be disclosed to the involved city services correctly, and with the appropriate commentary. How this can best be done is being reviewed in conjunction with these services.

Action 2.4: Creation of a vulnerability analysis on water nuisance

In addition to the information and maps available on the flooding risk for Ghent, an exercise is conducted in order to assess Ghent's vulnerability to water nuisance. For this purpose, an analysis is carried out on the consequences of moderate to extreme water nuisance for vulnerable city functions such as housing (with special focus on residential plots), road infrastructure (with special

focus on tunnels), underground parking facilities and other underground infrastructure, public transportation, care institutions (with special focus on hospitals), port, industry, food supply (agriculture), ... As part of this effort, a list is made with possible measures to prevent such vulnerability. Wherever relevant, the necessary map materials are developed.

In the spring of 2016, Integral Water Management students at UGent carried out a theoretical exercise in the same vein as the exercise being conducted at the Flemish level, in order to determine the risk objectives on water nuisance specifically for Ghent. This exercise assessed both the social and human impact and the economic impact of water nuisance. These risk objectives (what do we find acceptable, what do we wish to avoid) help to determine where we want to go with water policy and climate adaptation. The results of the exercise can in this context be evaluated regarding usability and, if so desired, be included in the vulnerability analysis.

Action 2.5: Development of a monitoring network for the analysis of precipitation patterns

Within the framework of knowledge build-up regarding our vulnerability to (summer) storms, the monitoring network for the recording and analysis of local precipitation patterns is further developed. In addition to the collection and analysis of the rain gauge data already in existence (from KMI, VMM, UGent, Farys, private persons), 6 additional rain gauges will be installed in Ghent. An agreement has already been reached with UGent for the new measuring stations to be equipped with rain gauges within the framework of the city climate (see action 2.1). At the moment, the monitoring network is slated for 3 years, but the intention is to keep this monitoring network operational for extended periods of time.

The precipitation data collected by means of the rain gauges can be used to calibrate the sewer model: do the results from the model based on actually recorded rain data correspond with what is observed in situ?

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Action 2.6: Inventory of heavy storms, floods, and “water on the street”

Floods or events involving “water on the street” can teach us a great deal on the situations where Ghent is vulnerable. It is important that such events (date, location, severity, ...) be recorded, entered into GIS, and subsequently analysed thoroughly. Next, preventive measures may be undertaken to prevent the consequences thereof. Moreover, this knowledge allows for the verification of model predictions and for the model system to be modified. Precipitation is recorded by means of the rain gauge network. This way, flooding and events involving water on the street can also be linked to the cause: the characteristics of precipitation.

Also, the damage occurring during floods or events involving water on the street can be included in these recordings. Usually, in the case of water on the street there will be no damage and thus no water nuisance. Somewhat similar to the flood risk maps, damage maps could be created for water nuisance from sewers. Policy can then be directed towards limitation of damage from flooding or water on the street.

The residents of Ghent could then easily report water nuisance in their streets themselves. These reports can be made, for instance, on a webpage of the City of Ghent, Farys, or the fire department, with the inclusion of location, a photograph, level of water on the street.

Specific actions pertaining to water nuisance from waterways:

Action 2.7: Follow-up of study efforts and flood risk management plans by water authorities

As water authorities, W&Z and VMM are required to draw up flood risk management plans (FRMP), in application of the European Floods Directive. As an involved partner, the City of Ghent wishes to join in the follow-up thereof, and gain an insight into the applied strategy and the measures to be taken to control flooding risks from waterways. At the forefront is a shared responsibility within the framework of multi-layered water safety²⁸, whereby prevention and readiness are key in addition to protection.

Also, specific study and modelling efforts will be made within the framework of the plan of approach for vulnerable areas spearheaded by higher authorities such as the Province of East Flanders, W&Z, ... (e.g. study Scheidbeek, Leebeek). Both Farys and the City of Ghent are involved and provide follow-up. Timing strongly depends on progress at W&Z.

Also as pertains to water drainage, close collaboration is of the essence, and wherever necessary procedures for water drainage should be (further) agreed.

Specific actions pertaining to water nuisance from sewers:

Action 2.8: Disclosing knowledge on planned sewer projects

Farys and the Roads, Bridges and Waterways Service are aware of the most significant structural (e.g. renovation requirement), hydraulic (e.g. undersized pipes), and ecological (e.g. overflow) bottlenecks present in the sewer system. In order to tackle them, a stormwater drainage vision (rainwater plan) was developed and various sewer projects were scheduled and budgeted up to 2020. The objective for new sewer projects is to avoid water on the street to rainshowers that, under the current climate, occur only once every 20 years (T20). It is important to have a good overview of these planned projects to gain a correct picture of the future situation after completion of these projects, among others within the framework of the vulnerability analysis.

Action 2.9: Development of the sewer model

Within the framework of the Plurisk project, the 1D model was refined to a 2D model for Sint-Amandsberg, allowing for the runoff of water from sewer covers to also be taken into account and thus provide a more correct estimation of water on the street during heavy rainfall. This 2D model is applied for Sint-Amandsberg, whereby a comparison with the 1D model maps may yield interesting information for the interpretation and/or refinement of the latter model.

The precipitation data collected by means of the rain gauges (see action 2.7) can be used to calibrate the sewer model.

In addition, Farys and the City of Ghent also follow the initiative of Aquafin involving a comprehensive update of the sewer situation for the Ghent urban area (not including Drongen, Sint-Denijs-Westerm, Oostakker, Sint-Amandsberg) (first a (re-)measurement of the actual sewer condition, then a calibration of the sewer model by means of rain gauges, ...). Both the existing

²⁸ This is a mix of measures ranging from the provision of dikes to better warning systems.

situation and the planned situation within 5 years (after completion of the works) are modelled. This exercise will also give rise to a stormwater drainage vision for Ghent city centre (this is a complex matter due to the many parameters).

KNOWLEDGE BUILD-UP ON DESICCATION AND WATER SHORTAGE

The theme of desiccation and water shortage must now also be placed on the agenda. Both the Flemish Environment Agency and the Province of East Flanders are pushing desiccation forward as possibly the most significant issue for our region due to climate change. For instance, 2015 was a very dry year, which has already had an impact on drinking water reserves in East Flanders. Therefore, initial follow-up should be conducted regarding what is moving at the Flemish and provincial levels regarding this issue. It is important to gain an insight into the precise bottlenecks and the impact of desiccation at the local level. The consequences for drinking water collection, for agriculture and industry, for shipping, for Ghent parks should all be considered. Subsequently, an insight should be gained into what measures are possible at the local level, both to prevent desiccation as much as possible and to tackle the negative effects thereof.

Action 2.10: Drawing up a vulnerability analysis on desiccation and water shortage

A vulnerability analysis should serve to chart the threats and opportunities for Ghent pertaining to desiccation and water shortage. A great deal of materials and information is already available and collected on water nuisance. This effort must also take place on desiccation. Furthermore, the risks and vulnerabilities for the City of Ghent for the current and future situation must be charted, and a list must be compiled of possible measures to limit these risks. Modelling efforts may be required to this end. The intention is to obtain an instrument that allows us to set priorities in the further determination of what measures must be implemented where, to ensure that we can achieve the goal of a climate-robust city by 2030.

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KNOWLEDGE BUILD-UP ON RISING SEA LEVELS

The rise in sea levels is an issue that is initially being investigated regarding the Flemish coast, but may also be relevant to Ghent in the future.

Action 2.11: Collection of available information relevant to Ghent pertaining to the consequences of rising sea levels

It should be investigated to what extent our water drainage system, which depends on the tidal effect, is influenced by rising sea levels. Is our canal area vulnerable? Salinization may also give rise to problems with drinking water collection, industry, agriculture, and nature. We follow up on this legislature as for what is moving at the Flemish level regarding the build-up of knowledge and matters relevant to Ghent.

4.3

KNOWLEDGE BUILD-UP ON CLIMATE ADAPTATION MEASURES

There is a general idea of what is needed to make an urban environment climate-robust. The principles as put forth in chapter 3 are accomplished through the implementation of spatial structural measures such as parks, street trees, green roofs, green façades, infiltration facilities, water-permeable surface hardening, SuDS, shadow infrastructure, ...

However, climate adaptation is a relatively recent story. Because of this, further build-up of knowledge is needed on these climate adaptation measures. Many questions linger, both general and specific, regarding Ghent's urban situations, including:

- What are the appropriate types of measures for climate adaptation? What are the technical parameters?
- What is the effect of these measures?
- What measures are the most (cost-)efficient?

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A key first step is the collection of information and examples of climate adaptation measures. A great deal of information is available among others in handbooks, studies, websites,... Local knowledge and practical experience are also exchanged at study days such as the VVSG Energy and Climate Day, Public Space, ... and within expert groups such as the LNE pilot group and the UGent Climate Adaptation think tank (see pillar 4.7).

In addition, when it comes to the local build-up of knowledge, the City of Ghent is explicitly focusing on **learning by doing** through applied study efforts and pilot projects.

APPLIED STUDIES

The idea is to gain answers to specific questions regarding climate adaptation measures, or to more specifically test out and refine generally available knowledge and information on the Ghent situation. Examples of studies conducted within the framework of climate adaptation are:

Ventilation study Houtdok



In early 2015, a ventilation study was conducted regarding the planned city development for Houtdok. This involved the modelling of the influence of infrastructure and different vegetation structures on air temperature and wind speed. This clearly showed that the combination of greenery (primarily when trees were used) and water causes a sharp reduction in air temperature, not just locally but also in the surrounding city areas. The different vegetation types will affect ventilation only locally.

UCAM study Dampoort

Engineering office Witteveen + Bos designed an index (called UCAM) to assess both the urban heat island effect and the air quality for a neighbourhood. The Dampoort – Sint-Amandsberg neighbourhood was used as a test case for the methodology. The UCAM study clearly showed the need for additional, accessible, and protective greenery for this neighbourhood.

Grey water recuperation study

Taking into account the rising issue of desiccation and water shortage, it is useful in certain situations to have rainwater infiltrate to supplement the groundwater table, and to refrain from using mains water or rainwater for non-human applications such as toilet flushes, (garden) maintenance, washing machines; but rather purified grey water (from sinks and showers). In addition, it is sometimes necessary for high-rise projects (small roof surface compared to the number of residential units) to supplement the limited quantity of rainwater in order to have enough water for toilet flushes. Purified grey water can then present an alternative to mains water.

A bachelor study compared the different purification systems, and concluded that a grey water system could be profitable (payback period of 8 years) for apartment buildings with 25 residents and more.

Through internship work, research was being conducted into the possibilities of reusing purified grey water at a number of city locations, but for now this appears to be less desirable (priority lies with rainwater recuperation and green roofs). It is more useful to look at grey water recuperation for future building projects, e.g. Steenakker boarding school.

The following applied study efforts are in the works.

Action 3.1: Active participation in user group from IWT VIS-programme 'Green Construction'

The widespread introduction of greenery in the city contributes to a climate-robust city. The effect of façade greenery is not yet fully understood, however. The goal for the project is on the one hand to eliminate prejudices regarding façade greenery by writing up a manual showing what systems can be applied to what walls, and in what way they have to be implemented and maintained. On the other hand, the advantages and effects of green façades are examined with respect to water management, acoustics, fine dust, sustainability, etc. Participation in the user group renders all information available, and allows us to help give direction to the research. Using the obtained info, we can shore up our advice and inform and raise awareness both internally (with facility management for city buildings) and externally (project developers, civilians, architects, ...).

Action 3.2: Studying Oostakker-Dorp: shadow study and research into possible water elements

For the reconstruction of Oostakker Dorp, research is being conducted into the kinds of water elements that can be used in the square and in relation to the kiosk to render water management visible. In this respect, focus must be placed on aspects such as the fun element, cost of maintenance, ... An exercise is being conducted by Integral Water Management students, under the guidance of Professor Renaat De Sutter (UGent), in the second semester of the 2015-2016 academic year. Results will be evaluated on usability, and if so desired be further developed into concrete applications.

In addition, a shadow study is also being conducted internally whereby the shadow effect of street trees is analysed both in the current situation and in the new design, allowing for the shadow effect to also be included in the planning of (additional) street trees.

Action 3.3: Framework contract infiltration measurements

Regulations obligate constructors to provide infiltration for rainwater that cannot be usefully reused. Deviation from this rule is only possible when measurements show that infiltration is not technically possible. To give architects and constructors an indication of where infiltration would or would not be possible, an infiltration map for Ghent was created based on soil composition and the drainage class of the soil. Measurements in the field will refine this map and enhance usability. Moreover, measurements are also useful in that they allow for advice from city services to be worded as concretely as possible at early project stages, for custom solutions to be found, and for later issues regarding the infiltration obligation to be prevented. This is why a framework contract was written up for the City's own infiltration measurements and measurements of the groundwater table, in addition to the measurements often carried out by the constructor at a later stage. Measurements are conducted at locations known by the City to be slated for new building projects in the coming 5 to 10 years.

In addition to the City's own measurements, guidelines will also be put out for (the timing of) infiltration measurements by external parties.

Action 3.4: Research into potential spaces for green/blue

The development of a green-blue network within the city is essential in becoming a climate-robust city. This requires a transformation whereby urban planners have a key role to play. Reshaping the public domain can create space for (the expansion of) green-blue infrastructure. An inventory and investigation of potential in Ghent is a necessary first step, with the next step focusing on the technical and financial feasibility of measures. Concrete research cases include the end of the Watersportbaan (the reduction of a 2x2-lane road to a 2x1-lane road, for instance, would result in a large additional surface available for green and/or blue. This scenario merits further investigation, taking into account the new traffic plan and the accompanying measures.) as well as the reconstruction of the De Pintelaan near the De Sterre university campus. Additionally, the systematic finishing of green axes is taken on by emphasizing conceptualization and designs.

PILOT PROJECTS

Pilot projects, or study projects, form an addition to applied study efforts, whereby a *learning-by-doing* approach allows for new techniques to be tested and valuable experience to be gained within the local city context. Pilot projects allow for the accrued knowledge to be tested out in concrete cases, and for answers to be found to practical questions. This knowledge can then be translated into specifications and policy frameworks, and can be shared with others who are joining us in the construction of Ghent. The final goal of it all is for successful pilot projects to give rise to a climate-robust approach as the standard way of working.

Pillar 5 'Implementation' also lists example projects, already allowing for people to get to work on climate adaptation and thus show what a climate-robust city will look like.

The Working Group on Climate Adaptation collects possible opportunities and assesses what pilot projects (and example projects, see pillar 5) will receive focus.

An example of a pilot project that is already in place is the **green roof wagon**:



May 2015 saw the opening of the green roof wagon in Voorhaven (outer port), showing what a green roof with a diversified plant and shrubbery range and extensive water-buffering capacity can look like.

The Parks and Public Gardens Service follows up on the water requirements of the green roof: will the additional water-buffering layer suffice for the present vegetation, or should extra water be provided during extended hot and dry periods?

Another realized pilot project is the construction of a **green bank along the Lieve near Kolveniersgang**.



The City of Ghent first had an extensive study conducted into the feasibility and design of green banks and possible biotope-improving measures in the inner and core city. This resulted in a number of proposals for execution. The proposal to provide a foreshore in the Lieve, near Rabot, with a marshland situation, was executed in November 2014. In the foreshore, marsh and water plants have the chance to develop, which also benefits the fish stock in the Lieve.

Such projects contribute to the development of the green-blue network within the city.

It is also important to learn from pilot projects that are having more difficulty developing. One example is the (planned) **reconstruction of the Bagattenstraat**:

The design plans for the reconstruction of the Bagattenstraat provided an alternative to the conventional tree pits, following the example of Stockholm (Sweden). The idea is for trees to have more root space and for rainwater to drain towards the trees through a tube in the pavement where it can easily infiltrate through the use of gravel and stones in the substrate. However, following its reconstruction, the Bagattenstraat will also serve as a bicycle street, meaning that salt will be scattered in case of snow and sleet. The 'Swedish' tree pit system is therefore less ideally suited to this location due to the high concentration of road salt that will flow towards the trees with the melt water, which is detrimental to tree survival. Discussions on possible solutions have taken place within the Working Group on Climate Adaptation (not using road salt, scattering sand, temporary screens, active carbon filter).



