

The Road to Dry Feet

A study of the implementation of sustainable urban drainage systems on roads in relation to transitions

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Abstract

This thesis is concerned with the implementation of sustainable urban drainage systems on roads and how this contributes to the understanding and support of the ongoing transition of the water regime. Furthermore, will the thesis investigate how the process of turning the roads into ‘climate roads’ contribute to the transition of the water regime in regards to the implementation of sustainable urban drainage systems (SUDS). When the water is being managed at the surface by using either permeable surfacing or nature based solutions it clashes with other practices outside the scope of stormwater management as well. The road regime plays a particular large role in the development of the solutions. However, sustainable urban drainage systems also function as a means of facilitating the change because the increasing volumes of water is a critical issue that needs action. One of the solutions needed is sustainable urban drainage systems and this solution on roads possess potential for adding more nature to the cities and transforming the roads into vibrant, green streets that contribute to the liveable city. However, the transition is happening slowly but the cloudburst in 2011 was a game changer because it became so apparent for both citizens and authorities that increasing stormwater volumes causes great challenges.

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Resumé

Danmark er, ligesom resten af verden, præget af klimaforandringerne der indebærer større mængder regn og hyppigere skybrud. Især i byerne er regnvandet en udfordring, fordi byerne er præget af mange befæstede arealer, som resulterer i større afstrømning af regnvandet. Vores traditionelle kloaksystemer kan ikke følge med de øgede mængder regnvand, og det resulterer i oversvømmelser af folks kældre og overløb fra kloakkerne. Der er derfor et presserende behov for at gøre vores byer mere robuste over for fremtidens klima. Når det kommer til håndtering af regnvand er der behov for plads til større volumener af vand, hvilket dog ikke altid er muligt i de tætte byer, og der er derfor et behov for at tænke i alternative løsninger. Vejene spiller som sagt en stor rolle i afstrømningen af regnvand, og dette gør vejene til en interessant lokation for håndteringen af de øgede mængder regnvand. Ved brug af naturen til håndteringen af regnvand, samt implementering af permeable belægninger på veje tilføres der mere natur til byen. Dette bidrager ydermere til at afstrømningen af regnvand mindskes, og mindsker derfor akkumulering af regnvand på sårbare steder, hvis vandet håndteres lokalt. Men implementering af regnvand på veje er ikke en problemfri proces, fordi det bidrager til et sammenstød med andre praksisser, når regnvandet bringes op til overfladen. Det er især vejregimet der udfordres, og aktører er nødt til at tænke i nye baner, når vejene skal anvendes i klimatilpasningen, fordi der ikke er plads nok til alle elementer. Dette speciale vil derfor undersøge processen bag implementeringen af regnvandshåndtering på veje, og hvilke barriere og potentialer, der er i denne process, og hvordan dette bidrager til omstillingen til en mere bæredygtig vandhåndtering. Vi undersøger processen bag implementering af regnvandshåndteringen, og dette gøres gennem valget af tre cases, der hver især indebærer regnvandshåndtering på veje, men med forskellige løsninger. Alle tre projekter er afsluttet i relation til implementeringen af løsningerne. Vi har suppleret casestudierne med interview med forskellige aktører, der har været involveret i processerne. Interviewpersonerne er blandt andet medarbejdere i forsyningsselskaberne, en repræsentant fra Københavns Kommune og beboere på de forskellige veje. Derudover har vi suppleret diskussionen med inputs fra en forsker i byplanlægning, som beskæftiger sig med udfordringen af det private bilejerskab og dets påvirkning på indretningen af vores byer.

Vi har analyseret vores cases ud fra *strategic niche management* og selve rammen for projektet er *multi-level perspective*, som bidrager med en forståelse af hvorfor systemer er fastlåste, men også at det er dynamikker og interaktioner mellem disse på forskellige niveauer, der kan understøtte en eventuel transition.

Vi har fundet frem til, at vejregimet og de praksisser der er indgroet i dette regime, har en stor betydning for implementeringen af regnvandshåndteringen på overfladen. Parkeringsnormer og forestillingen om, at vejene er reserveret til biler er en stor barriere i forhold til at gøre plads til forskellige elementer i regnvandshåndteringen såsom regnbede eller andet. Men regnvandshåndteringen kan også bidrage til at udfordre vejregimet, da håndteringen af vand er et presserende problem som kræver handling nu og her. Skybruddet over København i 2011 har bidraget til en øget bevidsthed omkring hvilke konsekvenser klimaændringer har, og det har sat skub i mange projekter vedrørende regnvandshåndtering. Etableringen af netværk er også vigtig i udviklingen af løsningerne, da hver aktør bidrager med vigtige ressourcer - det kan eksempelvis være i form af lokal viden, økonomiske ressourcer eller viden om bestemte teknologier. Samspillet mellem aktørerne og deres ressourcer bidrager til udviklingen af projekterne.

Preface

This thesis is submitted as the final work of the master program in Sustainable Cities at the University of Aalborg, Copenhagen. The work has been carried out in the period from February to June 2020.

By investigating the process in regards to sustainable urban drainage systems in three cases, this thesis aims at understanding the transition of the water regime in regards to stormwater management on roads and how this process of implementation can support the transition and at the same time contest the road regime and in the bigger picture contribute to the sustainable transition.

In the report we have used the Harvard referencing method and a reference is outlined as follows: (Author/Publisher, year), references used actively are outlined as Author/Publisher (year). The reference to an interviewee will appear as (Last name, month year).

We would like to thank our supervisor Birgitte Hoffmann for her valuable feedback and guidance during the project period.

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1 Introduction

Cities are facing severe challenges with flooding and heatwaves due to climate change. The rapid urbanisation contributes to urban growth and an increase in impervious surfaces. An increase in the frequency of cloudbursts along with a large amount of impervious surfaces have led to greater volumes of stormwater runoff. (Grimm et al, 2008) The conventional pipe-based system cannot cope with the increasing volumes of stormwater and it causes issues with combined sewage overflows (CSO's) in Copenhagen and Frederiksberg (Sørensen et al, 2006) The need for a transition towards more sustainable urban water management is acknowledged and sustainable urban drainage systems (SUDS) have been suggested as alternatives to the conventional solutions. (Qiao et al, 2018) However, the space is scarce in the dense city and we, therefore, need to think more creatively with the implementation of sustainable urban drainage systems. Roads take up a lot of space in the city and the impermeable surfaces are one reason behind the increasing volumes of stormwater runoff. (Grimm et al, 2008) That is why roads are interesting in the development of climate-resilient cities because they possess great potential for making the cities more green by integrating SUDS and managing stormwater locally contributing to source control as well. (Fletcher et al, 2015) However, the implementation of SUDS on roads is not an easy task because the changed practice with bringing the water to the surface will affect other practices as well. It is therefore relevant to delve into the process regarding this implementation and examine what barriers and potentials this approach entails.

