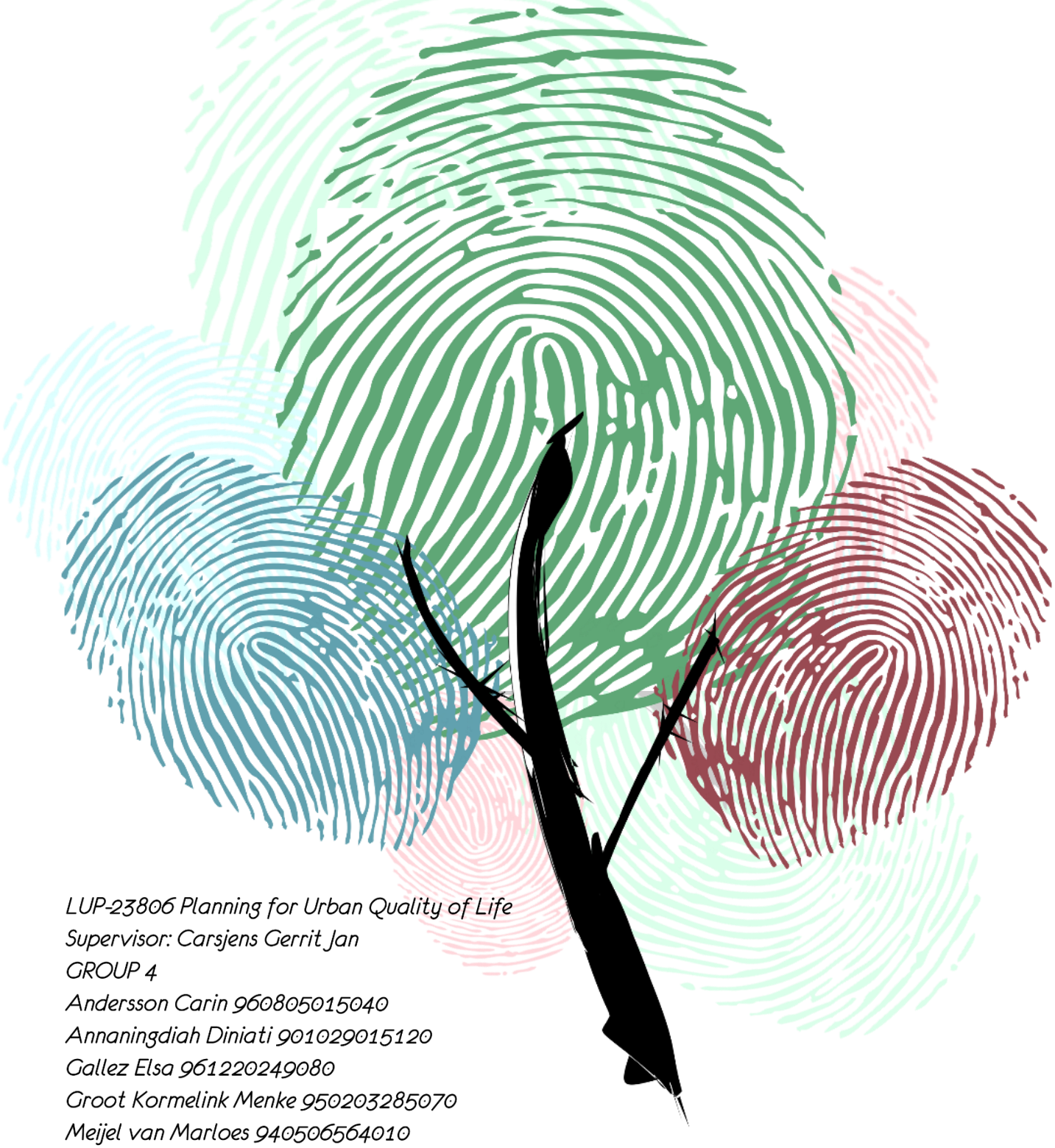
GREENMATE

NIJMEGEN 2050



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Content

Introduction

This background document presents the main information on the planning task of the region Arnhem-Nijmegen. This latter consists of elaborating, using a scenario approach, consistent strategies to plan the future urban (re)development of Nijmegen through the lens of "climate adaptation" with the time horizon of 2050.

The region Arnhem-Nijmegen is located in the province Gelderland, on the East of the Netherlands, near the German border. The region has a surface of about 1000km2 and a density of around 720 inhabitants/km2. It includes 19 municipalities (van den Hoven F., 2018).
The cities of Arnhem and Nijmegen are both constructed on the higher sandy lands: Arnhem is mainly located north of the Nederrijn and Nijmegen south of the Waal. The area between both rivers is vulnerable to floods because of the low elevation in the area. In the past, both rivers meander throughout this area. The soil thus mainly consists of clay with many nutrients that explains the high amount of agricultural lands, as croplands and grasslands, today present in the area. During the urbanization around 1950, both cities grew significantly, thanks to the better control of the rivers by dikes. By that time, the extension of both cities even jumped over the rivers: south of the Nederrijn for Arnhem, and north of the Waal for Nijmegen (where the village of Lent is located now).

The expansion of the urbanization was combined with a growing number of infrastructure links, as highways (A15), roads, railway tracks, public transport lines, and bicycle roads. This expansion made the region well connected to its surroundings. The river Waal, a tributary of the Rhine, also started to play a bigger role as it provided a good shipping line between the harbours of Rotterdam and Germany. All this infrastructure thus supports the growing economy of Nijmegen but also provides a better quality of life. Moreover, one strength of the region is to have been able to preserve natural areas as the national park of the Hoge Veluwe, Natura 2000 areas and the park Lingezegen for instance, maintaining biodiversity in the city. The region today supplies different functions: residential, recreational, economic, cultural, agricultural, natural, and industrial, even if this last function is decreasing since 1996 (Walsweer M., 2016), leading to a more service-based economy today.