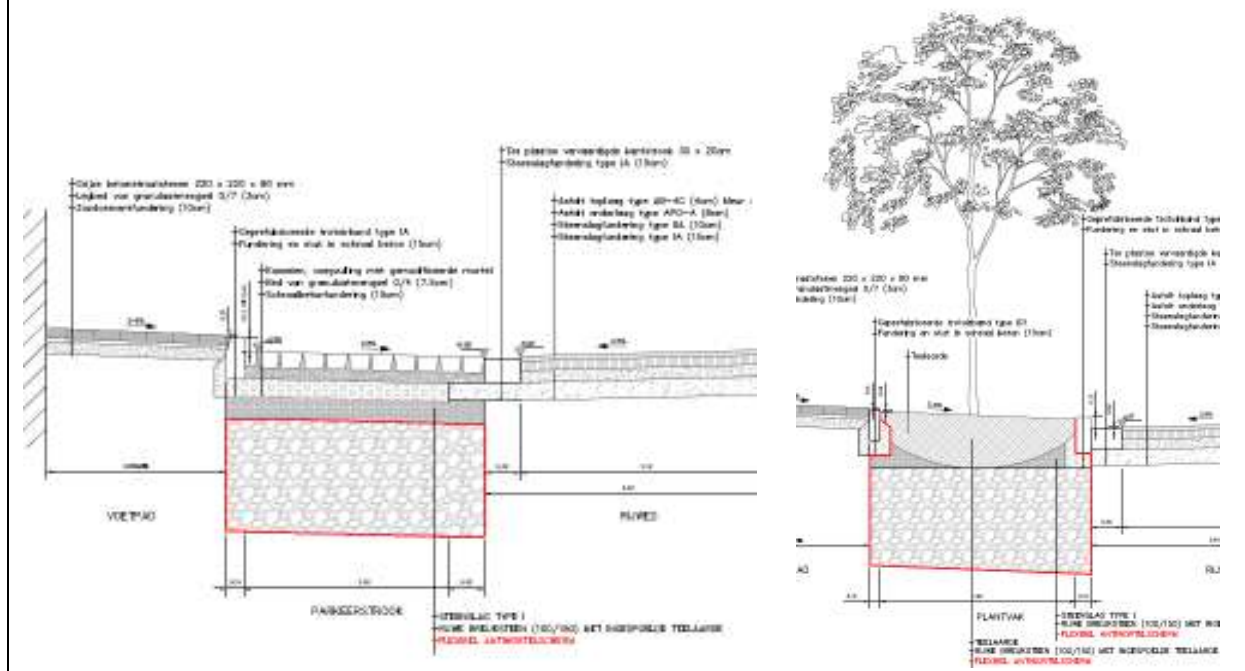
The following pilot projects are slated for this legislature:

Action 3.5: Pilot project 'Stockholm' model for tree pits

During the reconstruction of the Wittemolenstraat, a new set-up for the parking strip with trees was tested following the Stockholm example. The substrate is composed of gravel and stones to which rainwater is diverted for infiltration. This provides trees with more ample root space and a greater availability of water. This gives them a better chance at growing into tall, high-quality trees. In narrow streets with little space for greenery, this concept may provide a solution for retaining rainwater and enhancing the city's sponge effect. However, the adjacent road surface must be sufficiently robust to carry traffic.

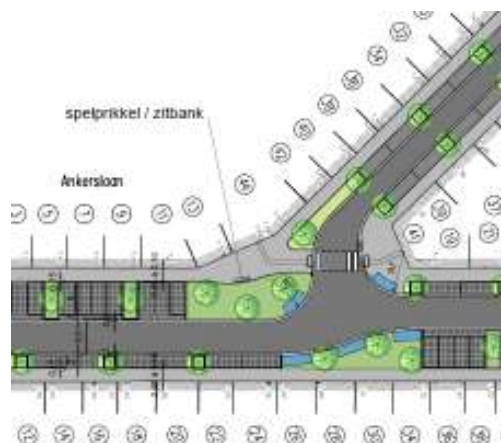
In addition, research should also be conducted into the proper introduction of trees into existing pavement. The growth of trees in Sint-Michielsplein (in between piping in lesser-quality soil) and

Korenmarkt (in specific tree granulate) will be followed as specific cases. The difference in growth should manifest itself starting in 2018, and then the effect of the various planting methods can be assessed.



Action 3.6: Pilot project Bioswale in Ankerslaan

For the reconstruction of Ankerslaan, a concept from New York was tried whereby rainwater draining from the road surface is led via an opening in curbstones to green areas for infiltration. Thus, rainwater is not drained off via a conventional sewer system, but retained in place with a limited green surface. The idea is to test this system for the purpose of a possible roll-out in similar future projects.



Monitoring during pilot projects is also important to truly understand the effect measures have.

Action 3.7: Knowledge build-up on water-permeable surface hardening by means of pilot project evaluation

In conjunction with the Research Centre for Road Construction (OCW), a number of recently installed surface hardenings with water-permeable materials will be subjected to measurements regarding water permeability in the long term in real conditions.

In addition, within the framework of the Voorhaven project, various mixtures of joint fillings/street layers will be applied in cobblestone surfaces around the warehouses. The different executions will then be evaluated on water permeability (with double ring test) and 'greening'. Also, open-end tests will be provided in the foundation to verify the difference between type I and type II crushed stone.

DIFFUSION OF KNOWLEDGE ON CLIMATE ADAPTATION MEASURES

The study efforts and pilot projects yield applied and practical knowledge on the construction, maintenance, costs, advantages and disadvantages of adaptive measures. This information must be collected in a clear manner and made available to relevant city staff. Under the pillar of Broadening within the city organization, general facilitation of the exchange of knowledge among city services was included as action 1.x. A permanent focal point for knowledge build-up, knowledge exchange, and consultancy is attuning the level of development to the needs of the services. Often relatively technical information is needed. This knowledge can then be translated into specifications and policy frameworks, and can be shared with others who are joining us in the construction of Ghent.

52**Action 3.8: Translating knowledge from applied study efforts and pilot projects towards policy frameworks and elements for specifications**

The pilot projects should yield practical knowledge on the construction, maintenance, costs, advantages and disadvantages of adaptive measures. In order to facilitate the implementation of this knowledge, it may be useful to draw up example passages for specifications that can be used as standard.

Not all adaptation measures will be universally applicable, but nevertheless the goal is to aspire to such universal applicability as much as possible. The parameters for deviating or not deviating from a climate-robust proposal should be established in policy frameworks that are politically validated.

Action 3.9: Diffusion of knowledge from pilot and example projects

In addition to the existing tools, it may be inspiring to assemble a type of climate adaptation toolbox with examples of adaptation measures from Ghent.

The climate adaptation toolbox is intended to assist spatial developers and project leaders. The toolbox provides an overview of possible adaptation measures at different spatial levels of scale and objectives. The objectives could be: to limit the risk of negative consequences of climate effects (prevention), to limit consequences or promote recovery following a flood for instance.

The climate adaptation toolbox is a 'menu' of measures, and a dynamic instrument. New solutions resulting from Ghent (pilot) projects are added to this toolbox.

PRIORITIZATION AND SELECTING MEASURES

With the build-up of knowledge on climate adaptation, it is also important to gather knowledge to help set priorities and select measures. Urban space is limited, and often choices need to be made between climate adaptation measures, and between climate adaptation and other interventions. This requires information, for instance, on **cost-benefits**.

The benefits generated by the proposed interventions are predominantly societal benefits, and often take the form of cost prevention. A study by the Flemish government²⁹ shows that the costs for Flemish society of a lack of adaptation amount to about 1 to 3.5 billion € per year, growing over time. Deaths due to heat stress are a large part of this. The cost related to coastal flooding is also very high. The average annual costs of climate change due to flooding from rivers lie between 90 and 770 million € for Flanders. This demonstrates the potential for societal benefits by focusing on measures that help prevent heat stress and water nuisance. However, the exact monetization of costs and profits from climate adaptation is not an easy task.

Cities such as Rotterdam³⁰ use a so-called societal cost-benefit analysis. This instrument provides an insight into the societal costs and benefits in the long term for various, flexible-selection measures. It also presents an overview of the contribution to the city's climate proofing. In its current form, it is a beneficial tool for Rotterdam in making strategic choices and in choosing between individual measures. Thus, it clarifies, among others, that clever ties with building projects or maintenance programmes nearly always lead to a positive cost-benefit ratio. Moreover, there is often even value creation.

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Cost-benefit tools were developed on the basis of a number of European projects as well:

- The *Climate-Proof Cities Consortium* has designed a directive to calculate these costs and benefits³¹.
- In 2015, the RAMSES project developed a tool for assessing the local economic cost of the health impact generated by climate change and climate adaptation³².

There are also a number of relevant Flemish tools such as the Nature Value Explorer for urban environments, Functional Green for green adaptation measures, and Plurisk for flooding measures that are of a technical nature. However, these instruments are quite complex and/or cannot be used autonomously.

²⁹ Technum (2012) Adaptation to Climate Change: global costs and practical examples – literature study

³⁰ Brief description of the societal cost-benefit analysis commissioned by Rotterdam:
http://rotterdamclimateinitiative.nl/nl/dossier-klimaatadaptatie/projecten/instrument-mkba?portfolio_id=130. Example of a developed case:
<http://www.rebelgroup.nl/nl/projecten/ontwikkelen-innovatieve-klimaatadaptieve-mkba-voor-rotterdam/413>.

³¹ Climate Proof Cities Consortium (2012). Guideline Costs of Adaptation Measures. Utrecht

³² <http://www.ramses-cities.eu/results>

Action 3.10: Follow-up of tools for cost/benefit analyses

We will not create a tool for cost/benefit analyses tailored to Ghent due to the high complexity, but will follow up on what is and becomes available, both at the Flemish and at the European levels. City services raise many questions on management costs of climate adaptation measures in the short and long terms, mainly regarding the rather technical solutions. We also search for tools to provide an answer on this topic. Naturally, we will be building up our own experiences over time as well, among others from pilot projects.

4.4

INTEGRATION INTO CITY POLICY PLANS, INSTRUMENTS, AND PROCESSES

Climate adaptation requires a focus on adaptive measures, taking into account the uncertainty. These adaptive measures are often spatial interventions that have not yet been taken into account, so it is important that the principles and measures regarding climate adaptation also be integrated into city policy plans, instruments, and infrastructural planning and implementation processes.

Because adapting to the changing climate requires a long-term approach, adaptive measures allow us to establish solid links with other spatial developments within the city, and to produce clever combinations with ongoing management and maintenance programmes. Maximum synergy with other planning processes is of the essence. We are riding the waves of the city, as it were.

This ride also requires intense collaboration with other partners working on the city. A climate-proof approach to projects will be the topic of discussion between the city and project initiators. A jointly carried ambition for climate-proof urban development is key in this respect. In this context, the city has a framing, facilitating, and stimulating role to play.

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We see opportunities for structurally embedding climate adaptation into

- the **policy plans**, with the new structural vision Room for Ghent 2030, the Green Structural Plan, and the memo Water in the City. The focus here can be placed on green lobes, green-blue networks, space for water, the provision of cool spots (green, water, shadow), the reduction of sealed soil surfaces and petrification, etc. The new structural vision 'Underground' to be developed likewise offers opportunities on rainwater infiltration, district heating, ...
- **urban instruments**, with the subsidy programme for green roofs, the local building regulations for the City of Ghent, the allotment directive, the green standard (guideline), the Sustainability Meter, SIPs... Their potential lies in the fact that they have a steering effect on both developments in the public domain and on private developments;
- **processes**: infrastructural planning and implementation processes, internal and external

The overview below indicates at what levels policy plans, instruments, and processes are implemented

	Policy plans	Instruments	Processes
Construction level		<ul style="list-style-type: none"> Local Building Regulations Subsidy green roofs 	<ul style="list-style-type: none"> Department of Facility Management Procedure Building Projects
Streets and squares		<ul style="list-style-type: none"> Integral Plan Public Domain (IPOD) 	<ul style="list-style-type: none"> Quality care (re)construction of public domain (integral quality management)
Neighbourhood level		<ul style="list-style-type: none"> Allotment Directive Farys SIPs Sustainability meter 	<ul style="list-style-type: none"> Design research
City level	<ul style="list-style-type: none"> Room for Ghent 2030 Green structural plan Structural vision 'Underground' Water in the City 		

POLICY PLANS

Room for Ghent

Society as well as the city are constantly changing, and in the process addressing the needs of the people: a pleasant place to live with sufficient greenery, possibilities for relaxation, sufficient employment, and appropriate accessibility to these places of work, open space with room for agriculture and natural development, ... The City Administration is tasked with finding the right place for all these societal needs. This requires a sound and smart spatial policy with sustainability as an overarching goal for all choices and decisions; spatial capacity and spatial quality are key terms in this respect.

A spatial structural vision is the instrument that is expected to outline this desired spatial policy of the city, not only in the short but also in the long term.

Ghent is currently implementing a programme for the creation of a new spatial structural vision 'Room for Ghent'.

On 1 October 2015, the council of mayor and deputy mayors took note of the Synopsis 'Room for Ghent'. The summary features the concepts and challenges, and a desired spatial structure for the city of the future. The steering and binding parts will be developed in 2016. This lays the basis for the final version of the structural vision. The official procedure in this respect starts in late 2016.

‘Room for Ghent’: a brief outline

The “structural vision 2030 – Room for Ghent” supports the climate objectives: Ghent, climate neutral city 2050 and Ghent, climate-robust city 2030.

The City of Ghent seeks to become climate neutral by 2050. In order to accomplish this ambition, we must also take into account the city’s spatial development: our mobility behaviours, layout of the public space, city-oriented agriculture, local production of renewable energy, natural development, ...

The City of Ghent seeks to be climate-robust by 2030. Ghent wishes to prepare for and adapt to climate change. A great deal of climate adaptation measures are spatial measures: reducing petrification, focus on greening, provision of space for water, design of cool spots, ...

It is important that the various interventions fit within an overarching vision that further develops a **coherent green-blue network**. The key elements of this network are the river valleys and waterways, the wooded areas, the 5 green hubs, the 8 green axes, and to a lesser extent neighbourhood parks and other green and green-blue spaces within the city. We fortify this network by undertaking the right measures in the right locations.

‘Room for Ghent’ puts forth a number of visionary elements that indicate how we can work towards a ‘future-proof city’ by offering a spatial response in the (mid)long term to the looming challenges - including the changing climate.

1. We are building a liveable city

Each spatial project is underpinned by the basic idea that it should contribute to enhanced liveability. When during a project we can no longer guarantee the liveability of the space and its environment, that is the point when the spatial capacity of this space has been exceeded. Elements of this capacity are protection, comfort, experience, and focus on children and youths.

2. We use the physical system as the basis for spatial development

Throughout its history, Ghent has developed around the physical system of the confluence of the Scheldt and Lys rivers. This physical system also forms the basis for the further spatial development of the city. Water structure and the water system are significant spatial elements. Many other patterns adapt to the physical system and in particular to the water. The underground is often literally an unexplored area; it not only presents parameters for development, but also offers a great deal of (spatial) possibilities which we wish to properly chart. The underground thus helps determine the structure of above-ground spatial developments.

3. We choose careful city development

The spatial uniqueness, the functionality and image quality of the Ghent space (landscapes, urban structures, open and public spaces and buildings) are three criteria for any spatial development. We continue to build upon the existing city and take into account the existing spatial and social fabric (improvement without suppression).

4. We make the city climate-robust with greenery and water

Greenery and water, from the major green hubs at the city’s edge, across the green(-blue) axes and neighbourhood parks, to street trees, façade greenery, and green roofs, make the city attractive, liveable, and climate-robust. Greenery, certainly when combined with water, cools down the city in summer, and tempers the urban heat island effect. Even the smallest green elements, including a lone tree, have a key part to play in this story. Green structures are not only important in residential

fabrics or in frequently visited public spaces, a high-quality green structure within economic clusters also constitutes an essential part of controlling city temperature, the water system, and the air quality in the urban conglomerate. Reducing surface hardening is important in allowing as much water as possible to infiltrate into the soil.

5. We interact with space in a sustainable manner by renewing instead of simply growing. City growth must take place in a sustainable manner. Wise growth is key. This can be done chiefly by renewing the city fabric and catching the city's growth within the existing hardened surfaces. Efficient handling of the available space is also of the essence if Ghent wishes to be a liveable, child-friendly, climate neutral, and climate-robust city.

6. We place a strong focus on public space
Optimal residential quality of the public space is of primary importance. The space in which everyone is able to reside and move independently is shaped in a child-friendly manner: in addition to cohesion, design criteria include (traffic) safety, scale, image quality, legibility, and comfort and user-friendliness.

7. Interwovenness and diversity are our aspirations, and proximity is our choice
One of Ghent's top assets is its unique interwovenness. The spatial choice must further enable and reinforce this interwovenness. Every resident of Ghent must have access to (local) basic amenities within their residential area (at walking or cycling distance). By introducing new amenity clusters and services, and by opening up large, monofunctional corporate and amenity complexes and making them fordable, we create micro-centrality. This also limits the number of car usages families make. It also enhances social cohesion, addresses demographic growth and the demand for amenities, and creates space for economic growth.

8. Our goal is selective but high-quality accessibility
Interwovenness, diversity, and proximity require selective accessibility. More people means more movement. The city must remain accessible to all, but not at the expense of quality of life in and around the city; we seek to be an accessible and liveable city, in short high-value and contemporary urban mobility.

9. We provide dynamic stimulation, and change-oriented construction.
By accounting for future modification and user options during the design and realization stages, we extend the useful lifespan of buildings and building elements. This way, we address our changing needs and reduce the environmental impact of construction.

10. We seek spatial synergies with the urban region
Spatial structures and developments do not stop at the municipal border. Spatial developments (such as housing, working, mobility, safety, the use of infrastructure and amenities, nature and green (hubs) or food supply) are discussed at the city region level. This way, we attune the (spatial) policy to the interwovenness that exists between Ghent and its neighbouring municipalities, we ensure that synergies are generated, and we help develop the city region in a well-balanced and sustainable manner.

Action 4.1: Further follow-up of the preparation of 'Room for Ghent'

While creating the new structural vision 'Room for Ghent', other sectors, authorities, and key players should be given the space to incorporate their interests into the plan. Climate adaptation is also one of these focal points being put forth. As climate-adaptive measures are primarily spatial measures, the embedding thereof within the spatial vision for the future is of the essence. On the one hand we must provide an extra impetus on climate adaptation for the nodes, strategic areas, and projects from Room for Ghent. In addition, we must also develop practical knowledge and the necessary policy frameworks and instruments in order to provide a climate-adaptive perspective to spatial projects. Also relevant, e.g. on the topic of rainwater infiltration, district heating, ... is the projected preparation of the 'structural vision underground'.