2 Water Management in The Dense City

History has shown that urban water management has become increasingly complex over the decades as society's expectations have grown together with an acknowledgement of the lack of natural resources. (Hoffmann & Jensen, 2015) This has led to multifaceted challenges and a need for involving multiple actors. A growing part of the urban water professionals are focused on the transition towards sustainable urban water management (SUWM), to accommodate some of the challenges, the cities are facing like, environmental degradation, continually growing urban population, and the impacts of climate change. (Van de Meene et al., 2011) Furthermore, the cities are a focal point for realising sustainable practice, as a big part of the world's population lives in the cities. (Brown & Wong, 2009) The water regime is shaped by the pipe-based system that was implemented when the sanitary conditions in the cities had to be improved and management underneath the surface. The pipe-based system was the dominating technology at that time. (Sørensen et al, 2006) The regime is therefore formed by a time where the water was managed underneath the surface separated from the traffic.

The aim for the future planning is to combine climate change adaptation with urban development to create added value to cloudburst projects (Københavns Kommune, 2012.) In order to do so, the water management must transition to sustainable urban water management (SUWM) and one approach is to relieve the sewers and look into sustainable urban drainage systems (SUDS). These solutions are based on disconnection of the stormwater discharge from the sewer system in order to relieve the pressure and delay the stormwater by using natural elements in the urban landscape to store, evaporate, filter and infiltrate stormwater within a local catchment area. (Mguni et al, 2015)

The sustainability is referred to as “*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*” (World Commission on Environment and Development, 1987) ‘Needs’ in this context refers to economic, environmental, and social aspects. Sustainable development then becomes the combination of conserving and sustaining the natural environment, the resources and community, and development of the societal goals and the economy. (Russo et al, 2014) The urban water cycle has changed due to more paved surfaces that increase the volume of stormwater runoff. The philosophy of sustainable urban drainage systems (SUDS) is to replicate the natural, pre-development principles of drainage in a specific site by using a

‘nature approach’. (Fletcher et al., 2015) SUDS contributes to the overall sustainable urban water management (SUWM) which is characterised by biophysical systems and integrated infrastructure that support economic, social, environmental and political contexts, water supply for ecological and human purposes, and contribute to a long-term perspective. (Van de Meene, 2011) The environmental benefits are primarily to reduce flood risks but they also provide a wide array of other benefits such as green spaces, improvement of air and water quality, enhancing biodiversity and creating a coherent networked landscape in the city that promotes mental health and well-being through recreational aspects and contributes to social cohesion. (Qiao et al., 2018) It also includes minimising the cost of stormwater management (Fletcher et al., 2015). The SUDS includes solutions that would involve permeable coatings as well. Permeable coatings will relieve the sewers as the precipitation can seep through the coating through the soil (Vejdirektoratet, 2015)

When combining climate change adaptation with urban development, some various actors and interests will take part in the development, such as citizens, NGOs, companies, and authorities. This affects the speed of the implementation of climate adaption elements in the urban environment. (Qiao et al, 2018) It seems like the technologies are already available but the

implementation processes are challenging due to the question about responsibility and organisational roles. The actors might also enter the implementation process with diverse and sometimes divergent interests and incentives. The utility company’s starting point is economic efficiency while a municipality is balancing different aspects such as supporting urban development with liveability in focus whilst addressing flood risk and the competition for space (Mguni et al., 2015).

Fact box

A cloudburst is, according to The Danish Meteorological Institute (DMI) defined as a rain event where the volume of water exceeds 15 millimetres in 30 minutes. (DMI, n/a)

The rain event that hit Copenhagen and Frederiksberg in 2011 was characterised as a triple cloudburst – which meant that the precipitation resulted in 50 millimetres in 30 minutes.

The highest intensity that was measured was 31,2 millimetres in 10 minutes. (Mørk, 2016)

The threatening consequences of climate change create demanding pressures on all levels and demand immediate action. (Geels, 2002) The cloudburst in 2011 (see fact box) in Greater Copenhagen is a great example of a critical consequence that contributed to making climate change more apparent to everybody - authorities as well as citizens (Københavns Kommune,

2012). The City of Copenhagen published a Cloudburst Plan after the big rain events in the summer of 2010 and again in the summer of 2011. These events created a "window of opportunity" for alternative climate adaptation because an expansion of the existing sewage system was too expensive and too time-consuming in order to act relatively fast and it would not contribute to a more liveable city (Københavns Kommune, 2012).

Copenhagen is a dense city and that means that it is challenging to implement large-scale sustainable urban drainage systems (SUDS). This is one of the reasons why climate adaptation of roads is very interesting, as there are so many impermeable paved surfaces in the city that creates more runoff (Grimm et al., 2008) but also poses a great potential to implement climate adaptation on a smaller scale in the city. It will contribute to source control meaning that the water will be controlled locally and not accumulate in large amounts in vulnerable places. (Fletcher et al, 2015) Using SUDS on roads will also contribute to the overall urban green infrastructure in the city as a connection between other larger green spaces (Burgess, 2015). It is interesting to investigate this specific context because roads play an important role in people's everyday life and they influence a variety of actors. Furthermore, roads are relevant to the aim of climate-resilient cities as they constitute a big part of the urban fabric and space is scarce. (Grimm et. al, 2008; Hoffmann et al, 2018).

The road regime, however, is a deeply rooted system with embedded practices and social behaviours.