However, as in many other areas in the Netherlands, the region Arnhem-Nijmegen faces several challenges regarding urban population growth and climate change. Indeed, around 1,5 million more people will live in Dutch cities by 2050 (UN, 2018) and the global temperature is expected to rise from 1° to 1.5° by 2050 (KNMI, 2014), leading to increased precipitation and drought periods. The floods and crop losses can have serious impacts on the economy and society. Therefore, climate adaptation strategies are needed to make the region more resilient.

The city of Nijmegen already started its "regional adaptation strategy" (Reijnierse, 2016) - RAS'program - with the recent project of "room for the river" (Gemeente Nijmegen & i-Lent, 2016.), with the objective of avoiding flooding in the city-centre by lowering the floodplain and implement a dike relocation. This city is also really dynamic regarding sustainable initiatives and integrated governance (with more citizens' participation) as it was the European Green Capital in 2018 (Nijmegen Green Capital, 2018). Besides, the urban (re)development of the city should tackle not only the problem of urban population growth but also sustainability and adaptive climate goals. Therefore, the concept of compact cities with higher densities (as developed by the VINEX program) but also its combination with the mixed land uses' approach are tools to reach this goal. The Honig residential complex was recently built in Nijmegen, but more projects are needed in the next few years. As being an old city, Nijmegen also brings interesting dilemmas between conservation and needs for changes in the urban core.

Hence, this paper provides four different scenarios, a vision, and a masterplan by 2050 for the city of Nijmegen regarding urban (re)development and climate adaptation.

Future possibilities

Scenario planning can be used to distinguish what the future might look like. These scenarios are based on social, political, technical, environmental and economic trends whose uncertainty and impact have been determined using the impact-uncertainty matrix. Of all the trends, the ten most relevant trends with the highest impact and the most uncertain outcomes are used to make four different scenarios. The ten trends we used are:

- **Export** will increase in all regions in the Euro area with ± 13% in 2060 (OECD, 2014)
- The average **energy consumption** of inhabitants in the Netherlands, based on income, will have an increase of 70% in 2050 (relative to 2015). The highest trend shows an increase of 130% in 2050 (relative to 2015). (van den Broek et al., 2016)
- **Life expectancy** will grow with 5.5% in 2050 (RIVM, 2018)
- An increase in **transport** around the world in 2050 (World Energy Council, 2011)
- **International conflict:** More conflicts and tension in the world which leads to less international confidence or relatively big international confidence which ensures more safety, liberalization and globalization. (CPB, PBL, 2015)
- In the lowest trend, a loss of **biodiversity** is predicted. In the highest trends, the achievement is to reduce the loss of biodiversity over the world in 2050 (UN 2017).
- The **education** level of people from an age of 15 years increases with 11% in 2050 in the Netherlands (Roser & Ortiz-Ospina, 2018).
- Change in **migration** between 2010 and 2060 from 25 million to 50 million (OECD, 2014)

The trends of the growing **urban population** and the increase of the **Urban Heat Island** effect in cities is concluded in every scenario.

The two most important factors, technological development, and climate change are used as axes of the scenario matrix. By exploring (extreme) opposite directions of development of these factors and choosing value-free extremes, the four permutations of the selected trends are worked out, and the external scenarios are the results (fig.1) (Carsjens GJ, 2018).

The impact of those factors in the future, as well for Nijmegen, will be important. Technology will be a big uncertainty in the future which can result in completely different scenarios in the future, but it can have a high impact. Technology can also be of great importance for Nijmegen as most forms of climate adaptation will involve some form of technology. This includes materials to realize new projects for climate adaptation, but these projects can only be realized with knowledge (UNFCCC, 2006). If there will be a strong climate change in the future than the river area in Nijmegen can be affected by floods or droughts, this will ensure a need for new technologies to solve the problems.

Climate change threatens the city's sustainability. In local scale, climate change affects resident's health and the living condition in the area with threats of drought, heat wave, and extreme weathers. This will also mean less biodiversity because of the threatened natural habitat, which will lead to less food stability. Nijmegen will also be significantly affected by climate change because it is situated along the Waal river, which is one of Europe's largest transport and ecological corridors (INNOVA ezine, 2018). Climate change will also affect the local economy and will risk the city's infrastructure.

The impact of the trends is for different themes and activities in Nijmegen described. In this case, we look to the impact on agriculture, the infrastructure, industry, education, river, residential areas, green areas, and public space, the culture and on commercial and shop activities.