Action 4.2: Drawing up a phased plan to prevent further soil sealing in Ghent

As mentioned in chapter 3, in the long term we seek to reduce surface hardening in Ghent in a deliberate and thought-out manner. On this topic, we are already working to prevent further soil sealing in the public domain, owing to our exemplary function and the fact that we hold the keys to this in our own hands. At the same time we are also developing an approach directed towards public/private development.

For the public domain, this approach consists of the following:

- systematic application of the principles described in chapter 3.1
- development of a monitoring system
 - every year, the Roads, Bridges and Waterways Service will generate an overview of additional and removed surface hardening based on the realized projects and the road information system (WIS)
 - the soil coverage maps generated by AGIV every three years since 2012 for Flanders are used to assess the evolution of the surface hardening level in Ghent
- performance of a screening regarding the possibilities for reducing surface hardening in the public domain and providing a maximum of alternatives

For the private domain, the afore-mentioned approach is supplemented with

- communication and awareness-raising to increase awareness on this issue
 - research in order to come to a suitable (spatial, legal, financial) toolkit
- whereby we already focus on small-scale surface hardening in (front) yards (see also action 4.9).

Action 4.3: Further follow-up of space pilots for 'Room for Ghent'

Within the framework of the creation of a structural vision, a participatory programme is also being held whereby 8 'space pilots' were selected among many proposals made by Ghent residents. The City is elaborating on these ideas with their submitters, and verifying what this may specifically hold for the Ghent of the future: study, scale model, 4D presentation, exhibition, or a trial project in the neighbourhood or area. A number of space pilots could serve as examples of climate adaptation in practice. They are 'Towards a green Krijgslaan, Kortrijksesteenweg, Voskenslaan, and Sint-Denijslaan', 'Protecting and optimizing internal areas', and 'Wondelgem Park City'. These projects will also be followed up in order to add a climate-robust element.

Action 4.4: Drawing up a structural vision 'Underground'

The underground soil is often literally an unexplored area, including from a spatial perspective. With spatial developments, our focus is on the *visible* spatial (network) structure. But also the (value of

the) underground (soil, groundwater, soil life) should be a criterion in the comprehensive assessment of spatial choices. The underground space is also finite, as is the above-ground space. This is why it is of the essence that sustainable, efficient, and clever use of the underground also be embedded into spatial policy. It is why a structural vision 'Underground' is being prepared. In it, we further develop the spatial potential and limitations of the underground in concrete measures and (regulatory) instruments. This is why the structural vision underground charts the following aspects by means of map materials:

- *Soil quality (among others brownfields)*
- *Groundwater* (provide more detailed mapping of water-sensitive and floodable areas, in particular within the urban area)
- *Archaeology*
- *Original soils* (based on soil valuation map, soil survey, and biological valuation maps)
- *Cables and pipes* (main pipes for gas, water, sewers, and electricity and planned pipes)
- *Soil energy* (opportunities for realizing open or closed underground energy systems)
- *Underground waterways*
- *Shallow groundwater tables*
- *Wetland areas*

Water in the City

Within the framework of the structural planning process 'Room for Ghent', a separate memo 'Water in the city' is being developed to provide strategic framing for spatial projects on and along the water. One of the objectives in the memo is to create policy instruments, priorities, or concrete actions. On the other hand, a comprehensive approach should ensure more consistent action whenever unexpected opportunities arise.

It is recommended that the City of Ghent and W&Z come to a supported and coordinated vision 'Water in the City'. The chosen method is for both W&Z and the City of Ghent to do their 'internal homework': gathering knowledge internally and having internal discussions. Then, very deliberately, two vision concepts are combined, complementarity is enhanced, and bottlenecks are removed.

Action 4.5: Further follow-up of preparation of memo 'Water in the city'

Climate adaptation should be at the forefront when preparing the memo 'Water in the city'. The note, among others, pays attention to water as a cooling element, the importance of green-blue axes, space for water, and water storage in public spaces. In addition to 10 types of "Ghent blue" being drawn up, dealing with segments of waterways to which functions and a type of facility are linked, 'the city as a sponge' will primarily be tied to a strategic ambition rather than an area-specific one.

Green structural plan

The green structural plan is a long-term vision: it charts the areas where the City of Ghent will provide space for greenery in all its forms for the coming 20 years. In addition to this long-term vision, the green structural plan also contains an initial action plan to be realized in the short term. These are actions the City will work on between now and 2018. A new action plan is drawn up for each legislature.

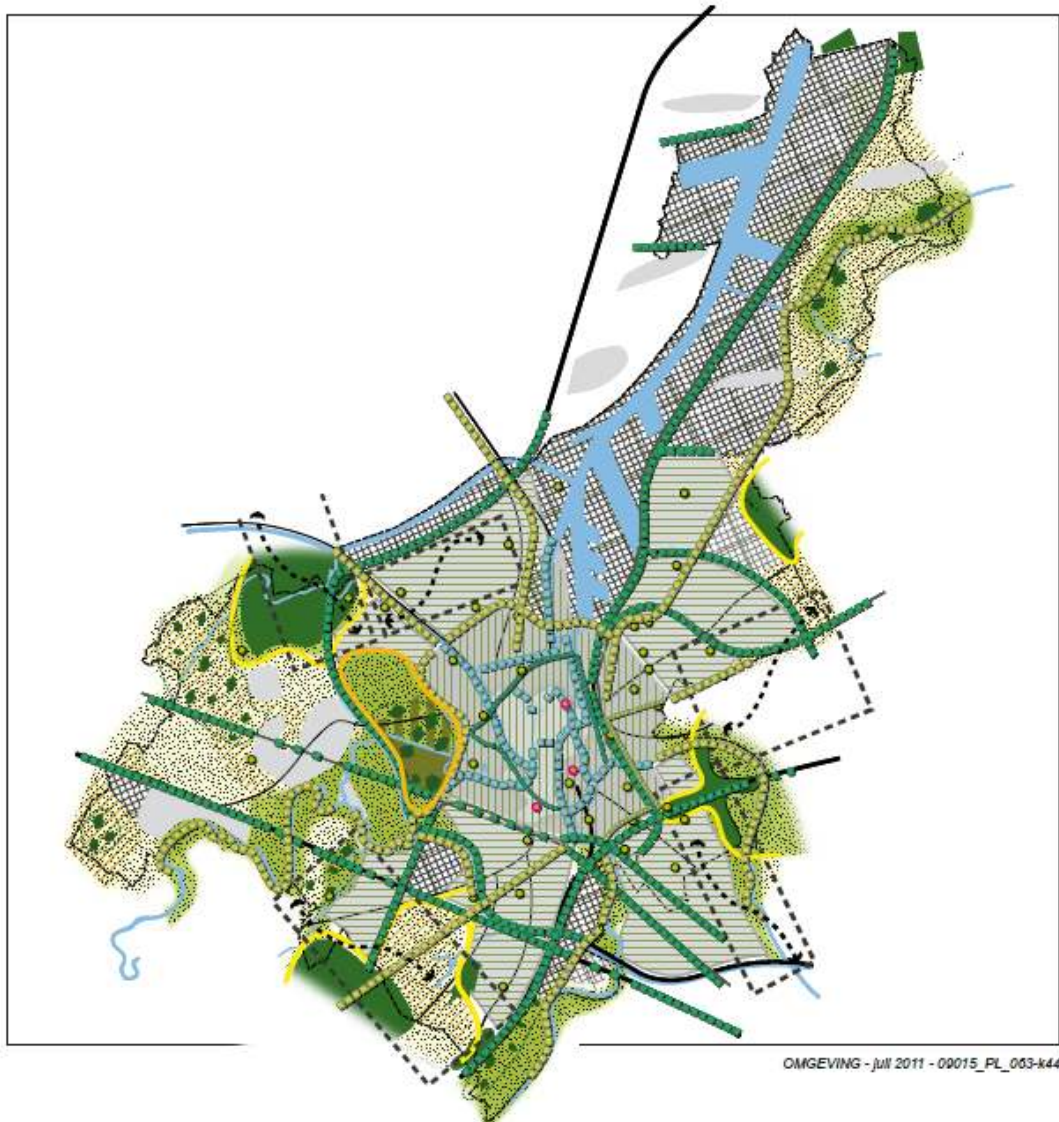


Figure 14. Desired Green Structure Ghent

For the green structural plan, a choice was made for the purpose of climate adaptation to actively provide more air and climate green, and to build a climate-robust green structure. This results in these actions towards a climate-robust city:

Action 4.6: Translating the green structural plan into climate and environmental goals

Each action from the green structural plan will make a positive contribution to the climate and environmental goals, for the purpose of stimulating knowledge on and insight into the climate and environmental situation both within the city and among the population, businesses, etc. A number of example projects realized by the City will reinforce this goal, and also motivate third parties to make efforts of their own.

For internal and external communication, additional attention is paid to the functionality of greenery within the climate adaptation context, for instance mitigating the heat island effect, the catchment, buffering, and infiltration of rainwater, or the capture of (fine) dust.

New insights on the effects of climate change (heat, water nuisance, drought, ...) or changes in climate mitigation or adaptation policy at the Flemish or city levels will be addressed. The results of the innovative Climate plan are integrated into the green structural plan.

Action 4.7: Drawing up a manual with design conditions for air and climate greenery

Research into concrete design strategies and design guidelines in relation to the optimization of the climate-regulating effect of greenery. The manual serves, for instance, to indicate what buffering and infiltration facilities in green zones, or within greenery, could look like and in what manner rows of trees, green buffers, or green volumes are to be put in place to achieve an optimal filtration effect (catchment and absorption of deposits of (fine) dust and volatile substances). The role of current greenery as air and climate greenery is also evaluated and optimized if so desired. By means of short-term studies highlighting the effects of greenery on the (micro) climate, “green design” can be further developed.

In fact, all measures within the green structural plan can contribute to climate adaptation, from the small-scale expansion of greenery to combat overheating, to the construction of major parks and green areas. However, within this context, focus must be placed on climate-robust green.

Action 4.8: Climate-robust green structure, design, and management

In the planning, design, and management of green zones, we strive for maximum resilience against climate change. Think of the construction of more and larger green cores that are more interconnected, the pursuit of maximum environmental gradients, (structural) diversity, and the continuity of management forms across environmental gradients. Emphasis is placed on spontaneous processes such as natural succession, grazing, and flooding dynamics.

The selection of seeds and plants takes into account their resistance against the expected effects of climate change. This is particularly important for trees, considering their lengthy lifespans. Mowing dates are adjusted according to shifts in blooming periods. Planting and pruning are attuned to shifts in the seasons. Management plans are subjected to interim reviews and adjustments where needed. Avoidable environmental pressure (e.g. desiccation, over-fertilization) enhances the effects of climate change and is reduced as much as possible.

Regarding green zones with very high biological value, it is considered whether negative effects of climate change (e.g. desiccation) can be mitigated (e.g. artificial water level management).

URBAN INSTRUMENTS

The city’s development also largely consists of private initiatives. Here, it is on the one hand important to communicate minimum requirements regarding climate adaptation, and on the other to join hands in pursuing attractive example projects for a climate-robust city. To accomplish all of this, the climate adaptation measures must for instance be introduced into the local building regulations, subsidy regulations, the sustainability meter, and spatial implementation plans, but also

in (preliminary) consultation with initiators and during design research. Areas with particularly great potential are comprehensive water policy, green spaces, and interventions regarding the public domain.

Over the past years, a number of instruments have already been modified to contribute to a climate-robust Ghent. In addition, we can take a look at what additional instruments can be implemented and how enforcement and supervision can be further organized regarding these aspects.

Local Building Regulations for the City of Ghent

Within the framework of climate adaptation, a number of local accents were added to the Local Building Regulations for the City of Ghent (ABR) as additions to and refinements of the regional urban planning ordinance for rainwater³³ (GSVH):

- Retention of rainwater at the source, both by maximum reuse (not only for new constructions but also thorough renovations) and by local infiltration, in order to prevent water nuisance and supplement the groundwater table;
- Maximum usage of flat-roof surfaces not being used for rainwater recuperation as green roofs because of the many positive effects of green roofs within urban environments (water buffering, heat island effect reduction, contribution to greenery and biodiversity in the city) and other positive effects regarding sustainability (extension of lifespan for roofs, better roof insulation, ...).

Action 4.9: Developing a (spatial) toolbox to further de-harden (private) hardened surfaces

As is the case anywhere else, many front yards in Ghent are being hardened to limit maintenance and add parking space. This makes streets look greyer and greyer, makes it more difficult to plant trees and design a high-quality public space. Moreover, it obstructs water infiltration.

A green front yard adds to the pleasant outlook of the street or housing block, and thus improves the quality of life for residents and locals alike. By not building upon or hardening the front yard, part of it will remain available for natural infiltration of rainwater into the soil, lessening the burden placed on public sewers and reducing the risk of water management issues. Moreover, any garden within built-up areas, no matter how small, is a natural oasis for birds, insects, ... and provides a slight reduction in the heating of the urban environment.

In Ghent, a limitation on the level of surface hardening has been included via the local building regulations, and within various local zoning plans and SIPs. Still, existing front yards could stand to be much greener. In addition to a focus on the enforcement and supervision of these regulations, there are also other ways to generate a change. On the one hand by embedding guidelines within IPOD (Integral Plan Public Domain) for the reconstruction of streets, and on the other hand by motivating and supporting individual citizens and companies (see also pillar 4.6 communication).

- **New front yards.** Experiments are being conducted on the location of the front building limit in a number of new allotments. This requires custom efforts in consultation with the developer, allotment manager, or constructor/owner.

One example is the Eekhoutdriesstraat allotment:

- Homes are given 4 metres of front yard (standard 5-metre front yards tend to be

³³ In full (in Dutch): *Gewestelijke stedenbouwkundige verordening inzake hemelwaterputten, infiltratievoorzieningen, buffervoorzieningen en gescheiden lozing van afvalwater en hemelwater, dd 5 juli 2013 en van toepassing sinds 1 januari 2014.*

used as parking spaces, and thus lead to surface hardening)

- Near the garage, the home is offset towards the rear, resulting in a parking space for a car (6m) - this surface can be hardened. This area can also be partially covered with construction.
- Thus, the 4-metre part of the front yard can remain green, and will not be hardened for parking more cars.



- **Existing front yards:**

- There are streets in Ghent where most front yards have been hardened to serve as parking spaces. When reconstructing these streets, we seek to reintroduce quality of design, pursuing minimal surface hardening of the public domain, taking into account other aspects such as parking guidelines, accessibility, ... For private front yards, an offer is made for de-hardening.

- **Driveways**

- The Roads, Bridges and Waterways Service applies a driveway strategy for the reconstruction of roads: 1 driveway per parcel/lot with access to all internal parking spaces. This is meant to replace multiple angled parking spaces that all connect to the public road. By reducing and clustering driveways, we can maximize green berms / ditches.
- The width of the driveways is also limited. This effort takes into account the minimal width needed for a turn-in manoeuvre from the available road width.

Farys Allotment Directive

For new allotment applications involving the construction of new road surfaces and/or modification of existing roads and sewers, it is important to take 'space for water' into account from the very beginning. In consultation with city services, Farys has drawn up guidelines for the new allotments regarding sewers and infiltration/buffering systems, attuned to the regional ordinance for rainwater, and the code for good practices. The new guidelines apply since October 2014.

These new guidelines also imply the application of the principles of comprehensive water policy for the future public domain:

- infiltration wherever possible
- buffering and delayed drainage as a second step

The sizing of infiltration and buffering provisions in the public domain must also take into account part of the private domain, allowing allotments to enjoy better protection against floods.

Subsidy regulations

For a number of years now, the City of Ghent has been granting subsidies for the creation of green roofs, both for private persons and project developers and companies. This has yielded the construction of 54,640 m² of green roofs in Ghent since 2002.

Action 4.10: Optimization and subsidization of green roofs

The City of Ghent grants subsidies to private persons and non-private entities for the creation of green roofs in Ghent with a buffering capacity of at least 35 l/m² in case of flat roofs. The subsidy amounts to 31 €/m² for private persons and 25 €/m² for non-private entities, with a maximum of 25,000 € per building. Despite this subsidy and the inclusion of the green roof obligation in the building regulations of the City of Ghent, the proportion of green roofs in Ghent remains limited. Subsidies for the green roofs are insufficiently utilized, requiring an optimization of the subsidy programme. Insufficient knowledge on load-bearing capacity forms a hindrance to the creation of green roofs on existing roofs. For companies, the financial impetus is too limited compared to the added cost of adding sufficient load-bearing capacity to large warehouses. The subsidy programme for green roofs will be assessed and optimized. In addition, research will be conducted into the possible enhancement of results within the climate adaptation policy through a reorientation of the budget. Beside the creation of green roofs, there are other climate-adaptive measures Ghent residents can undertake. We verify in what way we can best financially support this.