"Car culture is embedded in our everyday lives in ways that extend far beyond economic considerations, and the automobility system as a whole exerts a 'specific character of domination' over society, even with its harmful effects - pollution, congestion, injuries and deaths - are acknowledged virtually by everyone." (Kanger & Schot, 2016)

The cities of today are shaped by previous planning approaches with emphasis on cities being centres of economic growth and the importance of the car in this development. (Sheller & Urry, 2000; Urry, 2004) Geels (2005) also describes the infrastructure as being the material and spatial part of the socio-technical landscape and it is characterised by hardness and gradients which makes it challenging to deviate from. (Geels, 2005 [b]) People see the ability to move as an absolute right and the car becomes the logical instrument for exercising this

right. This affects the urban public spaces and the space of the urban road becomes subject to this free movement. (Urry, 2004)

It can be observed that all over the world, we still follow the same path when it comes to transportation, the optimisation and the increase in the capacities needed even though the automobile systems are counterproductive. The mobility systems of today are still based on the ideal of a flow and zero friction and the planning paradigm is still technocentric.

(Freudendal-Pedersen & Kesselring, 2016) 'Transport' seems to be too much in focus when studying travelling and less emphasis is put on the intersection between society and transport.

(Freudendal-Pedersen & Kesselring, 2016) Once the societies and economies more or less have bought the idea of the car, the infrastructure, practices, and society became 'locked in' and seems infeasible to break from. The pattern became irreversible and this ensured expansion of the car and all its associated products, practices, and infrastructure. This has also led to an urban environment that is "(...) '*unbundled*' territorialities of home, work, business and leisure that historically were closely integrated and fragmented social practices in shared public spaces" (Urry, 2004)

However, the road regime has been somewhat challenged in Copenhagen where infrastructure for biking and walking to a higher degree has been prioritised. The accessibility is made easier for pedestrians and bikes in the sense of broad bike lanes and bridges where only bikes and pedestrians are permitted. (Cathcart-Keays, 2016) The positive attitude towards a friendlier infrastructure for biking and walking in Copenhagen is for one thing based upon the popularity of biking among the citizens and recognition of environmental problems related to car-traffic. This has led the way for another narrative regarding biking and all the health benefits and experiences in the bike culture and infrastructure. (Jensen et al., 2017) The knowledge and narratives about biking were turned around and the tacit knowledge of the benefits became visible in another way which allowed controversial views of infrastructure and contributed to a change in policies in the transport planning in the municipality of Copenhagen. (Jensen et al., 2017) Biking was made visible in other ways because a different language was used to talk about it and different values and benefits were linked to biking. (Jensen et al., 2017)

The road regime has been challenged before in Copenhagen and the changed storytelling contributed to another prioritisation of the accessibility of the different modes of transport. (Jensen et al., 2017)

2.1 Summary

Climate change has become more visible and the increasing amounts of stormwater and more frequent events of cloudbursts puts pressure on the current water management system. This calls for action but space is scarce in the cities so the SUDS has to be integrated with urban development. This can happen through the integration of permeable surfacing and nature-based solutions that contribute to multiple benefits. (Københavns Kommune, 2012)

Furthermore, we need to think more creatively in the climate adaptation of the cities and use alternative spaces for the solutions as well. This is where the roads can play a role as an interesting space to use for climate adaptation. (Hoffmann et al, 2018) However, the road regime is not easily contested because it is an embedded system with deeply rooted values and practices (Urry, 2004). The road regime has to some extent been contested before in Copenhagen by changing the storytelling about biking and putting values on the positive aspects of biking and walking instead of focusing on e.g. incidents. (Jensen et al., 2017)

3 Research Question

The water regime is shaped by an ongoing transition to more sustainable water management. Stormwater management is included in this transition where sustainable urban drainage systems (SUDS) is one solution for making water management more sustainable. There are different potentials and barriers in the development of SUDS and this project will focus on the implementation of SUDS on roads. It is therefore relevant to dive into the processes behind this development in order to gain knowledge and learn about the underlying incentives for transforming roads into 'climate roads'. We, therefore, want to examine how we can understand the transition by looking into the development of SUDS and how this can support the transition of the water regime and potentially contest the road regime as well. This has led us to the following research question:

How can we understand and support the ongoing transition of the water regime through the implementation of sustainable urban drainage systems on roads?

The research will have its point of departure in a case study of three different cases with a focus on the implementation process of SUDS on roads. The cases are located in Copenhagen and Frederiksberg. Water knows no municipal boundaries, and the precipitation falling in Frederiksberg during an extreme rainfall event has to be led through Copenhagen, either to a sewage treatment plant or into the sea via the City of Copenhagen. There is therefore a general close collaboration between the City of Frederiksberg and the City of Copenhagen, which is the reason why this research looks into the work of both cities. When climate roads are mentioned in this research it is based on stormwater management with the use of sustainable urban drainage systems (SUDS). In the research, we will study different kinds of climate roads, but they all have that in common, that they are surface solutions. We have chosen three different climate roads, which all have different formats. A further elaboration of the cases is to be found in Section 4.2.1 and in Chapter 6.

Case 1) Helenevej (Frederiksberg)

Case 2) Prøvestens Allé / Kongedybs Allé (Copenhagen)

Case 3) Skt.Kjelds Plads / Bryggervangen (Copenhagen)

The project is concerned with the multi-level perspective and the cases will be analysed through the lenses of strategic niche management supplemented with network governance. The focus in the project will be on the process up to and including the implementation.



Picture 1 from the left Skt. Kjelds Plads / Bryggervangen, Prøvestens Allé / Kongedybs Allé and Helenevej (own pictures).

3.1 Limitations

This project is only focused on the sustainable urban drainage systems as the solution to stormwater management even though the whole system of water management includes water supply, cleaning of water, reuse of water among others (Van de Meene et al, 2011) and as before mentioned we assume the solutions to more sustainable than the traditional pipe-based system because of the multiple benefits. However, this project is not concerned with measuring the level of sustainability and which elements of sustainability the systems fulfill. The cases do include elements of cleaning and infiltration of stormwater adding to the aquifer, however, these elements will be mentioned with the description of the cases but will not be further elaborated. Furthermore, we will only investigate SUDS on roads and only in relation to the infiltration and detention of stormwater to relieve the pressure on the sewage system.

Moreover, the urban context for the project is dense cities in Denmark and this has resulted in the choice of Copenhagen and Frederiksberg due to the density of the cities and the challenge with the scarcity of space.