External scenarios

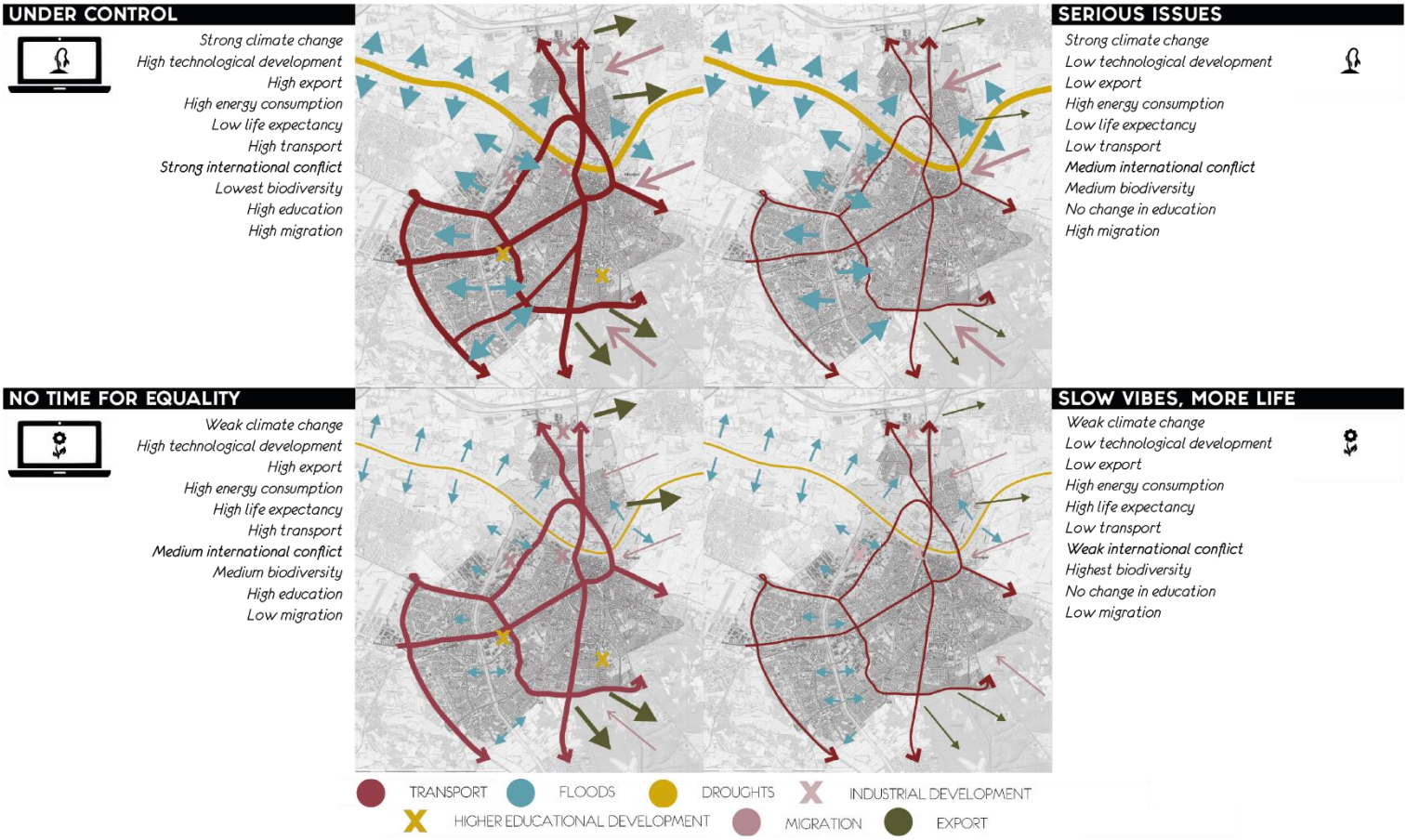


Figure 1: Scenario maps and trends

Scenario 1: Under control

This scenario describes what will happen when there is a strong climate change and high technological development. The agriculture in the surroundings of Nijmegen will be affected by climate change through an increase in extreme weather circumstances. They might have to endure droughts as well as floods, making the growing seasons longer and the change of a good harvest smaller. However, the Netherlands probably won't be that affected compared to other countries, making it interesting to export their products. This situation might lead to an increase in agriculture in Nijmegen, as Nijmegen has a good vantage point to distribute their products with the river, roads, and railways leading straight to the inner lands of Europe as well as the sea. Due to an increase in export and a growing population, there will be more transport throughout the city. For Nijmegen, this will result in more pressure on the bridges and the area around the city centre and more roads are needed to deal with this problem.

With new technological development, there might be a growing number of industries in the area. The combining number of the area used for housing, industry, and agriculture along with climate change might lead to a lower biodiversity as less room is left for nature. These industries will consume more energy during high-temperature periods to cool down their machines. This condition will happen in households too, as they need more energy to cool down or warm up their housing through climate change.

With the new technological developments, the number of people needing a university education will increase. In Nijmegen, this will lead to an expanse of the Radboud University, and a growing demand for student houses will appear.

The Waal is an important blue structure of Nijmegen. Because of a strong climate change, the discharge will vary a lot, with a lower discharge in summer and a higher discharge (with more peak discharges in between) in winter. Lower water levels in the Waal lead to problems with the inland shipping.
The increase of migration to the Netherlands as well as the common population growth in the cities will put more pressure on existing residential areas. More residential areas will need to be added, probably on the other side of the river. Green spaces and public space need to be added to deal with the higher temperatures (UHI) as well as the infiltration of water during heavy rainfall events. Water regulating pavement might also help with this problem. The higher temperatures in the city might lead to a lower life expectancy as old people, and young children are quite vulnerable during heat waves.
More migration might lead to a change in the typical Dutch culture, as people with different backgrounds and believes come to live in the city. This situation might lead to conflicts among the citizens. International conflicts might increase as well if they cannot agree on the measures to be taken against climate change.
Because internet shopping will increase, fewer shops will be present in the city centre and more distribution centres are needed in the area.
The problems mentioned above due to climate change might be counteracted through new technological development, taking the situation under control.