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Action 4.11: Continued focus on the subsidization of sustainable neighbourhoods for climate adaptation

With the Subsidy for Sustainable Neighbourhoods, Ghent is at the moment promoting neighbourhood initiatives whereby residents and residents' associations set up projects together towards saving energy and reducing CO₂ emissions. The subsidy can be used to acquire advice and expertise for instance in drawing up a business plan. It is vital that this project be for and by neighbourhood residents. As for the future, we seek to extend the scope of the subsidies towards making Ghent climate-robust, among others by including more suggested projects on climate adaptation for inspirational purposes (e.g. joint creation of green roofs on garages, test gardens for compact, affordable, ecological urban living).

IPOD IV

In order to render the design of its public spaces more cohesive, the City of Ghent has developed the Integral Plan Public Domain (Dutch abbreviation: IPOD). It shapes a general vision for the City regarding the use of materials in the public space (IPOD part 1), the desired dimensions (IPOD part 2), and soon also street furniture (part 3). The guidelines are a manual for every designer of projects within the public space in the City of Ghent.

Action 4.12: Drawing up IPOD IV

IPOD will be extended with a part 4, putting forth guidelines on the City's vision regarding liveability. Along with sound, air, and play, a chapter is dedicated to climate adaptation, under the title "liveable city". These guidelines are to inform and direct the designers towards climate-robust designs for the public domain.

Instruments for urban development

The design of space forms the starting point for urban development and quality utilization of space. Spatial design is necessary at all levels of scale: whether dealing with the design of the city, a submunicipality or neighbourhood (identity), a housing block, an individual building, or public domain. A good design is vital in achieving spatial quality, and cleverly integrates various sectoral desires and aspirations (regarding the environment, climate, greenery, economy, mobility, ...). A good design is often the result of **design research**. We notice that the (external) conductors of this design research do not always include space for climate-adaptive measures as a basic principle, seeing it rather as yet another obligation.

Through a **spatial implementation plan (SIP)**, the city ensures spatial harmony between housing, recreation, nature, mobility infrastructure, economy, agriculture, and other purposes and city functions. It is important to include attention to climate adaptation into the SIP, and not to wait until the licensing phase of a project. For instance, new SIPs must provide sufficient space for achieving both the green standard and the obligations regarding the catchment and infiltration of rainwater. As SIPs are drawn up for the purpose of future developments, the minimal demand for space in the current regulations is insufficient, and climate change must be taken into account already in order to assess future required space for rainwater.

A key instrument for the City of Ghent in enhancing sustainability in city projects and economic sites are the **sustainability meters** (of the City of Ghent, Flanders, BREEAM). They cover all aspects of sustainability (administrative, economic, social, and ecological sustainability). Climate adaptation is also addressed, among others in the provision of trees, space for infiltration, ... The sustainability meters provide direction and impetus. They clarify what the City means by sustainability, so that all parties know what is expected. At the same time, they leave enough (design) freedom and show different roads that lead to the objective. One focal point is to safeguard the agreed ambition level for the entire duration of the process, from design to realization.

Already, the sustainability meter has been utilized in city projects such as Tondelier, Oude Dokken (Schipperkskai, Handelsdok West), Gent Sint-Pieters (Rinkkskai), and at economic sites such as Eiland Zwijnaarde, Wiedauwkskai.

Action 4.13: Optimization of the (usage of) instruments for the integration of climate adaptation in urban development

We wish to urge the conductors of **design research** to include climate-robustness into their assignment. On the basis of design research for the Afrikalaan, which is the framework for further consultation with the various private owners and the framework for a future SIP, we identify margins for improvement and examine how to tackle them specifically.

Climate adaptation also requires that, in addition to specific and concrete provisions, **spatial implementation plans** (SIPs) also allow for the use of more general, more principle-based, broader provisions (such as the pursuit of rainwater neutrality). Currently, the fact that these provisions are too general in nature to become regulatory is a stumbling block. They could be included in the clarification memo added to a SIP, but this is only useful if reference can be made to them during licensing assessment.

We continue to search for the optimal manner for including space for climate adaptation into a SIP with legal backing. *Ruimte Vlaanderen* will be involved as well for this purpose.

We include the Dampoort SIP as a case example. Following the MER procedure, a SIP will be drawn up on this topic. As this neighbourhood is currently susceptible to heat stress, it will be examined whether essential climate adaptation measures such as de-hardening, the creation of accessible green zones, space for (running) water, green infrastructure such as green roofs and façade green, ... can be embedded into a SIP.

The Flemish government is working on creating a quickscan based on the new **sustainability meter for neighbourhoods**. The idea is to offer a concise and efficient instrument for assessing the sustainability of a housing development. The City of Ghent will verify in what manner this quickscan can be included in the preliminary consultation taking place between the city and private developers.

URBAN PROCESSES

When dealing with larger and smaller projects executed (partly) by the city, we ourselves hold the keys in our hands. We will lead by example when creating streets or bicycle paths, (re)building schools and homes, designing parks and squares, or renovating neighbourhoods by systematically opting in favour of climate-proof design. But here too, the right agreements must be reached with all involved partners within the City of Ghent for drawing up specifications (Department of Facility Management), quality control for the public domain (Integral Quality Management), and the utilization of design research for urban development and renovation, or the usage of the sustainability meter.

Reconstruction of roads

For the reconstruction of roads, the process integral quality management for the reconstruction of roads (abbreviated in Dutch as IKZ) is already in place. In it, all designs for the (re)construction of the public domain are monitored with the various city services. The IKZ process starts with the creation of the programme of requirements via a request for advice to all services, and goes through all steps of the design process, from concept to design. This way, sustainable projects are pursued that apply the City of Ghent's policy.

The IKZ process constitutes a key process within the City of Ghent for the implementation of the climate adaptation policy for the (re)construction of the public domain, more specifically roads and sewers. Various pilot projects and example projects for climate adaptation shaped at the IKZ conference table will be executed over the coming years, see pillar 5 Implementation.

Action 4.14: Evaluation of the climate-robustness of IKZ projects

An evaluation is to take place whereby the projects from the past years are reviewed and assessed on the topic of climate adaptation. What was realized, what could have been done better, what are the counterarguments. Such an evaluation is an interesting learning experience for future projects.

City projects

In addition, the other city projects also provide leverage towards achieving the objectives of a climate-robust city. Examples of city projects that merit focus are Gent Sint Pieters, Ecowijk – Gantoise site, Standaert site, Eilandje Zwijnaarde, Hogeweg, Afrikalaan, Jachthaven Snepkaai,... Likewise, the major city development projects of Oude Dokken, Muide-Meulestede, Dampoort – Sint-Amandsberg and Nieuw-Gent,... demand a climate-robust approach.

In this context, **cooperation** between the various services involved in city projects is key. For concrete projects, it is highly relevant that all involved services be on the same page from the very beginning in order to increase the climate-robustness of projects. Better agreements regarding project operation may facilitate this. This ensures that climate adaptation is brought up, included, and followed up at the right stages of the process.

Action 4.15: Agreements on project operation to safeguard attention to climate adaptation

Within the organization there is a need for increased professionalization of project operation. Within the framework of Ghent's reorganization programme Gent+, a decision was made to install a project office within the Pillar Ground, underneath the Department of Public Space. This project office (the "Project Point") coordinates a more structured approach and professionalization of project operation, and ensures that the entirety of project operation is made orderly and clear for the pillar Ground. As many climate-adaptive measures are spatial interventions, it is important that this approach via the project office and the further operational agreements that are made be included in the preparation and implementation of spatial projects in a timely fashion.

City real estate

The focus for our internal processes regarding the approach to Ghent's own city real estate lies with the following actions

Action 4.16: Development of climate-adaptation instruments for Ghent's building projects

The building project manual is an important instrument for the project managers with the Building Projects Service (and the Building Maintenance Service?) in the design phase. It provides guidelines, inspiration, and focal points regarding the approach to building projects. Since 2015, focus is also placed on climate adaptation, promoting climate-robust design. Both the principles established for green roofs, rainwater recuperation, and infiltration regarding our city real estate (see chapter 3),

and (links to) possible measures and inspirational examples are included. It is important to regularly update this building project manual with the latest knowledge on climate adaptation measures. In order to facilitate the execution of the rainwater aspect, a specific version of the “rainwater checklist” that has to be added to the building permit is generated for Ghent’s own city buildings. In order to provide guidance to the follow-up of climate-robust design, the RWEV visa (rational use of water and energy) procedure is reactivated, and the checklist is to be expanded with the focal points for climate adaptation. In the long term, the RWEV procedure is reworked, adding consultancy to the beginning of the design phase in addition to the inspection at the end of the design phase.

Action 4.17: Compiling a list of example projects on city real estate in the following legislature

In addition to the example projects being laid out for the coming years (see pillar 5 Implementation), it is useful at this time to compile a list of the projects involving city real estate on which we can focus during the following legislature. This involves looking at building projects both for the City of Ghent and OCMW Ghent (public centre for social welfare).

This allows us to incorporate climate adaptation from the very beginning of the process, and for the necessary funds to be earmarked during the budgeting for the following legislature.

One of our goals for this legislature is to demonstrate the realization of a climate-robust city by means of a **number of example projects**.

Indeed, actions are already being undertaken wherever possible. This is the basis for the so-called *no regret* approach: to already implement measures known to have a positive effect, e.g. regarding our water system, or greening the city; measures that already contribute to climate adaptation. It is best that certain measures be already incorporated to the utmost, such as the reusage of rainwater, the redesigning the creation of parks and green zones, the selection of water-permeable materials, focus on infiltration, the introduction of green roofs and façade greenery, etc. Opportunities such as the reconstruction of squares or public green provide excellent impetus for promoting climate adaptation at this time. Acting now ensures that the measures may be taken in time and at a reduced cost. Because the buildings, roads, utilities, sewer systems being built today will need to last decades, and are very costly to replace. Infrastructure adapted to coming climate change will in time generate lower costs and higher efficiency. This way, the investments of today become the climate-robust investments of tomorrow.

In addition, example projects provide insights into how we can specifically promote climate adaptation, and already show us what a climate-robust city may look like. They provide visibility to the principles of climate adaptation, thus giving concrete shape to climate adaptation in the eyes of the other city services, other stakeholders, and the residents and visitors of Ghent. They inspire and motivate others to act as well.

Indeed, this approach is a stepping stone towards the further implementation of a climate-robust approach as the standard working method.

EXAMPLE PROJECTS FOR A CLIMATE-ROBUST GHENT

Using the afore-mentioned approaches, this legislature is already focusing on the following specific example projects.

(RE)CONSTRUCTION OF THE PUBLIC DOMAIN

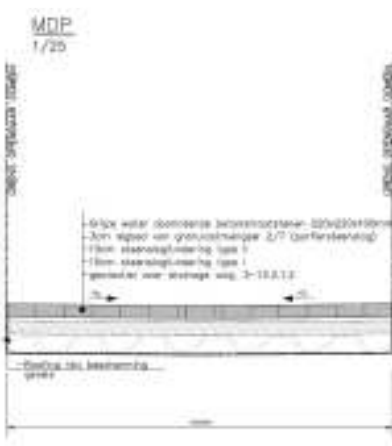
As for the example project in the public domain, focus lies with water policy, greenery, and the reduction of surface hardening.

Action 5.1: Water-permeable pavement in the alleys Jonkvrouw Matte and Heilig Bloedstraat - Inner city

Within the inner city, the possibilities for de-hardening are in many places minimal. One alternative could be to render the surface hardening itself water-permeable. However, the scope remains limited due to the various parameters at play: heavy traffic, presence of utility lines, risk of water nuisance for old houses, de-icing salts, ... In two small alleys these parameters carry less weight, and water-permeable concrete paving stones are used for the reconstruction of the road surfaces.



Current situation



New construction

Action 5.2: Reduced parking spaces, more greenery in Cité de Hemptinne (Hertstraat) - Inner city

The cité Hemptinne (Hertstraat) in the centre of Ghent consists of small workers' houses. The City of Ghent has put together a participation initiative with the residents and presented an ambitious concept. During this workshop, where residents could join in reflecting on their neighbourhood, the concept of 'more greenery' was met with a positive response, but the concern for sufficient parking spaces remained. This feedback will be taken into account during the rest of the design process.

Action 5.3: Climate-robust utilization of eliminated parking spaces - Pedestrian area

The extension of the pedestrian area in the centre of Ghent involves the elimination of a great deal of parking spaces. These freed-up spaces can be used for other spatial usage in the city such as play elements, terrace areas, and greenery. Climate adaptation (de-hardening, green design with water function) must be incorporated into this effort. An example project will be developed in consultation with Mobility Company.

Action 5.4: Climate-robust design for Kettingplein - Brugse Poort

The Kettingplein square is a traffic-free square, and at the moment completely covered in hardened surfaces. The City of Ghent wishes to make this square into an example project by transforming it into a climate-robust square with focus on water storage and thermal comfort. Ambitions can run high due to the traffic-free nature of the area. We are searching for a design office with the requisite level of knowledge and expertise regarding climate adaptation via a separate negotiation procedure. A participation project with the area is being set up. All city services are involved via the internal procedure of IKZ Reconstruction of Roads.

Action 5.5: De-hardening Nekkersberglaan and Belvédèreweg - Watersportbaan

Major expansion of the green zone. Reducing surface hardening by avoiding double roads, construction of a residential plot, elimination and optimization of parking spaces, removal of unnecessary footpaths. Wherever possible (primarily for parking spaces), surface hardening will be water-permeable.



Current situation



Designed situation

Action 5.6: De-hardening Zilverberklaan in Wondelgem - Residential neighbourhood

The reconstruction of the Zilverberklaan in Wondelgem is being made into an example project and aspirational example of a residential street in the 20th-century belt: narrow carriageway with green berms, parking spaces with cobblestone surfacing and grass joints, driveways to private lots made out of grass blocks. This strongly reduces surface hardening, and the street gains a pronounced green outlook with optimal growing conditions for street trees.

Action 5.7: Reconstructing Drongenplein - Drongen

The area surrounding the old Drongen abbey is being addressed. By 2018 the square will once again have a green outlook. The relationship with the Lys river is enhanced by extending the greenery up to the water, and by providing a berth. Parking facilities are moved to the Oude Abdijstraat in combination with new trees.



Action 5.8: Climate-robust measures in Oostakker village – 20th-century belt

The design for the reconstruction of Oostakker village is taking place via a participation programme in the neighbourhood. The neighbourhood is already much greener, the biggest challenge is to improve the liveability of traffic in the area. This is why specific climate adaptation measures will be systematically integrated into the project and tested among others based on the outcome of applied studies into possible water elements (see action 3.2). The shadow study (see action 3.2) allows for the shadow effect to be incorporated into the planning of (additional) street trees.

Action 5.9: De-hardening burial sites

The burial sites in Oostakker, Gentbrugge, and the Zuiderbegraafplaats in Nieuw-Gent will be addressed. Internal roads will be drastically reduced and stormwater drainage is greatly limited or removed altogether. Internal roads will be composed of reinforced lawn, narrow hardened pathways will provide drainage towards adjacent patches of grass. Wherever needed, the infiltration capacity of the soil will be improved, and water drainage will take place through infiltration.

During the de-hardening interventions, the at times protected heritage values will be taken into account.



Current situation (Zuiderbegraafplaats)

Designed situation (Zuiderbegraafplaats)

GREEN AREAS

Any project that introduces greenery to the city in itself more or less contributes to climate adaptation. The following projects are promoted as example projects.

Action 5.10: Façade greenery and green garlands in the Brandstraat - Inner city

The Brandstraat is a narrow one-way alley in the inner city. The street is being reconstructed due to the poor quality of the road surface. The possibilities for adding trees are minimal. The City of Ghent does see potential for façade green that can be made to grow across the street via cables. The Fire Department gives the green light, with a number of conditions. The Road Service can add the plant beds for façade green, the Parks and Public Gardens Service can offer advice on the choice of plants. The Social Cohesion and Urban Well-Being Service submits the proposal to the local residents. Depending on local interest and the number of spans, this method can provide shadow and cooling.



Action 5.11: 10,000 m² of new façade greenery in the city

Façade greenery greatly contributes to a greener street outlook. Façade greenery offers many other advantages for among others climate (adaptation)

- Cooling, reduced heat island effect
- Thermal insulation and better heat regulation of the building
- Financial benefit (savings on heating and cooling costs)
- Extended lifespan compared to a façade. Protection from the weather, temperature fluctuations, UV radiation, and the corrosive effects of pollutants.
- Contribution to the purification of polluted city air, filtration of fine dust
- Contribution to the building's sound insulation
- Enhanced presence of nature, flora and fauna³⁴ in the city; enrichment of biodiversity
- Natural experience, e.g. experiencing the seasons in the city
- Enhancement of city aesthetics
- Psychological effect, health, pleasant living environment

The city leads by example by greening its own walls.

(Citizens are also motivated to create a façade garden, the regulations for the creation of façade greenery have been simplified to this end, see pillar 6 Communication.)

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Action 5.12: Creation of neighbourhood park Wolterspark - Dampoort

The Wolterspark project (Denderlaan-Wolterslaan) redesigns and expands existing neighbourhood greenery into a neighbourhood park (ca. 1 ha). A residence and a warehouse have been demolished for this purpose; a (semi-)surface-hardened parking area will be optimized/reduced; the park will be redesigned in accordance with the principles of Harmonious Park and Greenery Management. Such a neighbourhood park is important in making the Dampoort neighbourhood more climate-robust, as it appears to be susceptible to heat stress and requires additional accessible and protective greenery.