In the theory, the starting point will be the regimes and the focus will be on how the niches can contribute to the transitions along with pressures from the landscape in the form of climate change in regards to increasing amounts of stormwater and more frequent cloudbursts.

4 Methodology

This chapter will dig into the methods used in this project. Furthermore, the choice of cases will be explained and a description of the type of interviews and interviewees will follow. The last section will include the research design to provide an overview of the process and how the theories interact with the methods.

4.1 Explorative Research

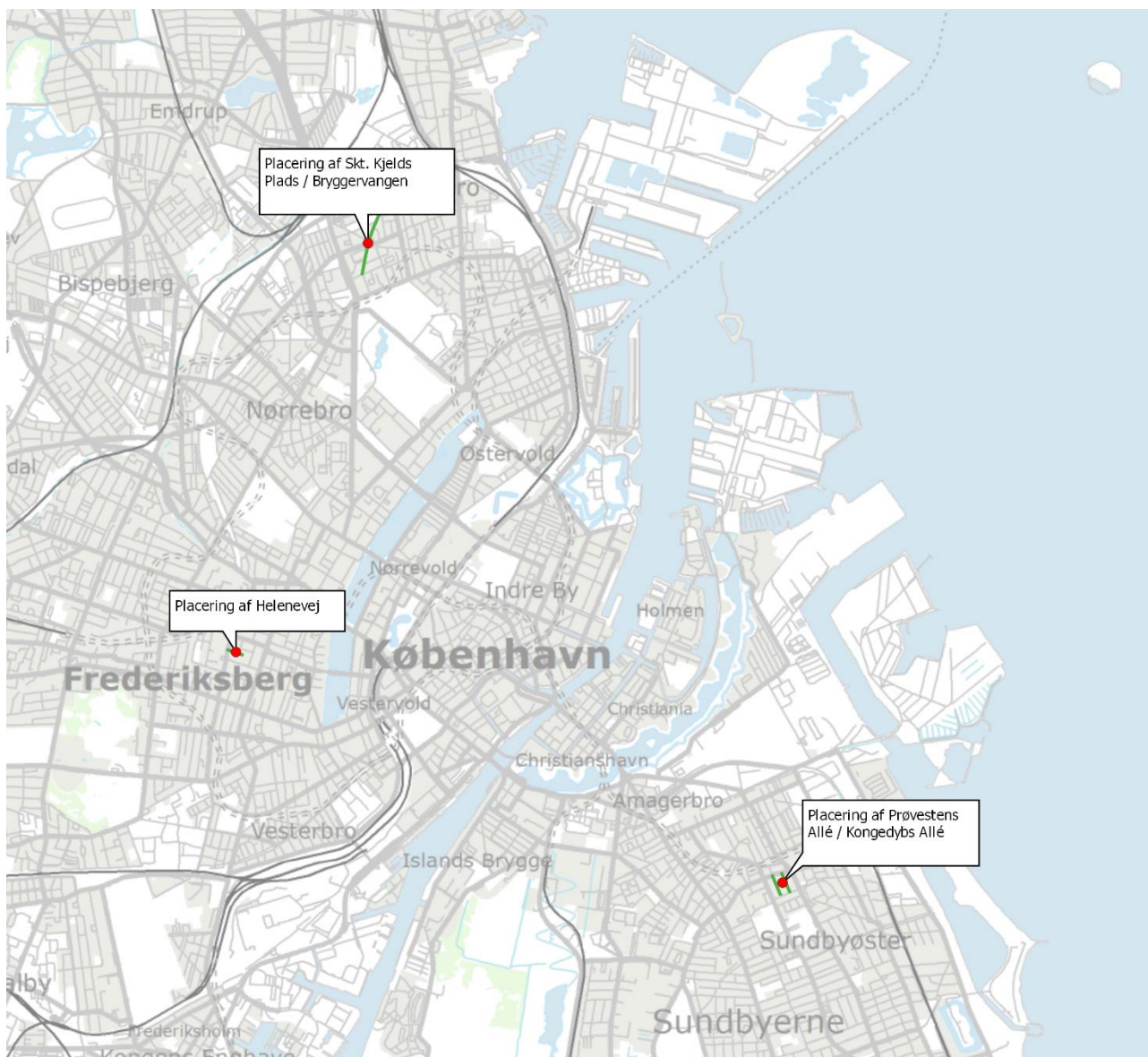
In this project, we seek to uncover some of the complexities related to the implementation of sustainable urban drainage systems (SUDS) solutions on roads and understand this phenomenon through the perspectives of a selection of actors and related policy documents. In explorative research, there is a need to use different methods to investigate the object and interesting information can be gained by observing and investigating a specific situation or case in full. (Olsen, 2003) By using different approaches and analysing different cases we can uncover some of the causes, effects, and correlations within the field of stormwater management on roads. The reality is more complex than theory but these specific cases must be picked intentionally because they will have different outcomes and therefore different contributions to understanding stormwater management on roads. (Olsen, 2003) The work is furthermore characterised as an iterative process and the focus has changed throughout the project when new knowledge or new perspectives was presented. This contributed to shifts according to what we found interesting.

4.2 Case Study Research

In this project, we want to understand the processes related to the implementation of SUDS on roads. A case study is an essential method to investigate such a phenomenon and to what extent it varies across cases or is present in a given case. (Flyvbjerg, 2010) The case study also possesses the ability to undertake an exploration of the phenomenon in its context. (Rowley, 2002) It is therefore relevant to look into three different cases with different contexts and investigate how SUDS has been carried out and the current expression of the solutions and their contribution to a potential transition. Flyvbjerg (2010) claims that context-specific knowledge is important in order to move up the ladder of knowledge and become experts in a given field. To investigate specific cases also contributes to a nuanced view of the world. (Flyvbjerg, 2010)

4.2.1 Choice of Cases

Three cases will be investigated and analysed in this project. Each case is unique in that sense that they are the first of their kind in regards to the development of SUDS on roads in the City of Copenhagen and Frederiksberg (see map 1). We, therefore, expect to gain knowledge from the cases as various actors have been involved in the process and the implemented solutions. Each case will contribute with specific information concerned with the specific context and the choice of cases will reflect this. All cases are concerned with climate adaptation of roads and are focused on stormwater management.