Scenario 2: Serious issues

This scenario describes the situation in case of a strong climate change and low technological development. Serious issues will happen without any possibility for further technological solutions. The agriculture will be affected by the strong climate change. Longer droughts and extreme precipitation events can be expected to have negative impacts on the agriculture in open fields. The low technological development will not provide enough innovations to tackle this problem. Other new efficient alternatives will need to be developed in order to adapt the agriculture process. Besides, the increased climate change may lead to more policies regarding CO_2 emissions by restricting the transport traffic. The number of cars per person will need to decrease, especially because there won't be enough technological innovations regarding the efficiency of transport. There will not be many new industries because of the low technological development, and the existing industries will mainly focus on the activities they are already engaged in, and mildly on a few new projects. The demand for higher education among employees is, therefore, lower and the R&D department within the companies has less importance. The slow increase in tertiary education will affect Radboud University. The technological development will be insufficient to tackle the problem of the high fluctuation of the Waal water level. With increased climate change, a bigger migration flow towards the EU can be expected. The urban population growth will, therefore, be high and will need a lot of new residential areas. However, few technological solutions will be available thus some other smart solutions will have to pop up to deal with this issue. The strong climate change will lead to an increasingly urban heat island effect in the city of Nijmegen. More green areas will thus be needed. The biodiversity will neither increase, neither decrease as the negative effect of climate change will be counterbalanced by the positive effect of low technological development (fewer infrastructure barriers). The population of Nijmegen will also be more diverse with the high migration rate, the culture of the region might thereby change. Finally, commercial areas will not undergo a big change.

Scenario 3: No time for equality

In case of a weak climate change and high technological development, agriculture activities in Nijmegen are influenced by the raising export that makes them produce more crops together with the technological development, that results in a more intensive way of production. This practice is not only done outside of the city, but also inside by urban agriculture.
Regarding transport, a terminal has been built functioning as a transfer station between railway and highway transportation, because of the strategic location of the region between Rotterdam

and Germany railway. This results in more linear connections between the terminal and all industrial spots in the region making natural barriers influencing the biodiversity. The impact on the biodiversity is medium because it can be partially rescued by technological development. The transport itself has considerable values due to population growth; more people also means more cars on the road. Due to the high export, the need for transportation increases. New technological developments can give new insights into the way of transportation for goods and people (public transport). The increase in export needs higher international cooperation. High energy consumption results in more complex energy infrastructure.
Technological development makes the industry less dependent on human labour in workflow, but more in the operational core, which requires a higher level of education. The productions grow because of intensification and the higher export ratio. A higher education level of people leads to a growing number of people undergoing university education. Because of this, the campus of Radboud University will expand.
he weak climate change in this scenario does not give extra pressure on the water levels of the Waal. By new technologies, ships can be adapted to the lower water levels to remain inland shipping over the river. Because of population growth, the residential area is growing, even though there will not be much migration into Nijmegen. More effective transport in residential areas is needed to prevent traffic crisis. Certain parts of residential areas are occupied by temporary residents, like students. This is because of the growing number of students in Nijmegen. Green areas need to be present in the growing urban areas to deal with climate change and to deal with effects of Urban Heat Island effect, thereby the health and welfare of the people, in the city. Growing urban areas leads to a higher pressure on the existing green areas in Nijmegen. Although climate change has significant consequences to the length of human life, the life expectancy will increase in this scenario due to the technological developments.
The university and student life in Nijmegen produces an important part of cultural experiences. Because of population growth, also the need for culture is growing. A stable society with no climate disasters also requires more cultural enjoyment. Technological development changes the view on commercial activities. It is being moved from cities to online platforms and fewer shops in the city centre itself.

Scenario 4: Slow vibes, more life

The agricultural lands will be attributed to local production and exports. The low technological development will not allow more production for exports and will have to develop alternative ways of production as permaculture, for local citizens.
The transport infrastructure will not expand, so the project of the new terminal (rail terminal) will be rejected because it could bring more traffic and climate change increase and strengthen the loss of biodiversity. Therefore, only some small bridges overhead existing highways and railways could be built, to avoid the landscapes' barriers that they create. With low technological development, the number of products exported, and the mobility of people will not significantly increase because no major transport infrastructures change will be created. The energy consumption will increase because the technologies in industries will not be as efficient as they could be if sustainable means of energy production were developed.
The low climate change will not decrease the life expectancy compared to today because the environmental change will not affect vulnerable people as it could do if major changes occurred. The number of students, in this case, will not grow significantly, so no campus expansion is needed.
The Waal river is already transformed to face a small climate change, so in this case, not a lot has to be improved there. The river will still be used for exports though, so in droughts season, there will be a need for other shipping forms or other ways of transport (train/highways). But this kind of technological solutions will be limited.
Due to population growth, there will be more people living in the city. This situation will not be different from the other scenarios. The low migration does allow Nijmegen to do not too much about expanding residential areas. Due to the same number of students in Nijmegen, there is no need for extra housing for students. The change in local climate will not change much in this scenario but the city already has problems with the urban

heat island effect in some areas of the city centre and as technology will not be improved in the future, this will remain a problem. The existing green areas are necessary to reduce the urban heat island effect.
There is an opportunity to develop higher biodiversity in and around the city. The high biodiversity will be able to develop in a more interlinked network of green areas and green corridors between the city core and the surroundings. Less technological investments may also result in more space for cultural investments or events related to brownfield areas in the city because less space will be needed for technology.
Concerning the international environment, there will be fewer tensions about resources between different countries if there is a low technological development because no new techniques that need to extract new raw materials will be designed. A weaker climate change will not increase inequalities (and thus international conflicts) between the different countries as much as in an environment with a stronger climate change.

A Vision for Nijmegen

Nijmegen 2050: *Green brings people together*

The vision for the city (re)development of Nijmegen 2050 (fig. 3) will be based on several basic principles related to the political, social, environmental and economic domains, to enhance the resilience of the area to a stronger climate change.