Action 5.13: Further development of (part of) Green Axis 4 – Upper Scheldt

A (draft) SIP was drawn up for Green Axis 4, with the intention of removing a number of obstacles for the realization of this green axis (Ledeberg Frans De Mildreef LO, up to the castle of Zwijnaarde RO). The legal establishment of a number of natural values firmly anchors the green axis. A number of natural areas bordering the green axis are likewise (better) protected: including the INW woodland,

³⁴ Nesting places for birds (some of which attract butterflies), winter spots for insects, habitat for spiders.

Zwijnaarde castle park. A green, car-free pedestrian and cyclist connection will be established near the Warmoezeniersweg (removing the surface hardening of the current road; green surroundings with high-trunk trees, shrubbery, and a herb layer). The area bordering the green axis is designated as recreational greenery. The ecohydrological condition of the terrain is taken into account in this effort. Because hardly any greenery is present at the moment, the acquisition of a strip of ground parallel to the existing public domain (currently relatively narrow) is necessary to realize the green axis. After all, as long as no initiatives are undertaken for the adjacent grounds, it is not possible to enforce the introduction of greenery.

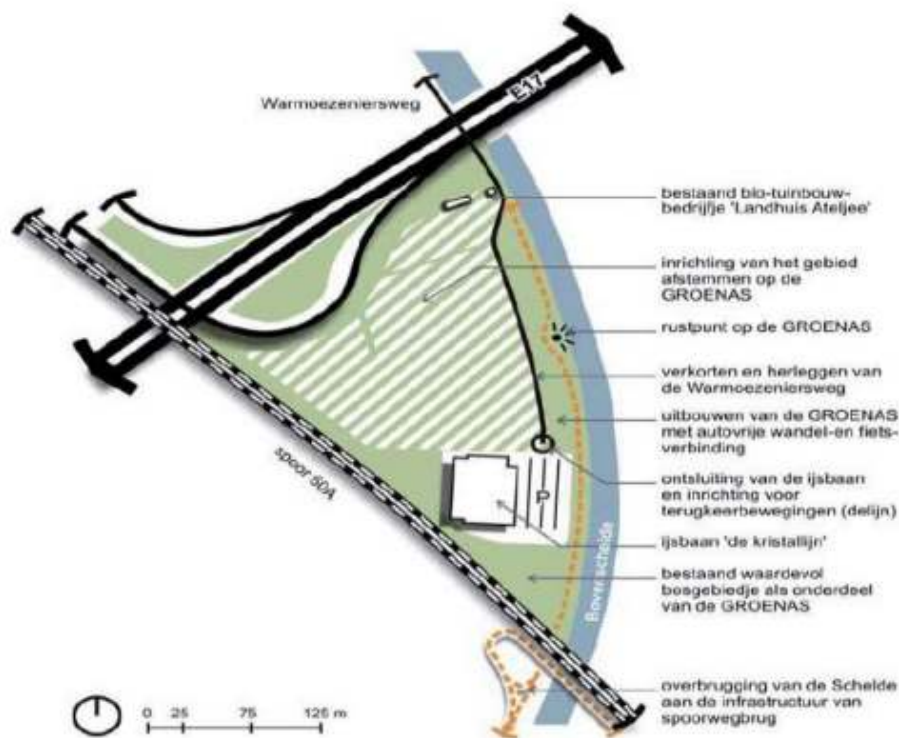


Figure is for illustration purposes.

Action 5.14: Gentbrugse Meersen - Gentbrugge

The Gentbrugse Meersen area - one out of four green hubs (five if you count Bourgoyen-Ossemeersen, Park Halfweg - Blaarmeersen – Snepemeersen) - emphasizes natural development. This is the most open of green hubs, its marshy nature (ca. 100 ha) is its defining characteristic. The projected woodland expansion (ca. 70 ha) will be situated primarily along the western building edge. The advantages for the City and for climate adaptation are numerous: green lung (fresh and filtered air), sponge effect, heat reduction.

The access area provides more active recreation as well as an extension to the allotment gardens, and is already completed.



SPACE FOR WATER

Action 5.15: Reopening the Lower Scheldt – Inner City

Project Reopening the Lower Scheldt is about restoring the visibility of this historic waterway between the Portus Ganda marina and François Laurentplein. The Lower Scheldt was vaulted over years ago, and was mainly used as an above-ground parking area. It is set to become a quiet waterway with banks for pedestrians and cyclists. The opening up of the Lower Scheldt is an example project regarding space for water in the city. Following the construction of the Scaldis lock in 2012 and the reconstruction of the quays in 2013, October 2016 will see the start of works to open up the waterway along Reep and Bisdomkaai.

Action 5.16: Reconstruction of Baudelohof - Inner city

The existing neighbourhood park Baudelohof is being redesigned and expanded (Bibliotheekstraat, Baudelokaai). The reconstruction explicitly involves increased accessibility to the adjacent water. Other climate-adaptive measures include the removal of surface hardening (reduction of the number of parking spaces); expansion of the park (more greenery); construction of a dry ditch for the drainage of (public) pathways (sponge effect of the city). Slow traffic is also promoted (improvement of bicycle paths and reduction of parking spaces).

Action 5.17: Revaluation of De Lieve, realization of natural stepping stones

The revaluation of De Lieve comprises ecological recovery, the (re)design, and the management of the waterway. Along De Lieve, various stepping stones are being realized with emphasis on natural development and greenery in the city. A number of stepping stones have already been completed (including Bloemekenspark, Pakketbootstraat). The coming years will see work continue on Ter Durme park.

Action 5.18: Sustainable Drainage Systems (SuDS) in Van Ooteghemstraat and Noendries

Wherever possible, the City is seeking to construct SuDS within the public domain as well. These SuDS provide a temporary buffer for rainwater and also allow the water to infiltrate. At the same time they illustrate the importance of careful treatment of rainwater and potentially make climate

change a bit more tangible. Over the coming years, SuDS will be introduced into a number of projects: Van Ooteghemstraat (2017), Noendries (2018/2019). We want to be considerate in our efforts, build up knowledge regarding the design of SuDS, wherever necessary learn from mistakes, and drive optimization. We want to learn from these projects on the topic of management as well. The key research themes are follow-up of sustained correct performance (including infiltration) and of quality (outlook, control, litter, ...), clear management agreements. Allotment projects including SuDS can be followed up in this manner as well.

BUSINESS PARKS

Action 5.19: Climate-robust development of the Wiedauwkaai business park

The City of Ghent, urban development company sogent, and Belgian railway company NMBS are set to further develop the Wiedauwkaai business park over the coming years. An area of 14.5 ha is being (re)designed as a high-quality and sustainable business park for SMEs with plot sizes ranging from 1,000 to 5,000 m². In accordance with the Farys allotment directive, the infiltration and buffering facilities for public roads are amply sized as an extra precaution in order to compensate for 50% of private roofs and hardened surfaces as well. These facilities take the form of SuDS and open ditches along the roads. Also relevant is the fact that, next to the new business park, space is being created for a green 4.5 ha bicycle and pedestrian axis along the Lieve. This allows for professional activities to take place in a green and pleasant environment.

Action 5.20: Climate-robust development of the Eiland Zwijnaarde business park

Over the coming years, regional business park Eiland Zwijnaarde will be developed by NV Eiland Zwijnaarde (sogent, provincial development company East Flanders, PMV, Alinso) and Waterwegen en Zeekanaal NV (W&Z). The area covers about 35 ha and is being designed as a sustainable business park for offices and laboratories used by knowledge companies (research activities) and mixed companies (waterbound logistics). Largely public and high-quality landscaping are part of the design choice for the area, including a natural 11 ha bank along the tidal section of the Scheldt, green corridors, and the creation of a landscape hill with a viewpoint. An encapsulated polluted zone is located underneath the site, making infiltration all but impossible. However, rainwater drainage is visibly slowed among others via ponds in the bank section.

CITY RENEWAL AND DEVELOPMENT PROJECTS

Action 5.21: Climate-robust development Houtdok site - Old Docks

A new neighbourhood park will be constructed at the Houtdok site (Koopvaardijlaan) as part of the city development project Old Docks. Construction will be carried out according to the principles of Harmonious Park and Greenery Management. A ventilation study was conducted based on the park design, researching the influence of various vegetation configurations on the cooling effect of the open water in the nearby docks (see applied study efforts under pillar 3). Climate-adaptive measures are: drastic reduction of hardened surfaces (about 1.3 ha); entirely new park/green zone; large

numbers of new trees; creation of marsh area; reuse of rainwater; dry ditch/wood edge with potential buffering action; sponge effect; development of green-blue network in the city.

Action 5.22: Charting climate opportunities in ongoing co-creative city renewal project

Muide Meulestede

A group of neighbourhood residents is joining Ghent in thinking about the future of the neighbourhood, searching answers to the key challenges (mobility, greenery, social fabric, stores, residential projects, ...). This reflection is dubbed 'concept study Muide Meulestede Tomorrow'. Engineering offices Ndvr and Architecture Workroom are coaching the study. At the direction of the Environmental and Climate Service and in consultation with the residential group from Muide-Meulestede, the project coordinator has opted to, in addition to the 3 already defined programmes, implement a 4th programme pertaining to climate, with the goal of making the neighbourhood more sustainable, climate-robust, food friendly, and pleasant as this addresses a number of concerns and ideas that have already been brought up by the neighbourhood.

The engineering office will now use the input from the residents to outline an overview of possible projects within a climate programme. These will then be discussed with the Environmental and Climate Service regarding their feasibility and complementarity with existing initiatives; supplementation with other projects is also possible (in consultation with the residents).

CITY REAL ESTATE

Lastly, at the building level we can also get to work and lead by example by renovating and developing our own city real estate in a climate-robust fashion. A number of example projects

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Action 5.23: Example projects façade greenery

1° Green outdoor space city building Old Docks: Along the Schipperskaai, sogent is erecting a public building with childcare centre, elementary school, after-school childcare, and neighbourhood sports centre. Keeping the building highly compact creates an area for a large 'outdoor space', an enormous pergola where various outdoor spaces are stacked. The steel frame is covered with a metal mesh onto which climbing plants can grow. Advice on plants is gained from prof. Hermy, expert on façade greenery at the KU Leuven university, division of Forest, Nature, and Landscape. Rainwater falling onto the playgrounds will be reused to naturally irrigate the climbing plants. Efforts are being made to figure out how to create a water curtain to water the plants.

2° Parking structure Ledeberg: along the Hundelgemsesteenweg in Ledeberg, an above-ground parking structure will be constructed with 500 spaces spread over 5 levels and a roof. The eastern façade along the Hundelgemsesteenweg will become a green façade with a mixture of soil-bound climbing plants that attach to stainless steel façade nets. The ground level will be covered with a water-permeable half-hardened surface without concrete slab, with ample openings around the existing trees that can be preserved (including 5 high-trunk horse chestnut trees).

3° AC Zuid: A public contract was issued for the renovation of city buildings at the Zuid site (AC Zuid and library). The Environmental and Climate Service and the department of facility management put forth AC Zuid as a possible location for the creation of a green façade (preferably soil-bound greenery). This topic is to be incorporated into the negotiation phase with the tenderers.



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Action 5.24: Extra water storage green roof De Klavertjes – Nieuw-Gent

The school *De Klavertjes*, Moutstraat 50, is being renovated, including the roof. Out of the total roof surface, 585 m² is set aside as green roof. However, 2 different types of green roof will be applied:

- 123 m² (bicycle storage and awning) will feature pre-grown plant trays with water reserve, increasing the water-buffering capacity of the green roof to 50 l/m². Part of the roof will feature an increased substrate height (up to 8 cm) for semi-intensive growth.
- 462 m² (part of the main building) will feature a hydroactive green roof, with enhanced water-storage capacity (100 l/m²) and water-storage technology. This roof will buffer water for some duration, and then follow up with controlled drainage towards the infiltration facility (about 2.5 days of drainage time from the hydroactive roof after heavy rainfall, versus a couple of hours in case of a conventional saturated green roof). The real-time input/output information for this hydroactive green roof is digitally monitored and wirelessly available for follow-up.



Image hydroactive green roof module

Action 5.25: Combination green roofs - rainwater recuperation in Jenaplan school De Kleurdoos - Ledeberg

The roofs of Jenaplan school De Kleurdoos (Onderwijsstraat 10) were already partly renovated in 2015. 2016 will see the renovation of one of the two playgrounds, the sanitary building, and the rest of the roofs. The playground will be designed as a green and adventurous playground with minimal surface hardening. The roofs will become green roofs. As the school has a high demand for water (300 pupils in kindergarden + elementary school), the school will also switch to the use of rainwater.

The rainwater drained from the green roof will be purified and used for flushing toilets. The school will look into using biological filtration instead of active carbon filtration.

Action 5.26: Building project elementary school De Zonnepoort - *Inner city*

On top of the legal requirements pertaining to the catchment, reusage, and buffering of rainwater (infiltration is not allowed there), passive construction project De Zonnepoort (Sint-Lievenspoortstraat) also incorporates a number of climate adaptation measures, such as

- Roofs are either green roofs or white roofs with high SRI (solar reflection index). 375 m² of green roof will be constructed, these are all flat roofs wherever possible (and realistic in terms of cost / orientation). By definition, a significant level of water buffering is provided by the makeup of these green roofs, exceeding legal requirements.
- The green roofs will be partly accessible, including greenhouse and flower beds for gardening on the roof.
- The site will gain unhardened surface area, albeit limited in terms of green value (= play area) and surface as part of the site also serves as parking space and manoeuvring space for buses (pupil transportation).
- Three trees will be provided on the playground (in front of the southern façade) to replace the one existing tree that is to be removed.
- The necessary exterior sunscreens will be provided to avoid overheating of the classrooms in the southern and western façades.
- The surface of the playground will be covered with grey, water-permeable concrete, and not black asphalt.
- The building itself is light grey, providing a higher light yield in narrow passages and the playground.

Action 5.27: Climate-robust design for elementary school Henri D’Haese – *Oud-Gentbrugge*

The goal is to create a new, climate-robust design.

Elementary school Henri D’Haese (Tweekapellenstraat) will see 3 existing volumes demolished and replaced with new construction. These 3 new parts are located along the street and in the corners of the existing playground. The goal is to create a climate-robust design for these 3 new parts. In addition to measures regarding water management, including green roofs, there are opportunities to work with green façades and materials with a high Solar Reflectance Index (SRI).

Any new theme requires awareness raising. Pillar 4.1 deals with internal communication and awareness raising, i.e. the political level and city administration. In addition, efforts must also be made towards an external communication strategy towards Ghent residents, businesses, professionals such as project developers, contractors, ... Robust communication will raise awareness regarding climate adaptation, and create a support base for the importance of measures for climate adaptation. This showcases the commitment of the City of Ghent. It also enhances the population's adaptability: a well-informed citizen can prepare for things like heat waves or water nuisance. Moreover, this can also motivate people to act, to take and shape personal responsibility, and to help build a climate-robust city.

The communication strategy for climate adaptation requires the following focal points:

- The message must be conveyed in a **positive manner**; communicating the severity of the issue, but steering clear from doomsday rhetoric. Focus must be placed on solutions, on the fact that we *can* prepare for climate change. Climate adaptation must be translated into the consequences and gains regarding health, safety, and liveability. Indeed, the core message for climate adaptation is for Ghent to remain a pleasant, safe, green, healthy city.
- The message must be conveyed as **specifically** as possible. This can be done by using specific examples showing what climate adaptation means in practice, and concrete actions, showing what the city is doing and what others can do themselves. The visibility of example projects must be enhanced, and the connection with climate adaptation must be clarified.
- Climate adaptation can also be specified by adapting communication to suit people's **own experiences**, such as heavy rainfall flooding people's gardens, or heat waves affecting everyone. Such extreme conditions can be used as concrete reasons to communicate on the matter of climate adaptation. It is important to be prepared and have communication at the ready (e.g. press release in the case of flood risks or heat waves) in order to update on current events at such times, e.g. via the City's social media.
- Always maintain the **nuance** that the City of Ghent is committed to being prepared for climate change, but that it is impossible to prevent all future events from having a certain impact. Indeed, a climate-robust city may still suffer flooded streets or gardens in case of very heavy rainfall. Climate adaptation also means that everyone is aware that extreme events may occur, and that people are prepared.

- Deliberate use of **terminology** on climate adaptation is important: for general communication it is not necessary to focus on the distinction between mitigation and adaptation³⁵ as this is often confusing. However, the use of terms such as "climate adaptation" and "climate-robust" can indeed have an added value for communication aimed at policy officers, experts, and professionals. The term 'climate adaptation' is used only for certain target groups.
- Climate adaptation must be further integrated into the **Ghent Climate City narrative**: after all, this is a very robust, existing brand. For the residents of Ghent, this is their information source for all things climate, aimed specifically at motivating them to spring into action for the climate; measures benefiting both mitigation and adaptation. Actions towards a climate-robust city are consequently framed within the communication strategy of Ghent Climate City.
- Communication on adaptation must also **be integrated into existing communication by the City of Ghent** regarding living and renovating in Ghent (Housing Service, Environmental and Climate Service, Urban Development and Spatial Planning Service, Monument Conservation), regarding city green (Parks and Public Gardens Service), regarding the construction of the public domain (Roads, Bridges and Waterways Service) and the spatial structural vision 'Room for Ghent' (Urban Development and Spatial Planning Service). It is also relevant to include climate adaptation in concrete projects such as city renewal and development projects (Old Docks, Muide Meulestede Tomorrow, Sint-Aamandsberg En Route) for which integrated communication is being carried out.
- The communication strategy for climate adaptation must be aimed at a **broad range of target groups**, such as the citizens of Ghent, households with children, schools, care institutions, builders and renovators, contractors and architects, gardeners, project developers, businesses, ...
It would be beneficial to use campaigns and activities to develop an offering for the different target groups and the various levels, from awareness to final behavioural change.