Map 1 shows the locations of the three cases. (own map, GIS)

The three chosen cases for this project are Prøvestens Allé/ Kongedybs Allé, Helenevej and Skt. Kjelds Plads / Bryggervangen.

The first case we have chosen is an area where the ownership of the road is private, which is assumed to influence the processes of implementation. This case is Prøvestens Allé / Kongedybs Allé and it is located in Amager in Copenhagen (see map 1). It consists of two private roads (private fællesveje) owned by The Homeowner's Association Øresund (GF Øresund). Even though it includes two physical spaces we refer to the roads as one case because the solutions have been implemented simultaneously and they are a result of the same process.

The reason behind the choice of the second case is, that it is the first 'climate road' (Klimavej) in Denmark and the chosen solutions only include permeable surfacing (Klimatilpasning, 2017) and no green elements as such. The name of the road is Helenevej and it is located in Frederiksberg (see map 1) and it was a private road with no established association, just a group of homeowners sharing the ownership of the road. The road went from private to municipal (Klimatilpasning, 2017) which made it interesting to analyse in order to see what effect it had on the process.

The last case is Skt. Kjelds Plads / Bryggervangen located in Østerbro in Copenhagen (see map 1) where the roads and the roundabout are owned by the City of Copenhagen. This case is also the first of its kind and it has gained a lot of publicity and the process has been going on for quite some years (Technical & Environmental Department, n/a [b]) so we expect the case to contain a lot of information regarding the implementation process.

All of the cases have been initiated around 2011, however, the implementation periods vary in length. Moreover, all the projects are completed.

Our aim is not to make a comparative analysis of the cases but to investigate each specific case and the circumstances regarding each case in order to analyse what has affected their transition from a simple road to a climate adaptation area. However, the framework for the analysis is the same and the analysis of each case will, therefore, include similar aspects. All though there might be different procedures and each case might represent different practices and reflect different aspects of the incumbent regime.

4.3 Semi-Structured Interviews

To get an insight into the different networks behind the cases we have conducted several interviews with actors on different levels of society. This contributes to an understanding of the topic from different angles. The interviews are used to understand the everyday life or the practices from the interviewees' perspectives. (Kvale & Brinkmann, 2015) The interviews are semi-structured in order to let the conversation flow and maybe obtain other aspects than first thought of.

The interview process is active and the knowledge is created through the relation between the interviewer and interviewee. (Kvale & Brinkmann, 2015) However, the interview also had a focus point and some questions that needed to be answered. The questions are shaped by the theory of the multi-level perspective in order to understand the incentives and the conditions for their practices.

The interviews were originally intended to be conducted as a conversation with the help of a physical timeline and a talk about values without specific questions, but because the interviews were conducted through online media we had to change the form. It was very new to us to conduct interviews online and it was not possible to use the physical tools. This also contributed to a more structured approach than intended and this made it difficult to talk about values without affecting the answers too much. The level of structure also depended on the interviewee, some of the interviewees requested to get the questions beforehand and this could also affect the type of answers we got, as the interviewee had time to prepare. Kvale & Brinkmann (2015) explain that the follow-up questions require active listening and dependent on the interviewee's answer we would ask other questions. We had a very explorative approach to the interviews - we did have a certain amount of background knowledge, but we also wanted the interviewees to be our sources of information. We had also intentionally omitted some of the more critical questions from the interview guide because some of the interviewees represent institutions based on political agendas and by saving these questions for the actual interview we expected to get bluntly responses.

The approach to the interviews was phenomenological because we wanted to get an insight into what the interviewees have experienced in order to get a better understanding of the underlying processes and practices regarding the implementation of SUDS from their perspective. (Kvale & Brinkmann, 2015) The way they were expressing themselves was not

important per se, as we also have analysed the conversations and interpreted the answers. The interview guides can be viewed in appendix 8.

The interviews with representatives from the utility companies are characterised by being expert interviews where knowledge related to the specific case was obtained but also on a more general level regarding the practice of stormwater management. The employees at the utility companies represent a certain practice within this kind of institution. We interviewed two residents - respectively from Helenevej and Prøvestens Allé/Kongedybs Allé. It was interesting to get their view on the process especially because they played a big role in the start-up of the two projects.

All interviews have been conducted online due to the corona crisis except for the first interview conducted in March with resident Karl Vogt-Nielsen.

Moreover, the reference to the interviewees in this report will include the month in which the interview was conducted in order to distinguish between our collected empirical knowledge, the secondary literature in the form of policy documents, legislation, the scientific journals, and theory. We do this because the interviewees only represent one perspective on the cases and in order to differentiate the references. The interviewees represent their perspectives but they are also situated in practice, research institutions, and a specific interest group. Further elaboration of the interviewees will follow next.

4.3.1 Karl Vogt-Nielsen, Resident at Prøvestens Allé/ Kongedybs Allé

The interview with Karl Vogt-Nielsen was conducted on a rainy day in March 2020. He is a resident at Prøvestens Allé / Kongedybs Allé and part of the climate group which was the main driver behind the process. Vogt-Nielsen was interviewed in his house where the main focus for the interview was to understand the process behind the implementation of SUDS on Prøvestens Allé / Kongedybs Allé. The interview also focused on the values following such a project which will not be present to the same extent in the other interviews as our focus changed throughout the project.

Vogt-Nielsen had a very good insight into the process of implementing SUDS on the two roads because he played a big role in the Climate group. He also had a good understanding of the political issues and perspectives because he told us that he has been working as a political

advisor for many years. Vogt-Nielsen also knew how to approach the initiation of such a project and which actors to talk to.

However, after this interview, our focus changed and we were not as interested in the specific values that the development of the roads had provided, but more about how the development occurred. We refer to Karl Vogt-Nielsen in the report as (Vogt-Nielsen, March 2020).

4.3.2 Dorthe Stender, Center for Climate Adaptation (at first Technical and Environmental Department)

Dorthe Stender is an employee at The Center for Climate Adaptation (Center for Klimatilpasning) and was the project manager at Skt. Kjelds Plads / Bryggervangen from around 2013 to the final implementation in 2018. The focus of the interview was to understand which actors were involved in the project, which interests they had, and which decisions and practices formed the solution. The result of the interview gives an insight into Stender's perspective on the aforementioned aspects. Although she was not present at the time when the project at Skt. Kjelds/Bryggervangen changed focus, however, she knew the more current aspects of the project and how it has turned out. She represents the practice and perspectives from a municipal point of view and she talks on behalf of her department. Though we must be aware that it is her experiences and perspectives on the project that forms her answers.