We want to develop a political governance based on more equality and democracy. We want the government to have a role of support to and control of lower-level initiatives. Thereby, more bottom-up projects will be able to emerge and develop at a local and regional level in a safer and more balanced manner. Every citizen should have the same opportunity to participate in local initiatives. At the European and international level, the partnership will still support global decisions as education, trade, and rights but will have a more moderate role that gives space for local development and economy. We want strong institutions that citizens can trust.

We want to build a more mixed community by improving the social cohesion and lowering the prevailing individualism. This goal can be reached by increasing the accessibility to education, improving the quality of education (based on more tolerance), supporting more equity and investing in the culture. Moreover, we want to build a more sustainable city and more sustainable communities.

In the future, we want to realize a more radical strategy for improving climate change in the city through climate adaptation measurements. This vision means the blue-green grid needs to change to restore the ecosystems within the city, (especially city centre because there is not enough green and biodiversity) this will result in more and a more diverse biodiversity in the green areas in the city. We think this is necessary because there will be changes because of climate change and there will be urbanization in the future so to keep the city liveable for residents and at the same time creating a sustainable city we need to connect and improve the blue-green grid.

Figure 2: Vasim in 2050

In the economic sense, we think it is needed to create an economy which is based on mixed activities, this relates to the kind of activities performed in the city which should not be focused on one specific key activity. These different types of activities should include innovation and new technological strategies. More attention should also be given to the responsibility of consumption and production processes as these should be diminished in the future. The industries, as well as the consumers, are responsible to achieve this.

In a nutshell, in a context of a growing urban population (UN, 2018) and a stronger climate change, we want to develop a more egalitarian society that lives in an adapted and equally accessible environment (fig. 2).

By 2050 in Nijmegen, the average temperature will increase by 0.8°, leading to more heat stresses and severe health impacts. Furthermore, the flooding and precipitation will be more intense - an increase of the total precipitation by 75mm -, especially in summer, bringing economic damages (Bernhard et al., 2018). That is the reason why adaptation plans to climate change are needed. Taking environmental measures is the first

envisioned manner to tackle this issue while thinking about the urban (re)development of the area. As we think building an egalitarian society is essential to support and participate in the development of a more sustainable environment, our second focus will be social measures.

GREEN

The environmental measures include a more radical implementation of the blue-green network by restoring ecosystems and provide more connections between existing green areas, especially between the city centre to the outer quarters. This aims to push further the idea of a green ring and green connections already planned (Gemeente Nijmegen, 2018b). We want to develop the green grid by creating green roofs, vertical gardens, balconies, and green space on each property. This can help for adapting to the urban heat island effects at the microscale and improve the air quality - in line with the air quality improvement goals of the "green capital projects" (Gemeente Nijmegen, 2018c). We want more climate adaptive public spaces to improve the infiltration of water. More green corridors (in as many streets as possible) inside the city will be necessary to connect better with natural ecosystems and provide social benefits. We want all the citizens to have a certain quantity of green area (minimum threshold) in their close surroundings, a goal that the "300-meter norm" already pursues (Gemeente Nijmegen, 2018b).

BLUE

The blue grid is an important system especially in Nijmegen because there is uncertainty about the future expansion of the river because of climate change. There is a possibility of more drought periods, but more floods and more extreme rainfall is also something which should be taken into account. So, for this reason, it is important to separate the rainwater and the wastewater in the future, so the rainwater does not have to go into the pipe system before it can go back to the river or the groundwater. This also ensures less polluted wastewater into the rivers when they are overflowing during extreme rainfall events. But not all water should be transferred to the river during extreme rainfall so there should be more places in the city which ensure more water infiltration, this means greener spaces and adapted pavement. This can be achieved with rain gardens, wadis, and permeable pavements. In some occasions, this will be not enough, and for this reason, water storage places should also be implemented.

The red grid will be attributed more space to public transport and less to cars. More car sharing spaces (with water-retention pavement) should be built. We want to delimit a car-free area with only public transport or slow mobility accessibility, especially in the city centre. This could be possible since the huge project of renewal of the campus (Radboud University, HAN University of Applied Sciences and Academic Hospital) is already investing in public transport (train and bus) and could support further projects of sustainable mobility (Gemeente Nijmegen, 2018a).

SOCIAL

The social measures first focus on developing more social cohesion, sustainable and equal community-building, therefore lowering the individualism. To reach this goal, we want more shared living in both already existing houses and new projects. Nijmegen has a long history of buildings with high density, mainly because of the late break of the wall in the early modern period, which is a part of the image of the city (Regional Tourist Board Nijmegen, 2010). Spaces should be there provided for each community including facilities both inside (kitchens, community meeting rooms) and outside (playgrounds, shared urban agriculture, community gardens) – as a continuity to projects based on norms of the number of playgrounds per certain number of children that the city is undertaking since 2003 (Gemeente Nijmegen, 2018a). This will help the community with stable, continuous and long-term development. Mixed types of housing and mixed-income neighbourhoods help with bringing all parts of the community together. That way also eliminates social segregation.