A number of products were already developed, and information sources utilized to communicate on climate adaptation:

- **Magazine "Ghent Climate City: Fall in love with a high-energy city"** (the climate booklet) including 8 pages on climate adaptation. This is an inspiring and accessible magazine that visually and clearly outlines the various themes behind Ghent Climate City (energy-efficient housing, mobility, sustainable food, sustainable business, and climate adaptation). It is packed with inspiring examples, projects, and ideas on what goes on in Ghent Climate City. It

³⁵ Mitigation comprises efforts to reduce the emission of CO₂ and other greenhouse gases with the intention of keeping climate change as limited as possible (it is no longer possible to stop it entirely). Adaptation means to adapt to the climate change that is sure to come in order to limit the negative effects as much as possible.

was a limited-edition print on stone paper, digitally available in Dutch at <https://klimaat.stad.gent/nl/online-klimaatboekje>.

- Under the tab “adaptation”, the **website** www.klimaatstad.gent contains concrete information, examples, and actions regarding climate adaptation.
- Two images were designed specifically for the **Ghent Climate City image campaign**, one on water nuisance and one on heat stress.

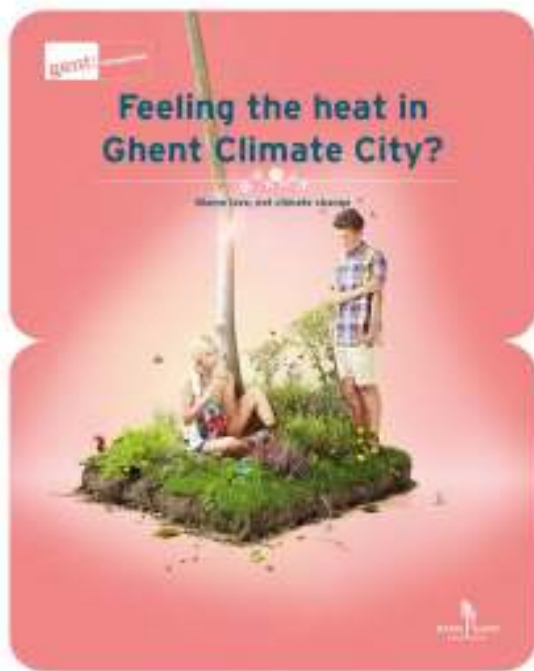


Figure 13. Campaign image on heat stress



Figure 14. Campaign image on water nuisance

- Two **video clips** were made that explain in an accessible manner what climate adaptation means. The first clip³⁶ has Maxim De Winne (a local actor) as the central character, and focuses on what citizens themselves can undertake. The second clip³⁷ is an animated short, and primarily focuses on what a climate-robust Ghent could look like and what initiatives the City of Ghent is undertaking. The video clips were distributed via social media, during presentations, ... and were always received very positively.

Surveys show that the developed products convey the message and have an inspiring effect. Their use can certainly be continued.

The afore-mentioned products mainly communicate a strategic narrative: what is climate adaptation, where do we want to go with a climate-robust city, how do we approach this, ... with the main goal of generating a support base for the climate adaptation policy of the City of Ghent. This way, citizens can understand why for instance a choice was made to eliminate parking spaces and replace them with street trees or ditches instead, why we seek to limit surface hardening, why we wish to catch

³⁶ <https://klimaat.stad.gent/nl/klimaatverandering-gent-tips-van-maxime-de-winne>

³⁷ <https://klimaat.stad.gent/nl/gent-bereidt-zich-voor-op-onvermijdelijke-klimaatverandering>

rainwater and use it in a useful manner. Or why the City of Ghent expects flat roofs to be used in a useful manner, for the catchment of rainwater or as a green roof.

In addition, more activating initiatives will be undertaken. Concrete examples are the approach regarding

- **Façade gardens:** The licensing requirement was removed in 2014, anyone may create a façade garden simply by notifying Gentinfo and respecting the conditions regarding dimensions and plants. A campaign on façade gardens, the offer of free information events for residential groups by the Parks and Public Gardens Service, and the systematic resident letters sent out by the Roads, Bridges and Waterways Service calling for citizens to use the opportunity afforded by the reconstruction of street and/or footpaths to create façade gardens, have ensured that over the past two years (1/4/2014 – 1/4/2016), 754 additional façade gardens have been created by Ghent residents.
- **Green roofs:** Through the use of a subsidy (up to 31 €/m²)³⁸, Ghent residents, businesses, and social housing companies are stimulated to create green roofs both onto existing and new flat roofs. Since 2002, 54,640 m² of new green roof surfaces have been created in Ghent in this manner. In addition to the green roof subsidy, May 2015 saw the opening of the green roof wagon in Voorhaven, showing in an accessible manner by means of an old freight wagon what a green roof with a diversified plant and shrubbery range and extensive water-buffering capacity can look like.

EXTERNAL COMMUNICATION

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As of 2016, a budget of 20,000 € per year is earmarked from the available budget for climate adaptation for communication and awareness raising. The following actions have been planned:

Action 6.1: Continuation of the already existing communication products

The climate booklet will be reprinted (with an update of its contents and layout), allowing for greater distribution. Indeed, indications show that this booklet is a successful promotional tool, with an interesting collection of initiatives and examples, and that many (be they colleagues, citizens, or professionals) are interested in owning a copy. We are also looking into an evening information event to tie in with the climate booklet.

The climate adaptation clips will be further distributed via the City of Ghent's social media, at events, and via TV screens in the waiting rooms of service centres and other locations of the City of Ghent.

Action 6.2: Integration of climate adaptation into the Energy Centre

The theme of climate adaptation is also specifically incorporated into the specifications for a new service provision assignment regarding sustainable renovation. This way, citizens may seek

³⁸ For more information, see <https://stad.gent/natuur-milieu/producten/subsidie-voor-het-aanleggen-van-een-groendak>

information from the Energy Centre regarding renovations whereby measures for climate adaptation are undertaken. Initially the focus lies with the catchment, reusage, and infiltration of rainwater, and the creation of green roofs. Possibly, attention may be given to green façades, shadow infrastructure, the use of lightly-coloured materials, ...

Action 6.3: Communication with the launch of the Ghent Climate Adaptation Plan

The Ghent climate adaptation plan will be officially launched after approval by the city council and submission to the EU. In addition to standard communication via press release, website, city magazine, ... efforts will be made to also “translate” the climate adaptation strategy and action plan for the general public. It is important to convey an eminently human, concrete narrative. The existing products (including video clips and climate booklet) can be used for this purpose.

Action 6.4: Communication regarding ‘Room for Ghent’

Climate adaptation is one of the pillars of ‘Room for Ghent’ and is incorporated into communication regarding ‘Room for Ghent’. ‘Room for Ghent’, and more specifically the climate challenge, are also brought to the fore at the exhibition at STAM regarding ‘the City of tomorrow’ (autumn of 2016). A number of video clips portray the five key spatial challenges for the coming years. Climate adaptation is one of these challenges that require a spatial solution.

Action 6.5: Promoting green roofs

The green roof wagon is located in Voorhaven, near former warehouse 21. It is freely accessible, and demonstrates what a green roof with additional water buffering capacity and a diversified range of grasses, herbs, shrubs, and even small trees can look like. An information event will be held for professionals such as contractors and architects on the creation of green roofs. In conjunction with the programme/neighbourhood directors for Muide Meulestede (Tomorrow), a workshop can also be organized in the neighbourhood during the activities for interested (local) residents, whereby the various green roof systems are explained, and it can be shown how residents themselves can get to work. Any group of residents gathering at least 15 interested persons can apply for such a workshop afterwards. Focus is also placed on a broader communication of the existing subsidy regulations for green roofs, including the possible changes to the regulations.

Action 6.6: Communication directed at schools

Schools are put forth as a highly relevant target group for communication and awareness raising on climate adaptation. Tools used include the various existing information sources and projects relating to schools.

- Many elementary schools in Ghent take part in the GRAS project (green and active playgrounds)³⁹ whereby the significantly hardened playgrounds are transformed into more natural and adventurous play areas. This intervention also contributes to climate

³⁹ In Ghent, 87% of city schools, 80% of community schools, 44% of Catholic schools, and 50% of VLOM schools (2/4) take part in the GRAS project. More information at <https://stad.gent/producten/subsidie-voor-het-aanleggen-van-een-groene-en-avontuurlijke-speelplaats>

adaptation by removing surface hardening and greening the urban environment. It is therefore interesting to utilize this action to inform both teachers and children in a specific and fun manner on climate adaptation.

- Communication directed at (GRAS) schools has the added benefit of reaching parents as well. Children are effective ambassadors in getting the climate message to the parents. In addition, many parents are actively involved in the GRAS project of their children's school. This is an opportunity not only to inform these parents on climate adaptation in general and the added value of greening the school playground, but also to establish the link with the parents' own backyard, and to point out the importance of limited surface hardening there as well (front yards, driveways, terraces), to safeguard sufficient unhardened space where rainwater can permeate into the soil, and to provide sufficient shading. For specific advice, they can be referred to the Energy Centre.
- The climate education range offered by the Environmental and Climate Service, such as Ghent 2050 -The Game, Climate Kids, Climate Schools, Gardening at school, ... clarifies the link with climate adaptation, and further reinforces this link where needed. We also look at the communication method and products that can be used to best raise awareness among young people in secondary education.
- Climate-related communication and education by the Department of Facility Management directed at city schools will establish a connection with climate adaptation through energy-saving measures, rainwater reusage, and the creation of green roofs.
- Additionally, an educational programme will be held along with the example projects in support of reconstruction for city schools (see actions 5.20 up to and including 5.23), in consultation with the relevant city services and schools. Focus will lie with years 5 and 6 (Flemish elementary school system).

Action 6.7: Actions regarding the removal of surface hardening on private property

One of the most vital measures regarding climate adaptation is the reduction of sealed soil and of the petrification of the city. This is important to tackle the issues of heat, water nuisance, and desiccation. The City of Ghent is undertaking measures for the public domain, but the private domain is also relevant, requiring improvement as well. We wish to raise awareness on this topic among the involved households and professionals of Ghent with a major event, allowing them to chip in, or rather chip away at the pavement...

Possible initiatives are

- "The Great Ghent Breakout": a community event along the lines of "*Gentsche Gruute kuis*" ("great Ghent cleaning") whereby participants are given the equipment and containers in order to jointly break out unnecessary surface hardening in people's own (front) yards under the slogan "Chip in by chipping away".
- Availability of a number of inspiring designs for rain-friendly (city) gardens, through collaboration with garden designers who were asked to create a design for an urban context. This also includes a specific range with designs for de-hardening front yards. Perhaps a number of recognizable partners can be found (famous designers, TV personalities, garden shops, ...). The different designs are explained at a workshop. Examples can be shown during open garden days.
- Information campaign directed at landscapers, tile companies, contractors, ... on the importance of limiting surface hardening (terraces and the like) and the possibilities of water-permeable surface hardening.

- In addition to consultancy regarding climate adaptation measures for renovations (see action 6.2), an unburdening range could be developed – in the vein of energy-efficient renovation – for the de-hardening of front yards when the streets are under reconstruction.

Action 6.8: Raising awareness on the importance of ditches and their maintenance

Ditches are a crucial part of the urban water system, especially in the peripheral area. Indeed, they drain excess rainwater and thus prevent water nuisance. Contrary to hardened infrastructure such as sewers or canals, ditches have a natural form factor, which provides the added benefit of slowing down the drainage of water and allowing the water to partially infiltrate, in turn supplementing the groundwater table.

The local building regulations provide that it is forbidden for waterways of the third category, unclassified waterways and ditches to be wholly or partially filled in, to be covered in materials that hinder infiltration, or to have their flow profile altered. The Province, the City, Polders en Wateringen, or adjoining landowners are responsible for the maintenance of ditches, depending on their classification and location. An initiative is underway whereby the latter are informed on the importance of ditches, and on the regulations and approach to maintenance. Research will be conducted into the possibilities for unburdening adjoining landowners who are having difficulty honouring their maintenance obligation (e.g. where they can turn for help).

Action 6.9: Promoting green garlands

After the realization of the trial project in the Brandstraat (see action 5.10), a positive result will lead to the promotion among residents of green garlands (street greenery made up of climbing plants that are suspended between two façades and provide greenery and shading). The idea is for residents to suspend their own cable. Technical specifications will be incorporated into IPOD IV (Integral Plan Public Domain) (see action 4.11).

Action 6.10: Informing construction professionals such as project developers, architects, contractors, ...

Construction professionals such as project developers, architects, contractors, ... play a significant role in giving shape to our city, through both large new developments and smaller construction and renovation projects (including the public/private collaboration 'schools of tomorrow'). This target group must also be involved, informed, and made aware in order to turn Ghent into a climate-robust city. This can be done by creating a customized brochure with tips on climate-robust design and construction (rainwater catchment and reusage, rainwater infiltration and buffering, green roofs, green façades, shadow infrastructure, flood-safe building, ...). Workshops or lectures at seminars, fairs, ... are also possible.

Informing the professional target group is important as this effort has a ripple effect; the professionals inform the citizens and other constructors.

The building professionals are already being approached by the Urban Development and Spatial Planning Service, the Housing Service, the Environmental and Climate Service, and the Building Projects Service. The information on climate adaptation is incorporated.

Action 6.11: Climate adaptation bicycle tour

As more and more example projects on climate adaptation are realized, a themed bicycle tour will be organized along major and minor examples of climate adaptation in the city. This bicycle tour can be offered on a number of dates with guides, but can also be permanently offered via the website and perhaps a future *app* to be developed.

HIGHER AUTHORITIES

A city regional approach is certainly relevant, but pertains to a supralocal authority. The City of Ghent strongly believes that the local level can and must play a significant role in climate adaptation. Local policy has key instruments to address this topic. One crucial element is of course also policy upheld by higher authorities, and the interaction between local and higher policies. The higher authorities must assume their roles and provide the requisite instruments and support. Indeed, the provincial and Flemish levels are key partners on the theme of water nuisance as they control and manage a large part of the waterways of Ghent. Also as pertains to the realization of green hubs and the development of a city regional approach to climate adaptation, the provincial and Flemish levels have a significant role to play. In this sense, the intention is to enter into active discussions with the higher authorities, and to search for synergies and leverage to come to a solution-driven approach.

Province of East Flanders

- 2012 saw the creation of the Climate Effect Sketchbook for West and East Flanders⁴⁰, whereby the possible consequences of climate change (water nuisance, water shortage, rising sea levels, and salinization) for spatial functions were charted.
- September 2015 saw the approval of the provincial climate plan⁴¹. In addition to measures for reducing the emission of greenhouse gases, this plan also contains actions for the maximum mitigation of the negative effects of climate change, such as flooding, drought, erosion, etc.
- In 2016, the province of East Flanders is researching how municipalities can best be supported in developing their climate adaptation strategy.

Flemish Government

- The Department of Environment, Nature, and Energy (LNE) is spearheading the Flemish adaptation policy, and is a key player for national adaptation policy (see paragraph 1.1 Flemish context for an overview of study efforts and policy plans).

⁴⁰ http://www.west-vlaanderen.be/kwaliteit/Leefomgeving/milieu/energie/Documents/klimaateffectschetsboek%20west-%20en%20oost-vlaanderen_def.pdf

⁴¹ <http://kg.loket-oost-vlaanderen.be/wp-content/uploads/2015/09/klimaatplan-Oost-Vlaanderen-klimaatgezond.pdf>

- The LNE's department of climate adaptation is coordinating the pilot group containing the Flemish cities whose mayors signed the *Mayors Adapt* covenant in 2014. In addition to Ghent, the group also consists of Antwerp, Leuven, Kortrijk, Hasselt, Zwijndrecht, and the Province of Antwerp. LNE wishes to support this pilot group in developing a climate adaptation strategy and action plans. At the moment efforts are underway to provide a Flemish working tool in support of the creation of local adaptation plans.
- Flemish Environment Agency (VMM) is coordinating climate reporting, whereby the observed trends and future scenarios of climate change in Flanders are analysed (see paragraph 2.1 for the 2015 MIRA climate report).
- Waterwegen en Zeekanaal NV (W&Z) and the Flemish Environment Agency (VMM) are the waterway managers for the navigable waterways and the unnavigable waterways of the first category respectively, and are also responsible for the development of the flood risk management plan (ORBP).
- The Nature and Forest department (ANB) is a key partner for the realization of green hubs.
- *Ruimte Vlaanderen* is a key partner for (metropolitan) spatial structure and building permit policy.

Federal Government

- There is a federal Climate Change service⁴². The focal point of federal climate policy lies with the prevention of climate change (climate mitigation), among others through the accomplishment of Belgian reduction goals within the framework of the Kyoto protocol, European climate commitments, and international climate summits (COP). In addition, federal climate adaptation policy is laid out. One of the objectives is to develop a federal knowledge centre for climate.
- Thanks to their monitoring network for various climatological parameters (with series of readings since 1830), the Belgian royal meteorological institute (KMI) has gathered valuable information on climate change in Belgium. They also conduct (model-based) research in this area.