She is a practitioner just as the employees at the utility companies, however, the municipality functions as an institution that is politically governed and functions as an authority as well. We refer to Dorthe Stender as (Stender, March 2020).

4.3.3 Helle Rye Westphall, Hydraulic Planner, Frederiksberg Forsyning (The utility company of Frederiksberg)

Helle Rye Westphall was the project manager for Helenevej. She could, therefore, provide us with a view of how the project was developed, which actors were involved, and which focus they have had when developing Helenevej. However, the process happened some years ago and not all information was fresh in her memory. In the interview, we had some questions about how the utility company in general works in practice and some questions about their

work with innovation. Westphall thought it was better if we talked to Henrik Bay about these questions because she had just recently returned from maternity leave and was not updated on the current practices. She represents the practitioner in the context of the utility company in Frederiksberg. And because she has been a project manager, Westphall has a more thorough insight into the actual processes of implementing the solution on Helenevej and other projects as well and she also took part in the meetings and the conversations with the residents from Helenevej. We refer to Westphall as (Westphall, March 2020a/b), the reason behind the letters is that she participated in two interviews. The first one (a) she was the only one participating and the second one (b) she was together with her boss Henrik Bay. We distinguish between the two interviews because the first one (a) was related to the process of Helenevej and the second interview (b) was about the more general practice and other projects as well.

4.3.4 Henrik Bay, Head of Planning, Frederiksberg Forsyning (The Utility Company of Frederiksberg)

Henrik Bay is head of the department of planning at the utility company of Frederiksberg. He could provide knowledge about the focus of the utility company when developing climate adaptation projects and how they collaborate with other actors. Compared to Westphall, he works with the climate adaptation projects on a more general level and he is managing the projects from within and does not have direct contact with the external actors in the local projects to the same degree as Westphall. However, Bay has knowledge about which barriers the utility might experience when managing stormwater, and how their practice related to operation and innovation have changed over the years. We refer to Henrik Bay as (Bay, March 2020)

4.3.5 Jan Nielsen, Resident at Helenevej, Frederiksberg

Jan Nielsen is a resident at Helenevej and was the one who started the project for developing Helenevej. The purpose of this interview was to get an understanding of the process behind the development of Helenevej as well as how the residents were involved and which actors had an influence on the outcome. Nielsen was the resident who came up with the idea of permeable surfacing and he initiated the whole process and got in touch with the utility

company and the municipality. Furthermore, Nielsen is an engineer specialised in roads and traffic and this added an extra dimension to the interview because he had another point of departure concerning the knowledge and background information.

4.3.6 Louise Grøndahl og Lotte Kau Andersen, The Utility Company in the Capital Region, HOFOR

The interview done with Louise Grøndahl and Lotte Kau Andersen was made in order to get an understanding of how HOFOR as the utility company of Copenhagen develops solutions for managing stormwater on the surface. Andersen is responsible for the planning of the green roads and Grøndahl is head of the cloudburst program. We also wanted to get an insight into which barriers and drivers they have experienced in relation to climate adaptation and if they have seen a change in the way they operate and innovate new solutions. We do not distinguish between Grøndahl and Andersen in the references because the conversation was very fluent and they contributed equally to the conversation. However, Andersen had a deeper insight into the planning of the green roads but they work closely together and agreed with each other. We refer to Louise Grøndahl and Lotte K. Andersen as (Grøndahl & Andersen, April 2020)

4.3.7 Malene Freudendal-Pedersen Researcher at Aalborg University

Malene Freudendal-Pedersen is a professor in urban planning at Aalborg University. She was interviewed in order to get a more critical perspective on the implementation of SUDS. Her research is concerned with the role of the car and how this role can be changed. It was therefore relevant to talk to her about how SUDS influences the road regime and how it can challenge it. She is a researcher and not a practitioner and does not have to 'protect' the interests of the municipality or the utility companies. In the context of this project, she contributes with being a critical voice in relation to the road regime and she might contribute with more radical views. The interview with Freudendal-Pedersen was unstructured and we did not provide her with an interview guide. The interview intended to have a conversation based on certain themes and then let the conversation flow and let her contribute with other

aspects than we have thought of. We refer to Malene Freudendal-Pedersen as (Freudendal-Pedersen, May 2020)

4.4 Transcription

The conducted interviews have been transcribed in order to make the data more practical and to ensure that we did not overhear important knowledge. Gibson & Brown (2011) furthermore explain that it saves time to have the interviews transcribed instead of replaying the recordings. Transcriptions are not neutral but are a form of representation and we must keep this in mind when analysing the data. (Gibson, & Brown, 2011) Transcription includes a process of interpretation (Gibson, & Brown, 2011) thus we have chosen to write the words in full instead of representing the spoken language precisely. Moreover, the transcriptions of the interviews do not include onomatopoeic words because this was not relevant in this context, we had a focus on the content and ‘what happened. (Gibson, & Brown, 2011) In the process of transcribing we have also re-visited the interviews and the knowledge and information have been refreshed. The transcriptions have therefore been unfocused because we did not have any specific analytic focus (Gibson, & Brown, 2011). We have used punctuations but have not consciously reflected over this use even though this implies certain intonations and interpretations (Gibson, & Brown, 2011). We have used punctuation in order to make the data more manageable.

Furthermore, all interviews have been conducted in Danish, and all the quotations have been translated into English as directly as possible but changes in structure and wording might occur in order to make it comprehensible in English as well. The quotations used have been marked with purple in the appendix and have been approved by the interviewees.