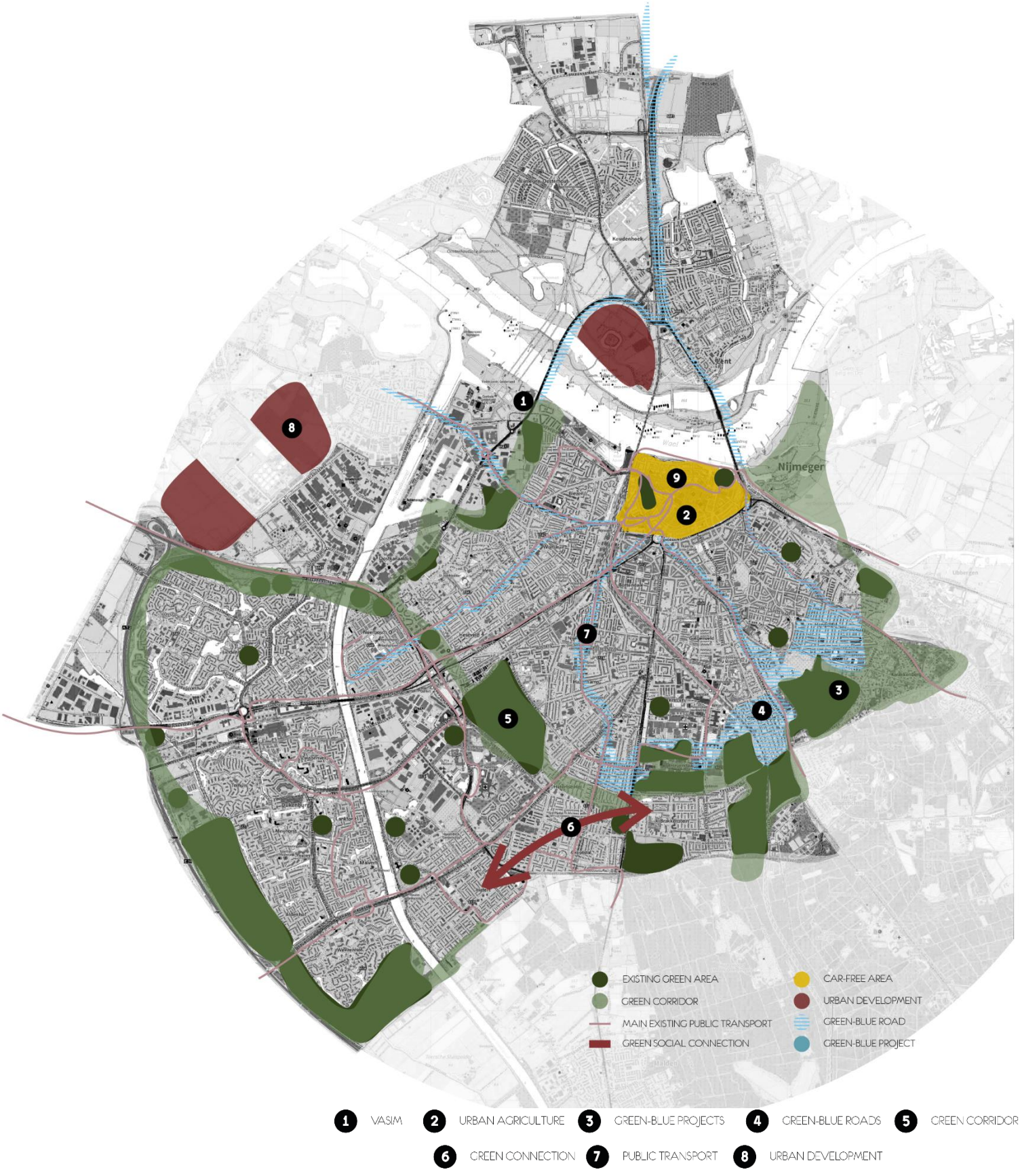


Figure 3: Vision map Nijmegen 2050

The Master strategy for Nijmegen

MASTER STRATEGIES

The master strategy (fig. 4) consists of several actions concerning gradual developments, no-regret options, postpone decisions and flexible options.

Gradual Developments

- A car-free area in the city centre will be developed gradually, depending on the availability of technologies and the importance of climate change. The area will be combined with more or less technological public transport.
- The urban redevelopment will also be gradual; the new residential area will be built in time responding in advance to the urban population growth (due to migration and thus to climate change). The density will also thereby gradually increase.
- Some prototypes of integrated green-blue projects, like a green-blue amphitheatre, will be built at first and will gradually take place everywhere in the city.
- The green-blue structures will be more or less extensive depending on the extension of urban development.

No-regret Option

- The existing pavements will have to be transformed into more adapted pavements (increasing the infiltration of water in the streets). The citizens can take part to the implementation of this action already at the household level. The municipality will be an actor for the transformation of the streets.

Postpone Decision

- The new terminal will only be constructed in case of a high technological development. So its construction depends on uncertain conditions as the level of technologies available and the will of a growing economy. This strategy will be taken by the province and the municipality.

Flexible Option

- While droughts period can bring lower levels of the river, this has some risks for the boats of not having the possibility to use that way anymore. The solutions, like adapted boats, will depend on the development of technologies. If there is a low technological development, some alternative solution will come up, like increasing the number of trains and building more roads to ensure the transport of the products.

KEY ACTIONS

1. **Vasim**

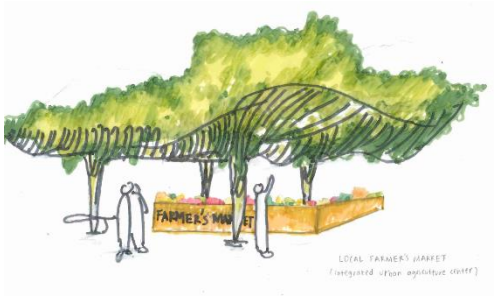
The Vasim area will be redeveloped as a “Green Capital Heritage” hotspot and will be a symbol of future development of the area combining a socio-cultural function and an environmental function with a showcase of all the principles of the green-blue (re)development. Projects like urban agriculture, integrated green-blue amphitheatre, green corridor, green road parks, and green roofs will be implemented. The Vasim will be created in the first stages of the timeline as its first goal is to increase the awareness of citizens and build more acceptance between the population for all the further changes that will be needed to occur in the city for climate adaptation.