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EUROPE

In addition to spearheading the European Covenant of Mayors for climate mitigation and adaptation, the European authorities are also a key partner in the exchange and financing of knowledge. Indeed, the European Environment Agency⁴³ plays a significant role in disclosing data and insights on climate change in Europe.

At the moment, Ghent is a partner to the European subsidy dossiers BEGIN and RESIN:

⁴² www.klimaat.be

⁴³ <http://www.eea.europa.eu/>

Action 7.1: Participation in the European BEGIN project

The City of Ghent is a partner to the European Interreg North Sea region project BEGIN. BEGIN stands for Blue Green Infrastructure and Social Innovation. Approval of this subsidy project will boost the further realization of green axis 4 (following the Upper Scheldt south from the city centre) thanks to the assignment of a project coordinator, a budget for external expertise, and investments. A key element of this case for the BEGIN project is the focus on involving the various stakeholders such as W&Z, IVAGO, University of Ghent, businesses, project developers, residents along the axis, ...

Action 7.2: Participation in the European RESIN project

The City of Ghent is taking part in the European Horizon 2020 RESIN project (Climate Resilient Cities and Infrastructures). We are a “tier 2” city, next to “tier 1” cities Bratislava, Manchester, Paris, and Bilbao. As a tier 2 city, we become a privileged partner to the planned exchange of knowledge, with the opportunity of being the first to have access to the newly developed methodologies, tools for vulnerability analyses, information on the effectiveness of urban adaptation measures, ... and face-to-face training on how to work with all of the above.

KNOWLEDGE INSTITUTIONS

Knowledge institutions can have a role to play in innovative research on climate adaptation. Here too, partnerships are a must.

- University of Ghent and other institutions of higher education are key partners in the framework of knowledge build-up regarding climate change, the consequences thereof for cities, and possible measures. Indeed, the Department of Physics & Astronomy at UGent is developing a monitoring network in Ghent for the analysis of the urban heat island effect (see action 2.1). In addition, UGent also has its own climate policy, and through its extensive patrimony in Ghent also constitutes a key stakeholder in the pursuit of developing a climate-robust city in practice (de-hardening, greening, rainwater recuperation, etc...)
- The Urban Climate Service Center⁴⁴ by the Flemish institution for technological research (VITO) is an initiative that supplies urban climate information and services, specifically to help cities develop and monitor their climate adaptation strategies.
- The Flanders Climate Adaptation think tank (DKA) mobilizes the knowledge and concrete cases regarding adaptation in Flanders from four different domains of our society; authorities, businesses, knowledge and societal institutions. Coordination is provided by the Department of Mobility and Spatial Planning at UGent. The think tank specifically seeks to focus on the following aspects with the City of Ghent and the other involved parties (Port Company, businesses, Province of East Flanders, ...):
 1. To create a platform for Port Company and port-related companies to stimulate the realization of green roofs and de-hardening

⁴⁴ <https://vito.be/nl/landgebruik/duurzame-steden/urban-climate-services>

2. Research into the health aspect that constitutes a bottleneck in the implementation of cooling fun water elements in the city
 3. Research into the manner in which SIPs can be flexibly implemented for climate adaptation
- The Cleantech Cluster Region of Ghent is a partnership between the City of Ghent, the Ghent Port Company, the University of Ghent, the Province of East Flanders, Provincial Development Company East Flanders (POM) and i-Cleantech Flanders with the ambition of turning the region of Ghent into a shining example of a resilient and active cleantech ecosystem by 2030. The key elements are sustainable usage of energy, materials, water, and sustainable mobility. Particularly regarding the water theme, the development and visible implementation of clean technology within the urban fabric contribute to climate adaptation.

LOCAL STAKEHOLDERS

Rendering the system of waterways, sewers, and public space climate-robust and maintaining it is a duty and responsibility of authorities. However, climate adaptation also requires cooperation with other parties. Because adaptation takes place in the urban space, residents, businesses, project developers, knowledge institutions, care institutions, interest groups, ... can also participate and positively contribute to climate proofing Ghent, in addition to the city itself. By external local stakeholders we mean everyone who has a role to play in Ghent. In addition to its framing role, the city has a facilitating and stimulating role to play.

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What we do regarding citizens, and regarding (construction) professionals on a related note, has been included under pillar 4.6 external communication. In addition, it is also relevant to take a look at the following external local stakeholders

- **Active midfield**
To boost the city's resilience, a great deal of expertise and ideas can be found among the active midfield (residential groups, citizen initiatives, themed action groups, terrain management associations such as Natuurpunt, ...) with countless initiatives including on the topics of urban agriculture, nature management, sharing, new entrepreneurs, green track, temporary implementation, etc. In addition to a relevant information source for various groups, we also wish to actively involve them in reflecting on the goals, the development of projects, ...
- **Project developers**
Project developers are further stimulated, via instruments such as the sustainability meter, and more explicitly through the issuance policy for projects, to help build a climate-robust city. Project developers are certainly already undertaking initiatives in this regard. For instance, the Rinkkaai project (= Fabiolalaan zone C) will draw heat from grey water, which will after purification be used for toilet flushes. In the context of Schipperskaai project as

well, research will be conducted into reusing grey water as process water (following additional purification) at Christeys, in addition to heat recuperation.

- Businesses

Global warming is also increasingly affecting the corporate world. In addition to the fact that they can have a key role to play in buffering and catching water during heavy rainfall, in the afore-mentioned de-hardening, or in the selection of materials for surfacing ground, buildings, and roofs, climate change may also have an effect on their production capacity. This may include energy blackouts on hot days, introducing more cooling breaks for workers, no longer utilizing certain production lines, raising water-sensitive equipment off the ground, etc. On the other hand, climate adaptation also certainly has economic potential, with innovative materials and new techniques that can be marketed.

- Port company

Climate adaptation is a top priority for both the City of Ghent and the Port Company. By mutual consultation we wish to examine how to focus on developing the port area in a climate-robust manner. The intention is to safeguard the quality of life of the people living and working in and around the port, including under a changing climate. In this context, it is important to focus on the one hand on social aspects, such as approach to work schedules during heat waves, but also on spatial and structural measures, both in the context of heat stress (removing surface hardening, providing greenery, green roofs) and in the context of comprehensive water management (alternatives for the discharge of rainwater into the canal).

With the signing of the *Mayors Adapt* covenant, the City of Ghent is committed to monitoring and periodically evaluating our climate adaptation policy. *Mayors Adapt* has not yet indicated any directives on the indicators to be followed. A number of relevant indicators are listed below, part of which are already being annually monitored and evaluated for the city's own management and budget cycle. Follow-up implementation of the climate adaptation plan will take place within the Working Group on Climate Adaptation.

INDICATORS ON CLIMATE CHANGE AND VULNERABILITY

In addition to the climate-related parameters observed at the national and Flemish levels by KMI and VMM, the measurement data from Ghent's climate stations provide valuable input on local events regarding rainfall and heat. Calls regarding water nuisance recorded by the Fire Department and Farys are likewise of interest.

INDICATORS FOR THE CLIMATE ADAPTATION STRATEGY

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Proportion of covered soil

In 2015, AGIV drew up a covered soil map for Flanders by carrying out automated mapping of (un)covered surfaces among others based on digital aerial photos from 2012. A covered soil map (available in 1m and 5m resolutions), a sealed soil map (5m resolution), and a water permeability map (5m resolution) are all available. AGIV indicates its willingness to regularly update the maps (e.g. every 3 years). These map materials will be followed up and used to monitor our objective of limiting, and ultimately even reducing, any further surface hardening of the city.

In addition, the road information system (WIS) will serve as a basis for annual evaluations of the proportion of surface hardening (in aggregate figures and in percentage terms) that has been removed within the city-managed public domain thanks to the implemented projects.

Green in the city

The Parks and Public Gardens Service keeps various relevant green indicators, such as

- Locations and surface area of the neighbourhood parks and neighbourhood greenery
- Percentage of residents within a reasonable distance from public greenery
- Locations and surface area of façade greenery on public buildings/constructions
- Number of private façade gardens
- Proportion of natural areas with green function

- The quality of Ghent's street trees: the proportion of street trees with a circumference exceeding 1 metre compared to the total number of street trees
- Surface area (valuable and highly valuable) nature and woodland in Ghent (compared to total surface)

In addition, the Environmental and Climate Service keeps a record of the additional green roofs (m²) being created annually by means of subsidies. The green roofs that are created as a result of building regulations have not been structurally recorded as of yet. Efforts are underway to see whether the AGIV map materials can also be used to monitor the evolution of the green roof surface area within the framework of our goal to double the green roof surface area by 2020 compared to 2013.

Shading

One parameter of note could be the recording of the shadow proportion. For instance, what parts of the city have shade on 21 July at 12 noon thanks to tree crowns, buildings, or specific shadow infrastructure. Further research is necessary to review how this can be presented.

INDICATORS FOR THE 2016-2019 CLIMATE ADAPTATION ACTION PLAN

The implementation of the Climate Adaptation Action Plan will be monitored annually on the basis of the overview table in annex 1.

OVERVIEW OF CLIMATE ADAPTATION ACTIONS 2016-2019

An overview of the actions from this Climate Adaptation Plan, with the spearheading city service, the involved parties (internal/external), the provided timing and budget (excluding staff cost) if known.

GHENT CLIMATE ADAPTATION PLAN: ACTIONS PER PILLAR

		<u>Spearheaded by</u>	<u>Involved parties</u>	<u>Timing</u>	<u>Budget</u>
POLITICAL SUPPORT BASE AND BROADENING WITHIN THE CITY ORGANIZATION					
<i>POLITICAL SUPPORT BASE</i>					
1.1	Naming the ambition to be a climate-robust city in the following Ghent multi-annual plan	Cabinet of the deputy mayor for climate	Cabinets of the deputy mayors for city development, public greenery, public works, mobility, Environmental and Climate Service, Working Group on Climate Adaptation, Strategic	2018-2019	not applicable

1.2	Budgeting the management cost	Parks and Public Gardens Service, Roads, Bridges and Waterways Service, Building Projects Service, Department of Facility Management	Coordination Service Environmental and Climate Service, Urban Development and Spatial Planning Service, Coordination Service, Farys	2017-2019	internal operation
<i>BROADENING WITHIN THE CITY ORGANIZATION</i>					
1.3	Broadening operations around climate adaptation to include sogent, Mobility Company, Farys, and OCMW-Facility Management	Working Group on Climate Adaptation	sogent, Mobility Company, Farys	2016-2017	internal operation
1.4	Further development of the knowledge platform on climate adaptation	Environmental and Climate Service	Working Group on Climate Adaptation, Coordination Service, sogent, Farys	2016-2019	internal operation
1.5	Continuation of training initiatives for the city staff members in question	Environmental and Climate Service	Working Group on Climate Adaptation, Coordination Service, sogent, Farys, Career Counselling and Training Service	2017-2019	internal operation and/or budget in consultation with the Career Counselling and Training Service
1.6	Continuation of broad internal communication to all city staff members	Environmental and Climate Service	Working Group on Climate Adaptation, Communication Service, Sports Service	2017-2019	internal operation, supplemented with specific communication budget (see pillar 6)

KNOWLEDGE BUILD-UP ON CLIMATE EFFECTS AND VULNERABILITIES

KNOWLEDGE BUILD-UP ON HEAT STRESS

2.1	Development of a monitoring network for the analysis of the urban heat island effect in Ghent	University of Ghent	Environmental and Climate Service, Working Group on Climate Adaptation, Department of Facility Management-Real Estate Management, KMI	2016-2018	provided by UGent
2.2	Further collection and analysis of knowledge on heat stress and mitigating measures	Environmental and Climate Service	Working Group on Climate Adaptation	2016-2019	internal operation
KNOWLEDGE BUILD-UP ON WATER NUISANCE					
2.3	Further collection, disclosure, and analysis of available and relevant map materials pertaining to water nuisance	Roads, Bridges and Waterways Service	Environmental and Climate Service, Working Group on Climate Adaptation, Data and Information Service, Farys, VMM, W&Z	2016-2019	internal operation
2.4	Drawing up a vulnerability analysis on water nuisance	Environmental and Climate Service	Roads, Bridges and Waterways Service, Working Group on Climate Adaptation, Farys, VMM, W&Z	2016-2017	70,000 €
2.5	Development of a monitoring network for the analysis of precipitation patterns	Farys	Roads, Bridges and Waterways Service, Environmental and Climate Service, UGent	2016-2019	provided by Farys
2.6	Inventory of heavy storms, floods, and “water on the street”	Roads, Bridges and Waterways Service	Environmental and Climate Service, Fire Department, Farys, VMM, and W&Z	2016-2019	to be provided

2.7	Follow-up of study efforts and flood risk management plans by water authorities	Farys and the Roads, Bridges and Waterways Service	Environmental and Climate Service, W&Z, VMM, Province of East Flanders	2016-2018	internal operation
2.8	Disclosing knowledge on planned sewer projects	Roads, Bridges and Waterways Service	Farys, Environmental and Climate Service	2016	internal operation
2.9	Development of the sewer model	Farys and Aquafin	Roads, Bridges and Waterways Service, Environmental and Climate Service, Urban Development and Spatial Planning Service, Aquafin, KULeuven (Plurisk)	2017-2018	provided by Farys and Aquafin

KNOWLEDGE BUILD-UP ON DESICCATION

2.10	Drawing up a vulnerability analysis on desiccation and water shortage	Environmental and Climate Service	Roads, Bridges and Waterways Service, Parks and Public Gardens Service, Working Group on Climate Adaptation, Farys, VMM, W&Z	2017	50,000 €
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KNOWLEDGE BUILD-UP ON RISING SEA LEVELS

2.11	Collection of available information relevant to Ghent pertaining to the consequences of rising sea levels	Environmental and Climate Service	Roads, Bridges and Waterways Service, VMM, W&Z, Port Company	2018-2019	internal operation
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KNOWLEDGE BUILD-UP ON CLIMATE ADAPTATION MEASURES

APPLIED STUDIES

3.1	Active participation in user group from IWT VIS-programme 'Green Construction'	Environmental and Climate Service	Parks and Public Gardens Service, Building Projects Service Department of Facility Management, PCS,	2015-2019	4,000 €
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3.2	Studying Oostakker-Dorp: shadow study and research into possible water elements	Roads, Bridges and Waterways Service and the Parks and Public Gardens Service	WTCB Urban Development and Spatial Planning Service, Environmental and Climate Service, Data and Information Service, UGent	2016	internal operation
3.3	Framework contract for infiltration measurements	Environmental and Climate Service	Roads, Bridges and Waterways Service, Parks and Public ,Gardens Service, Urban Development and Spatial Planning Service, Coordination Service, sogent, Farys, Flemish Government (Database Underground Flanders)	2016	30,000 €
3.4	Research into potential spaces for green/blue	Urban Development and Spatial Planning Service	Mobility Company, Roads, Bridges and Waterways Service, Parks and Public Gardens Service, Environmental and Climate Service	2016-2017	internal operation
<i>PILOT PROJECTS</i>					
3.5	Pilot project 'Stockholm' model for tree pits	Roads, Bridges and Waterways Service and the Parks and Public Gardens Service	Farys	2016-2018	included in overall project budget
3.6	Pilot project Bioswale in Ankerslaan	Roads, Bridges and Waterways Service	Farys, Parks and Public Gardens Service	2018	included in overall project budget
3.7	Knowledge build-up on water-permeable surface	Roads, Bridges and	Environmental and Climate	2016-2018	partly included

	hardening by means of pilot project evaluation	Waterways Service	Service, Urban Development and Spatial Planning Service, Public Space Staff, Working Group on Climate Adaptation, Farys, Research Centre for Road Construction (OCW)		in overall project budget, to be partly discussed with OCW
	<i>DIFFUSION OF KNOWLEDGE ON CLIMATE ADAPTATION MEASURES</i>				
3.8	Translating knowledge from applied study efforts and pilot projects towards policy frameworks and elements for specifications	Working Group on Climate Adaptation	Coordination Service, sogent, Farys	2018-2019	to be provided
3.9	Diffusion of knowledge from pilot and example projects	Environmental and Climate Service	Working Group on Climate Adaptation, Coordination, sogent Service, Farys	2018-2019	to be provided
	<i>PRIORITIZATION AND SELECTING MEASURES</i>				
3.10	Follow-up of tools for cost/benefit analyses	Environmental and Climate Service	Working Group on Climate Adaptation, Coordination Service, sogent, Farys	2017-2018	internal operation
	INTEGRATION INTO CITY POLICY PLANS, INSTRUMENTS, AND PROCESSES				
	<i>POLICY PLANS</i>				
4.1	Further follow-up of the preparation of 'Room for Ghent'	Urban Development and Spatial Planning Service	Environmental and Climate Service, Parks and Public Gardens Service, Roads, Bridges and Waterways Service, Coordination Service, Mobility Company	2016-2017	internal operation
4.2	Drawing up a phased plan to prevent further soil sealing in	Urban Development and	Parks and Public Gardens	2016-2018	internal