4.5 Desk Study

A literature study is a method that includes every form of indirect observation of a particular phenomenon. (Andersen & Gamdrup, 2011) This method is used to obtain a pre-understanding of climate adaptation and which opportunities and barriers that are related to the topic. Furthermore, the literature study has been helpful to identify the cases and the associated actors who are concerned with the topic and their visions and goals for the projects. We have also used desk studies to analyse policy documents in order to get an understanding of the regime related to SUDS. The literature study has included municipal

plans, different publications regarding the topic, web pages related to certain projects and books

4.6 Research Design

The multi-level perspective is used in this project to understand the regime within water management and which factors in the landscape that fosters the need for a transition in the regime. In order to gain an understanding of the regime, we have used desk study research to conduct qualitative document analysis of the policy documents from the City of Copenhagen and Frederiksberg, here among their cloudburst- and climate adaptations plans. In relation to this, we have used case studies to investigate SUDS in its context by looking into three cases managing the stormwater on the surface. The main perspectives regarding the process and actors in the case study are obtained through qualitative semi-structured interviews. The strategic niche management is used to analyse the cases in order to understand how the development of the niche affects or accelerates the transition of the regime. Because SNM constitutes a process of network formation and coupling of expectation it shares characteristics with governance models according to Schot & Geels (2008). We supplement the theory of SNM with network governance to analyse and understand the political system in a Danish context, where these experiments and processes of the implementation of SUDS takes place.

On the next page we have illustrated the structure of the project. The figure shows in which chapters we have used the methods, theory and empirical data.

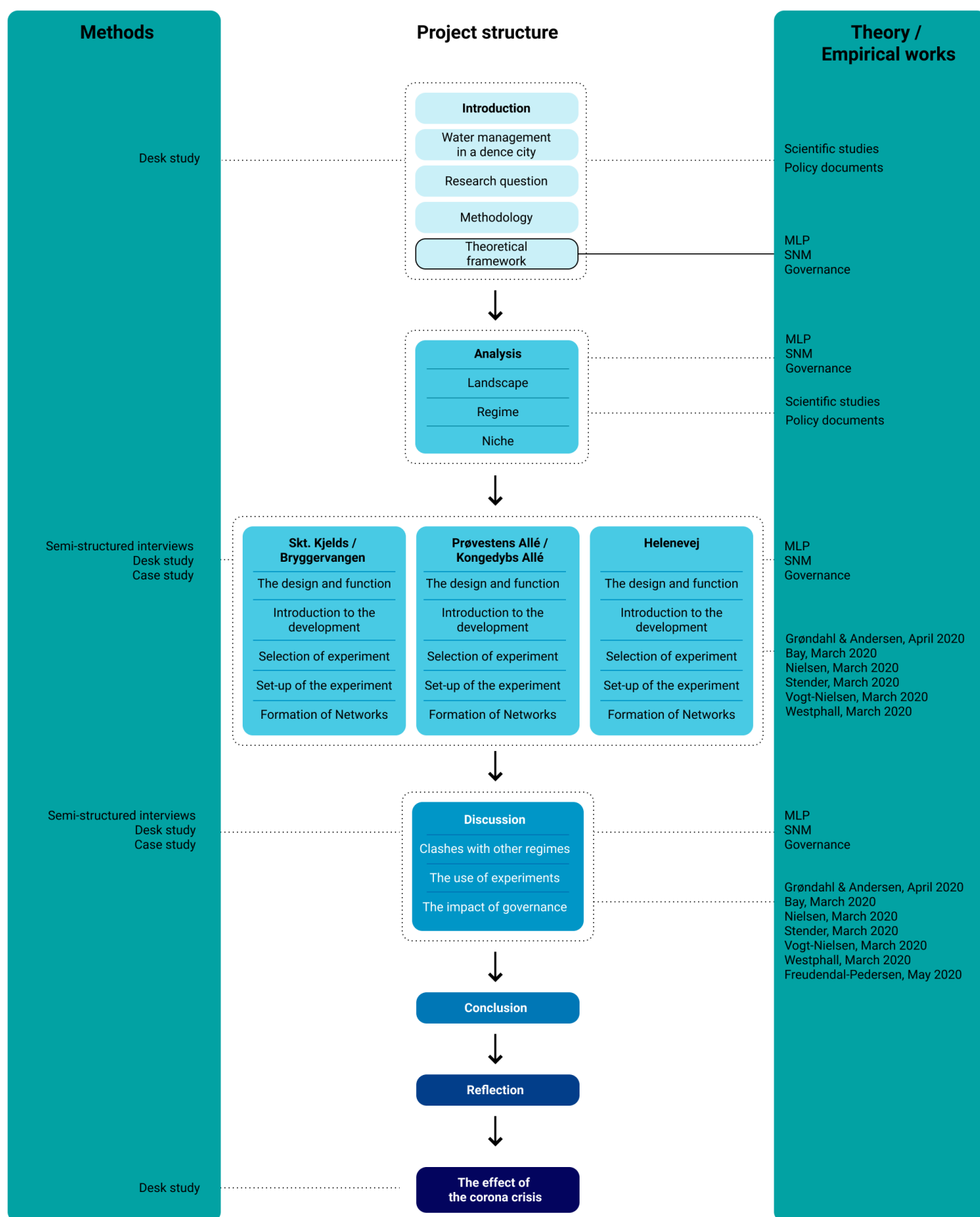


Figure 1 shows the structure of the project (own figure).



5 Theoretical Framework

This chapter will explain the theories used in the project and the relation between the theories. The theories are the multi-level perspective (MLP), strategic niche management (SNM) and network governance. The first section in the chapter will deal with the historical management of water in order to understand the prior transitions in the system and to explain that the water regime is dynamic. Furthermore it will provide an understanding of the different perceptions of the water networks and how this has affected the management.

5.1 Historical Water Management

In order to understand the transition towards a more sustainable urban water management, we must understand the historical incentives for the transformations in the system. The urban water management system has changed throughout time. (Hoffmann & Jensen, 2015)

The closed sewage system leading the wastewater and stormwater into the harbour in Copenhagen was constructed from 1860-1885. The motivation for this construction was to improve the sanitary conditions in the city. When the wastewater was discharged to the harbour it contributed to bad conditions for the harbour life and problems with sludge that had to be dredged away. A further improvement of the sanitary conditions happened when intercepting sewers were installed from 1893-1903 along the harbour, and most of the water from these sewers were pumped into the Sound. Considerations regarding the recipients' capacity to receive wastewater were taken into account in the early 1930s. (Sørensen et. al, 2006) The sewage system constructed before the 1960s is a combined sewage system managing both wastewater and stormwater and the system constructed after this time is a separate system where the wastewater and stormwater is managed separately. (Sørensen et. al, 2006)