To fund this project, different companies will be invited to help with the funding. They will improve their environmental image and will be a part of the Green Capital project. In return, they have to create a green space in the area as well. They will also be responsible for its maintenance. So for example, a water management company can be asked to create the water retention space in the area. The municipality will be the one to contact the different companies, and they will set the guidelines for creating the different spaces, preventing a chaos.

After creating the green spaces, to attract more people to the area local artist at the Vasim can be asked to create statues for the area, creating a kind of arboretum. In return, they will get more publicity.

2. Urban agriculture

Some lands or roofs will be allocated to urban agriculture by the municipality. Therefore, a discussion with local actors, as landowners or farmers, takes place to find an agreement to make the land free for urban farming. In exchange, the citizens could help the farmers or even pay a participation fee for the use of the land. Many citizens want to take part in such projects, so the demand is there. The fee should not be a problem. This activity will also be possible on green roofs.



After the allocation of lands, citizens will be able to organize themselves for the maintenance of the community gardens. They will have to work together, and that will probably strengthen the social cohesion of the neighbourhoods. Some exchange of knowledge can also be created between local farmers and citizens by workshops or another kind of activities. The local products will be sold in a permanent market, which will be created on the north side of the river.

The increasing role of fresh and local food will thereby be promoted, and the local economy supported. Even schools could be partners in the maintenance and use of urban agriculture lands as part of their education program. This activity will first take place in the north of the Waal in the first stages showcased in Vasim, but in the long run, the goal is to broaden the activity to the whole city.

3. Green-blue projects

Integrated projects like the « green-blue amphitheatre » will be built to combine a water retention function by creating a water square that stores water during heavy rainfall and a more social function by creating nice meeting places. To make the social connection with the place we want to have several performances by local groups in the amphitheatre. In this way, the people doing the performances and their visitors get nice connections with the area. Due to the weather, this is possible in summer. During winter, the place can be used as an ice-skating location. The water collected in the lake can be used during droughts periods for the close urban agriculture activities taking place in the surroundings. Therefore, some new pipes will be implemented.

The amphitheatre is an investment of the municipality toward the city and their citizens. It is a public space, so people do not need to pay to visit it. The money needed to build the amphitheatre has to come from somewhere else. The maintenance will be done by water and green-related companies because the amphitheatre does also have the technical function of water retention. We do not want to get problems in lower areas near the amphitheatre due to eventual defects. The plants and trees in the surroundings need to be able to deal with the wet circumstances. Because of this, the maintenance will be outsourced to a company that is specialized in this.

4. Green-blue roads

(Gollings, J. 2011)

The existing pavements will have to be transformed into more adapted pavements, thereby increasing the infiltration capacity of the streets is needed. This strategy can already start now as there is an urgency to reduce damages during flooding events, and it takes quite a long time to transform most of the streets, parking lots, to build more rain gardens, that can store the rainwater off the roofs, and to convince people of avoiding pavements in their gardens. The streets that will be transformed in this way are local streets located in the higher lands as the priority for infiltration is situated in the upward of the water flow; and bigger arteries where public transport lines are developed.

The municipality will be an actor at the city level, but citizens can also take part in this action at the neighbourhood level. To get the citizens to be more involved at the neighbourhood level, the municipality will raise awareness regarding the benefits of unpaved gardens through flyers and with more communication with the citizen board. The goal is that citizens unpaved their gardens. Another incentive is to implement a tax based on the area that is paved in the citizens' gardens. This tax will also be based on the income of the household.

5. **Green corridor**

There will be a green corridor that will run throughout the city, connecting all the old and new green spaces. This will give the city a green look and support the biodiversity, as well as providing a solution to the Urban Heat Island effect, as green spaces have a cooling effect. These green areas can also be used as water retention areas. First, areas will be selected that can be transformed into green spaces. After that, trees will be planted along the roads connecting those spaces, creating a green corridor with different routes throughout the city.

6. Green social connection

(Haven Green community, NYC)

In the current situation, there is an obvious distinction between certain neighbourhoods, as it is quite visible which neighbourhoods receive a lower or a higher salary. In the hope to erase those lines, there will be a green connection between those neighbourhoods. This will be done, by building a better connection between existing and new green areas in these neighbourhoods, creating cycling and walking paths. This strategy has a function of also increasing the biodiversity and improving the social climate. For example, some pieces of land can be granted to people who want to take care of it (like a community garden), hoping to bring people together from different social classes. Further, subsidies can be given to neighbourhoods, so they can take the initiative themselves to involve their citizens.

7. Public transport

For a sustainable public transport, it is important to consider not only the ecological factor but also to understand the social and economic factor, especially the conditions specific to the area. Stakeholders involved in this strategy are the Ministry of Infrastructure and Water Management, the municipality and neighbouring cities, the public transport companies, and the infrastructure management company. Also, very important is the involvement of knowledge institutions, companies, and civil society organizations.

In the area, we want to create a better network of public transport, which means strategic placement of stations, high frequency, and direct connections. Also important is that public transport needs to require minimal waiting

times and comfortable to travel between residential areas and popular places in the city. The mobility will encourage multimodality. The first step is to build new tram lines in the city centre (that will be car-free by 2040). Their tracks will enable the rain to infiltrate (as with grass tracks for instance). A little further, existing bus lines will be replaced by tram lines to connect residential areas to the city core. The trams will not go beyond the city limits. Further bus lines will be provided to connect the surrounding villages to the city. This will be possible by multimodal platforms at the edges of the city. All buses will switch to alternative fuels and use sustainable infrastructures and materials. Trams will use the electricity from the new sustainable energy production system of the region.
We also want to involve the citizens for the location of the bus stops and decorating of the places. Finally, it is important to use friendly, affordable, automatic, and more integrated payment of travel subscription system and do something that people feel the advantage of the public transport such as discounts or free travel days.