	Ghent	Spatial Planning Service, Environmental and Climate Service	Service, Roads, Bridges and Waterways Service, Coordination Service		operation
4.3	Further follow-up of space pilots for 'Room for Ghent'	Policy Participation Service in collaboration with the Urban Development and Spatial Planning Service	Environmental and Climate Service, Parks and Public Gardens Service, Working Group on Climate Adaptation	2016-2017	internal operation
4.4	Drawing up a structural vision 'Underground'	Urban Development and Spatial Planning Service	Environmental and Climate Service, Roads, Bridges and Waterways Service, Parks and Public Gardens Service, Farys	2018	to be provided
4.5	Further follow-up of preparation of memo 'Water in the city'	Coordination Service	Roads, Bridges and Waterways Service, Environmental and Climate Service, Parks and Public Gardens Service, Urban Development and Spatial Planning Service, Mobility Company, W&Z	2016-2017	internal operation
4.6	Translating the green structural plan into climate and environmental goals	Parks and Public Gardens Service	Environmental and Climate Service, Urban Development and Spatial Planning Service, Roads, Bridges and Waterways Service	2009-2018	internal operation
4.7	Drawing up a manual with design conditions for air and climate greenery.	Parks and Public Gardens Service	Environmental and Climate Service, Working Group on Climate Adaptation	2018	internal operation
4.8	Climate-robust green structure, design, and management	Parks and Public Gardens		2016-2019	internal

		Service		operation	
URBAN INSTRUMENTS					
4.9	Developing a (spatial) toolbox to further de-harden (private) hardened surfaces	Environmental and Climate Service, Roads, Bridges and Waterways Service	Urban Development and Spatial Planning Service, Parks and Public Gardens Service, Mobility Company, Housing Service, Inspectorate for Living, Building and the Environment	2017-2018	internal operation
4.10	Optimization and subsidization of green roofs	Environmental and Climate Service	Economic and Entrepreneurial Support Service, Parks and Public Gardens Service	2016-2017	annual provision of 300,000 € for subsidization of green roofs
4.11	Continued focus on the subsidization of sustainable neighbourhoods for climate adaptation	Environmental and Climate Service	Urban Renewal Service, Policy Participation Service, Social Cohesion and Urban Well-Being Service, Parks and Public Gardens Service, Housing Service, project submitters, external jury members with expertise regarding the project theme	2016-2019	annual subsidy of 90,000 € provided
4.12	Drawing up IPOD IV (Integral Plan Public Domain)	Urban Development and Spatial Planning Service	Roads, Bridges and Waterways Service, Environmental and Climate Service, Parks and Public Gardens Service, engineering office	2016-2018	30,000 €
4.13	Optimization of the (usage of) instruments for the	Environmental and	Urban Development and	2016-2019	internal

	integration of climate adaptation in urban development	Climate Service	Spatial Planning Service, Coordination Service, Roads, Bridges and Waterways Service, Parks and Public Gardens Service, Mobility Company, sogent		operation
<i>URBAN PROCESSES</i>					
4.14	Evaluation of the climate-robustness of IKZ projects	Environmental and Climate Service	Roads, Bridges and Waterways Service, Urban Development and Spatial Planning Service, Parks and Public Gardens Service, Mobility Company	2017	internal operation
4.15	Agreements on project operation to safeguard attention to climate adaptation	Coordination Service	Working Group on Climate Adaptation	2016-2017	internal operation
4.16	Development of climate-adaptation instruments for Ghent's building projects	Building Projects Service	Building Maintenance Service, Real Estate Management Service, Environmental and Climate Service	2016-2017	internal operation
4.17	Compiling a list of example projects on city real estate in the following legislature	Building Projects Service, Building Maintenance Service, OCMW-Department of Facility Management	Environmental and Climate Service	2017	internal operation
IMPLEMENTATION					
<i>(RE)DESIGNING OF THE PUBLIC DOMAIN</i>					
5.1	Water-permeable pavement in the alleys Jonkvrouw Matte and Heilig Bloedstraat - <i>Inner city</i>	Farys	Roads, Bridges and Waterways Service	2017	included in overall project

5.2	Reduced parking spaces, more greenery in Cité de Hemptinne (Hertstraat) - <i>Inner city</i>	Roads, Bridges and Waterways Service	Parks and Public Gardens Service, Urban Development and Spatial Planning Service, Farys, Policy Participation Service	2016-2017	budget included in overall project budget
5.3	Climate-robust utilization of eliminated parking spaces - <i>Pedestrian area</i>	Environmental and Climate Service	Mobility Company, Roads, Bridges and Waterways Service, Urban Development and Spatial Planning Service, Parks and Public Gardens Service, Policy Participation Service	2017-2018	to be provided
5.4	Climate-robust design for Kettingplein - <i>Brugse Poort</i>	Roads, Bridges and Waterways Service	Environmental and Climate Service, Urban Development and Spatial Planning Service, Policy Participation Service, Social Cohesion and Urban Well-Being Service, Parks and Public Gardens Service, Youth Service, Farys	2017-2018	40,000 € for design, 450,000 € for execution
5.5	De-hardening Nekkersberglaan and Belvédèreweg - <i>Watersportbaan</i>	Roads, Bridges and Waterways Service, Parks and Public Gardens Service	Urban Development and Spatial Planning Service, Farys	2016-2018	included in overall project budget
5.6	De-hardening Silberberklaan in Wondelgem - <i>Residential neighbourhood</i>	Roads, Bridges and Waterways Service	Parks and Public Gardens Service, Farys, Urban Development and Spatial Planning Service	2017	included in overall project budget
5.7	Reconstructing Drongenplein - <i>Drongen</i>	Roads, Bridges and	Farys, Urban Development	2017	included in

		Waterways Service	and Spatial Planning Service, Parks and Public Gardens Service, Policy Participation Service		overall project budget
5.8	Climate-robust measures in Oostakker village – 20 th -century belt	Roads, Bridges and Waterways Service	Environmental and Climate Service, Policy Participation Service, Parks and Public Gardens Service, Urban Development and Spatial Planning Service, Farys	2016-2018	
5.9	De-hardening burial sites	Parks and Public Gardens Service	Roads, Bridges and Waterways Service, Farys	2017	ca 800,000 €
<i>GREEN AREAS</i>					
5.10	Façade greenery and green garlands in the Brandstraat – Inner city	Roads, Bridges and Waterways Service, Parks and Public Gardens Service	Social Cohesion and Urban Well-Being Service, Fire Department, Urban Development and Spatial Planning Service	2016-2017	included in overall project budget
5.11	10,000 m ² extra façade greenery in the city	Parks and Public Gardens Service	Department of Facility Management, Environmental and Climate Service, Urban Development Service, Fire Department	2018	internal operation and/or as part of project operation
5.12	Construction of neighbourhood park Wolterspark - Dampoort	Parks and Public Gardens Service	Urban Development and Spatial Planning Service, Policy Participation Service, Farys, residents, vzw Kunsthart	2016-2018	
5.13	Further development of (part of) Green Axis 4 - Upper Scheldt	Parks and Public Gardens Service, Roads, Bridges	Urban Development Service, Economic and	2017 (depends on	490,000 € for the acquisition

		and Waterways Service	Entrepreneurial Support Service, Policy Participation Service, Environmental and Climate Service, Strategic Grants Service, adjoining landowners	acquisition of land)	of land (to be further examined)
5.14	Gentbrugse Meersen - <i>Gentbrugge</i>	Parks and Public Gardens Service	Roads, Bridges and Waterways Service, Environmental and Climate Service, Sports Service, Policy Participation Service	2016	ca 2.1 million €
	<i>SPACE FOR WATER</i>				
5.15	Reopening the Lower Scheldt – <i>Inner City</i>	W&Z	Roads, Bridges and Waterways Service, Urban Development and Spatial Planning Service, Policy Participation Service, Farys	2016-2017	
5.16	Reconstruction of Baudelohof - <i>Inner city</i>	Parks and Public Gardens Service	Urban Development and Spatial Planning Service, Roads, Bridges and Waterways Service, Farys, W&Z, Policy Participation Service	2017-2019	1,735,000 €
5.17	Revaluation of De Lieve, realization of natural stepping stones	Parks and Public Gardens Service	Roads, Bridges and Waterways Service, Farys	2017-2018	total project budget ca. 700,000 €
5.18	SuDS in Van Ooteghemstraat and Noendries	Roads, Bridges and Waterways Service	Parks and Public Gardens Service, Farys, Ivago, Urban Development and Spatial Planning Service,	2017-2019	internal operation (knowledge build-up), part

			Environmental and Climate Service, Working Group on Climate Adaptation		of total project budget (construction)
<i>BUSINESS PARKS</i>					
5.19	Climate-robust development of the Wiedauwkaai business park	Economic and Entrepreneurial Support Service	sogent, Roads, Bridges and Waterways Service, Farys, Parks and Public Gardens Service, Environmental and Climate Service	2016- ...	part of overall project budget
5.20	Climate-robust development of the Eiland Zwijnaarde business park	sogent	Economic and Entrepreneurial Support Service, Environmental and Climate Service, partners NV Eiland Zwijnaarde, W&Z	2017-2019	part of overall project budget
<i>CITY RENEWAL AND DEVELOPMENT PROJECTS</i>					
5.21	Climate-robust development Houtdok site - <i>Old Docks</i>	Parks and Public Gardens Service	sogent, Coordination Service, Urban Development and Spatial Planning Service, Environmental and Climate Service, Policy Participation Service	2017-2019	2,942,000 € for new neighbourhood park
5.22	Charting climate opportunities in ongoing co-creative city renewal project <i>Muide Meulestede</i>	Urban Renewal Service	Environmental and Climate Service, Urban Development and Spatial Planning Service, Coordination Service, Policy Participation Service, neighbourhood residents Muide-Meulestede	2016-2019	part of overall project budget
<i>CITY REAL ESTATE</i>					
5.23	Example projects façade greenery	Sogent, Mobility	Sogent, Mobility Company,	2017-2018	

		Company, Department of Facility Management	Department of Facility Management, Parks and Public Gardens Service, Environmental and Climate Service, designers		
5.24	Extra water storage green roof De Klavertjes – <i>Nieuw-Gent</i>	Building Projects Service	Building Maintenance Service, Department of Education, Architect, Contractor	2016-2017	part of overall project budget
5.25	Combination green roofs - rainwater recuperation in Jenaplan school De Kleurdoos - <i>Ledeberg</i>	Building Maintenance Service	Department of Education, Environmental and Climate Service	2016-2017	to be provided
5.26	Building project elementary school De Zonnepoort - <i>Inner city</i>	Building Projects Service	EVR architects, elementary school De Zonnepoort	2016-2017	included in total building project budget (4,081,585.28 €)
5.27	Climate-robust design for elementary school Henri D'Haese – <i>Oud-Gentbrugge</i>	Building Projects Service	Department of Facility Management, Department of Education, school users, Environmental and Climate Service	2016-2019	included in total building project budget

COMMUNICATION AND AWARENESS

EXTERNAL COMMUNICATION

6.1	Continuation of the already existing communication products	Environmental and Climate Service	Working Group on Climate Adaptation	2016	5,000 €
6.2	Integration of climate adaptation into the Energy Centre	Environmental and Climate Service	Working Group on Climate Adaptation, external adviser	2016-2019	200,000 €/year for renovation guidance

6.3	Communication with the launch of the Ghent Climate Adaptation Plan	Environmental and Climate Service	Working Group on Climate Adaptation	2016	15,000 €
6.4	Communication regarding 'Room for Ghent'	Urban Development and Spatial Planning Service	Environmental and Climate Service, STAM	2016-2017	Included in project budget expo STAM
6.5	Promoting green roofs	Environmental and Climate Service	Policy Participation Service, Parks and Public Gardens Service	2017-2018	5,000 €
6.6	Communication directed at schools	Environmental and Climate Service	Working Group on Climate Adaptation, Youth Service, Educational Services Office, Department of Facility Management, selected pilot school	2017-2018	15,000 € communication budget, 10,000 € for educational programme with Department of Facility Management
6.7	Actions regarding the removal of surface hardening on private property	Environmental and Climate Service	Working Group on Climate Adaptation, Social Cohesion and Urban Well-Being Service, IVAGO	2017-2018	20,000 €
6.8	Raising awareness on the importance of ditches and their maintenance	Roads, Bridges and Waterways Service	Environmental and Climate Service, Urban Development and Spatial Planning Service, Parks and Public Gardens Service, Policy Participation Service, Farys	2017-2018	5,000 €
6.9	Promoting green garlands	Environmental and Climate Service	Parks and Public Gardens Service, Roads, Bridges and	2018-2019	3,000 €

			Waterways Service, Urban Development and Spatial Planning Service, Fire Department		
6.10	Informing construction professionals such as project developers, architects, contractors, ...	Environmental and Climate Service	Urban Development and Spatial Planning Service, Housing Service, Building Projects Service	2018-2019	5,000 €
6.11	Climate adaptation bicycle tour	Environmental and Climate Service	Working Group on Climate Adaptation	2018-2019	10,000 €

NETWORK AND PARTNERSHIPS

HIGHER AUTHORITIES

EUROPE

7.1	Participation in the European BEGIN project	Environmental and Climate Service, Parks and Public Gardens Service, Urban Development and Spatial Planning Service	Strategic Grants Service, Economic and Entrepreneurial Support Service, Policy Participation Service, external stakeholders	2016-2019	400,000 € of which 50% co-financed
7.2	Participation in the European RESIN project	Environmental and Climate Service	Working Group on Climate Adaptation	2017-2019	internal operation

KNOWLEDGE INSTITUTIONS

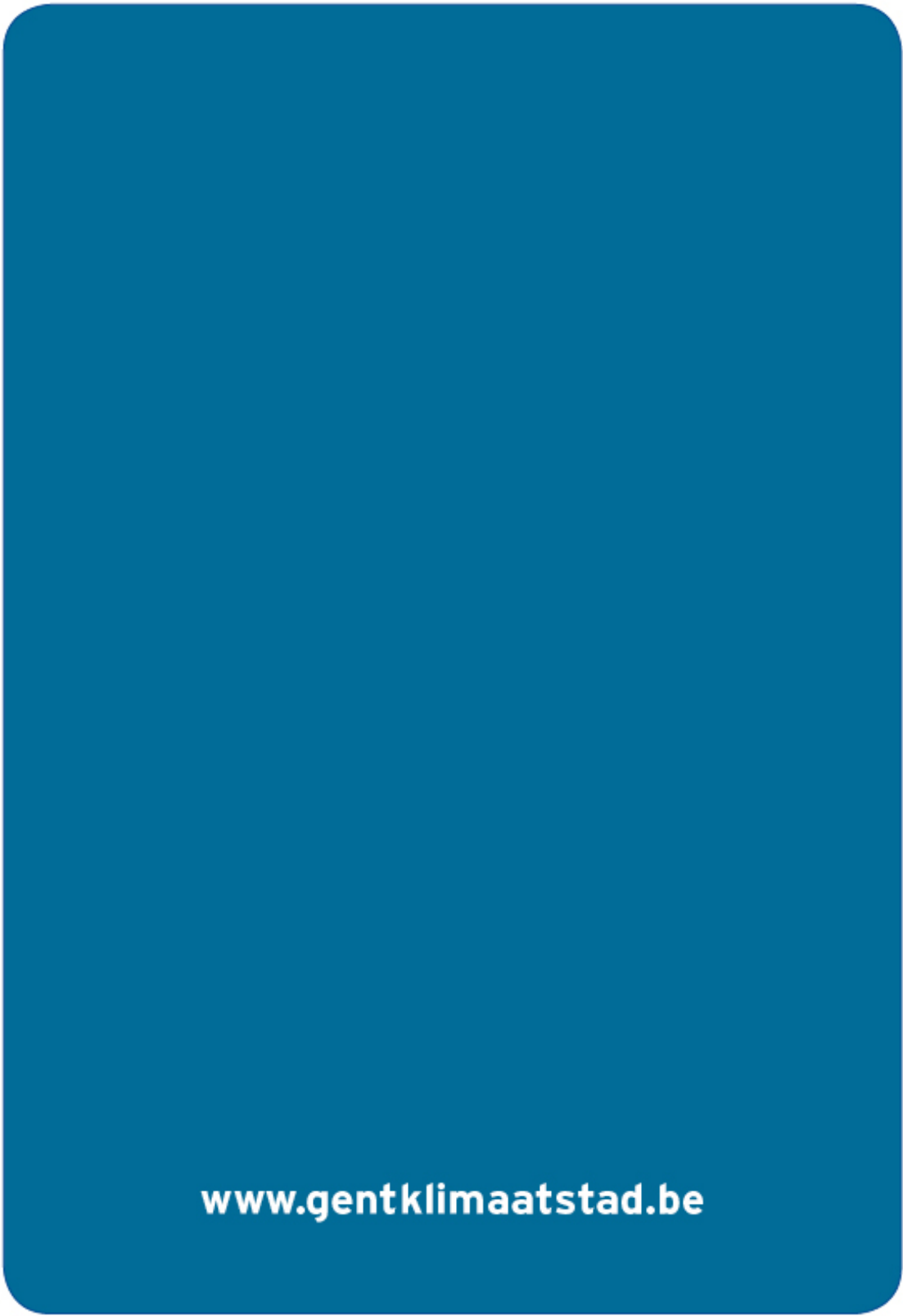
LOCAL STAKEHOLDERS

MONITORING AND EVALUATION

INDICATORS ON CLIMATE CHANGE AND VULNERABILITY

INDICATORS FOR THE CLIMATE ADAPTATION STRATEGY

INDICATORS FOR THE 2016-2019 CLIMATE ADAPTATION ACTION PLAN



V.U. Paul Teerlinck, Botermarkt 1, 9000 Gent