8. Urban development

As the urban population of Nijmegen will increase regardless, new residential areas will need to be constructed. These should be all ecologically built, as dense as possible (by keeping the balance with green spaces) and as accessible as possible (regarding money and distance). The new neighbourhoods will be well connected to the city centre as a new tram line will be built there. Even if the municipality will take the lead in the choice of location for the new urban areas, the involvement of citizens in the projects could be a real added value, as they could share ideas, build a certain community and evolve in the same direction regarding sustainability while proposing concrete actions. Some experts are of course also needed.

9. Car-free Area

The delimitation of a long-term car-free area in the city centre, decided by the municipality, will take place. This will improve the air quality but also let more space for green and water retention, and for slow mobility, there will also be less noise disturbance. Some streets will be gradually transformed, and the cars will be invited to park in new parking places around the car-free areas, so they can go further with public transport or by bike. These parking spaces will allow the emergence of new e-car-sharing concepts or even more e-bike services. The public transport and the parking places should be as cheap as possible to make it feasible for the citizens especially in the beginning of the project so that people will get used to this new form of transport.

This project first starts with the main streets in the city centre and later it can extend to other areas in the city because the people and the city have to adapt to this new transportation system. As most of the streets will be converted into greener public spaces (without cars), this will probably create a chaotic situation at the start because cars will take other routes. However, the goal is to make it gradual in time and space and to keep some car roads available for delivery of products to shops and police and ambulance cars, but these roads can mainly be used as bike roads. The municipality should provide enough spaces to park the bikes as people will probably use more bikes. The municipality also should provide the money to transform the car roads into green public spaces, and the green department and the citizens should maintain these.

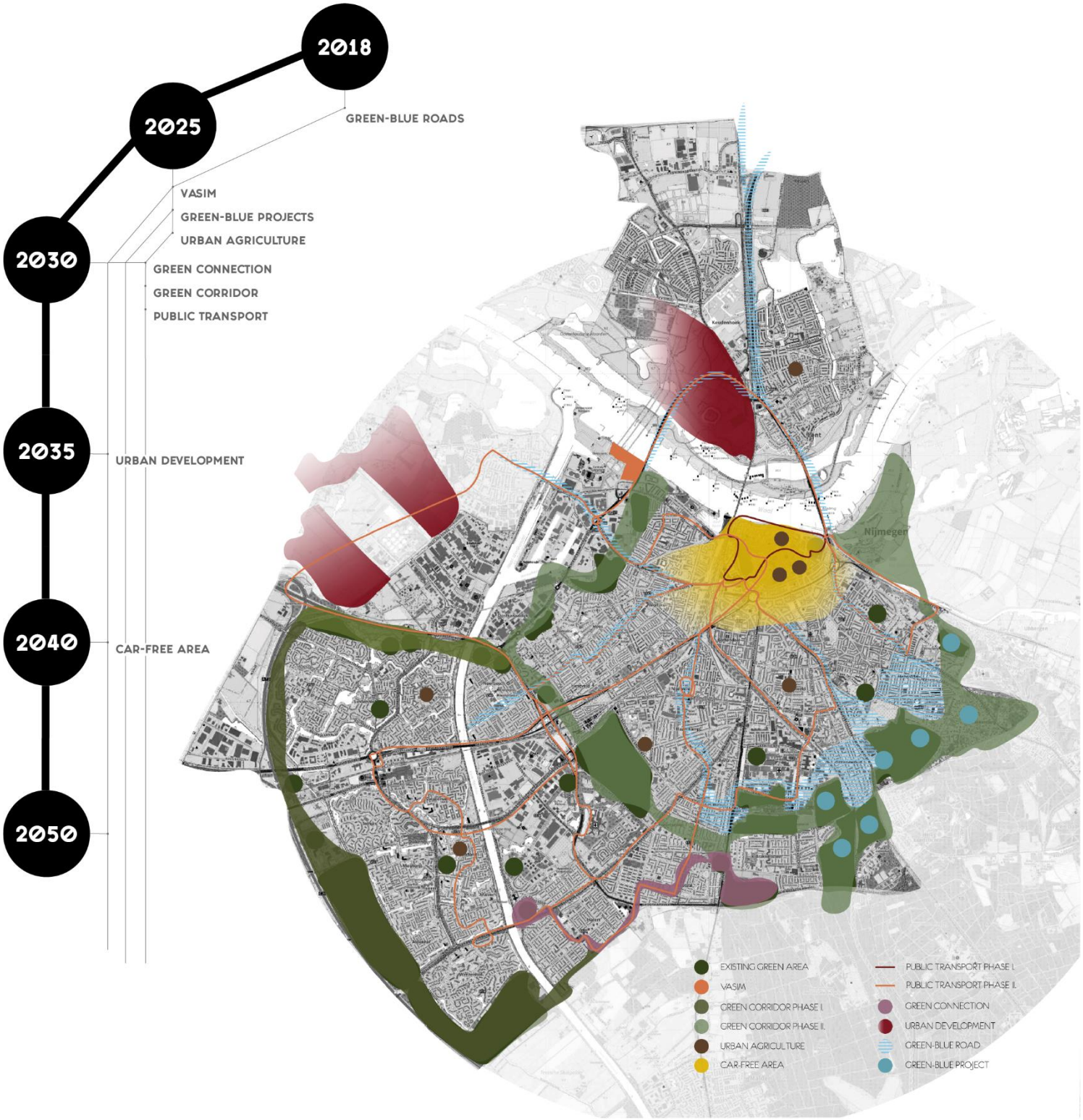


Figure 4: Strategy map and timeline

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