A shift in the way we lived, with more single-family housing and an increased focus on agriculture, led to a wish for more control with the water through damming, draining, streamlining of landscapes, and control of the water movement. This created a shift from the sewered city to the drained land. (Hoffmann & Jensen, 2015)

Hoffmann & Jensen (2015) suggest that the water management system can be viewed through the understanding of networks. Furthermore, Hoffmann & Jensen (2015) explain that the development of the system happens through local 'micro-navigations' that connect the

various water networks and other networks in new ways. (Hoffmann & Jensen, 2015) The modern system is the dominating network in Denmark and it is a socio-technical system that is a combination of water supply, the sewered city, and the drained land. It consists of an invisible and underground system where the management and conveyance of water match with the expectations about service and security. It is marked by a service-oriented relation between the (invisible) professionals and the (unlearned) citizens. (Hoffmann & Jensen, 2015) However, the system is not static but is marked by constant development. For instance, environmental aspects such as pollution were put on the agenda in the 1970s by new constellations of networks including the media, students, and leisure fishermen. In the same period, the densification of cities created a need for green spaces in the city and the possibility to use the water in a recreationally manner as well. (Hoffmann & Jensen, 2015) Today the climate change impact on the system has become more visible and this has added an environmental aspect to the management system such as protection against flooding and pollution control. The great pressure on the sewage system can lead to expansion of the current sewage systems as that is what the knowledge and practices are geared to at the moment, however, Hoffmann & Jensen (2015) explain that new solutions regarding surface solutions and integrated approaches with nature and water have been brought into play. These solutions are cheaper and the linkage to new networks creates support for the new practices and the vision about climate-resilient cities. We can now decide in which direction urban development should go in relation to the water management system and nature. (Hoffmann & Jensen, 2015) This creative and liveable system is though under pressure from the ‘market and the efficient water’ where the economic tools have been introduced in order to cope with the inefficient water sector. (Hoffmann & Jensen, 2015) The development of the solutions is still focused on the cost-effective equations between the ‘traditional’ solutions including a expansion of the sewers and surface solutions where nature is integrated. (Mguni et al, 2015)

5.1.1 The Hydro-Social Contract

The urban water management system is dynamic and transitions in the system have happened before and as Hoffmann & Jensen (2015) explain there is a greater focus on the approach where climate adaptation is integrated with urban development with visions about resilient and liveable cities. (Hoffmann & Jensen, 2015) According to Brown & Wong, (2009) the water management system is transitioning through temporal, ideological, and technological

contexts and the transitions are sensitive to other contextual values such as ecologies, histories, geographies, and socio-political dynamics. The framework for the development of the water management system has been conceptualised through a 'hydro-social' contract which Brown & Wong (2009) has adopted from Turton J. Lundqvist and S. Narain from their text about *Social, institutional and regulatory issues*. (Brown & Wong, 2009) The hydro-social contract changes along with the transitions. The hydro-social contract is the values and implicit agreements between communities, businesses, and governments regarding the management of water. The contract is influenced by contextual historic urban water values, culture, geographies, ecologies, and socio-political dynamics. The contract is expressed through the institutional arrangements and the regulatory framework and is physically manifested in the infrastructure. (Brown & Wong, 2009) The hydro-social contract can be used in a Danish context as well and as Hoffmann & Jensen (2015) explain, the water management system in Denmark is based on expectation about service and security. Furthermore, when the water management system is viewed as networks the hydro-social contract becomes relevant as well because it is shaped by the values and approaches related to the water and the institutional arrangements such as the division of responsibility between municipalities and the utility companies. (Hoffmann & Jensen, 2015)

The interests in the hydro-social contract can also be diverging as the case with the development of the sewage system in Copenhagen The first formal hydro-social contract was regarding limitless water supply for the citizens. The development accelerated when it became clear that people got ill through bacteria from waste, sewage, and industrial effluents in the water supply and the need for a new infrastructure was therefore urgent. (Brown & Wong, 2009) This system was based on the expert knowledge from doctors, engineers, and arguments from the growing upper class. The agriculture needed the nutrients but lost the battle and the output ended up being a combined sewage system as we know it today. (Hoffmann & Jensen, 2015) This meant that the overall hydro-social contract remained, but was now including a promise to protect public health (Brown & Wong, 2009)

Because of the pressure from climate change and the need for action the water is now an integrated part of the planning function and the climate adaptation plans are striving to make the water visually and recreational integrated into the city. (Copenhagen, 2011) With new normative value added to the urban water new actors, such as the communities and environmental groups gets involved in the development (Hoffmann & Jensen, 2015) The

hydro-social contract is changing along with the systems and is beginning to include environmental protection and flood control as well as public health protection, supply security, and other well established normative values. (Brown & Wong, 2009). The water management system is dynamic and is in a process of transitioning to a more sustainable water management system with a focus on the integration of water and nature along with urban development. (Mguni et al, 2015) But to understand how the transition is fostered we need to dig into how the systems are built and what affects the possibility for changes. The next section will explain the multi-level perspective (MLP) and the context of transitions.

5.2 The Multi-Level Perspective and Transitions

The multi-level perspective (MLP) provides a framework for understanding and analysing how the major changes and transitions are happening in a multi-level perspective. The model operates with three levels; the regime (meso-level), niches (micro-level), and the landscape (macro-level). (Geels, 2005 [a]) This project will have its point of departure in the regime and niche development as it is used to understand how a transition can be influenced.

The MLP suggests that dynamics on multiple levels makes transitions from one socio-technical system to another possible. MLP analyses how the co-evolution of technology and society, involving technical innovations, cultural, political, economic, and behavioral changes can influence each other in a co-evolution process. (Geels, 2005 [a]). The overarching structure of a society includes markets, consumer demands, institutional and regulatory systems as well as cultural and social values. Technologies are embedded within this wide network of economic and societal systems. (Fratini et al., 2012) The embedded practices, deeply rooted patterns, and cognitive routines explain why the rapid diffusion of new technologies does not happen. That is why sustainable transitions presuppose transformation of large-scale socio-technical systems (Jensen et al., 2017) A transition is an outcome of linkages between multi-level developments and radical changes can happen when the ongoing processes in the landscape and regime levels create a 'window of opportunity'. (Geels, 2002)

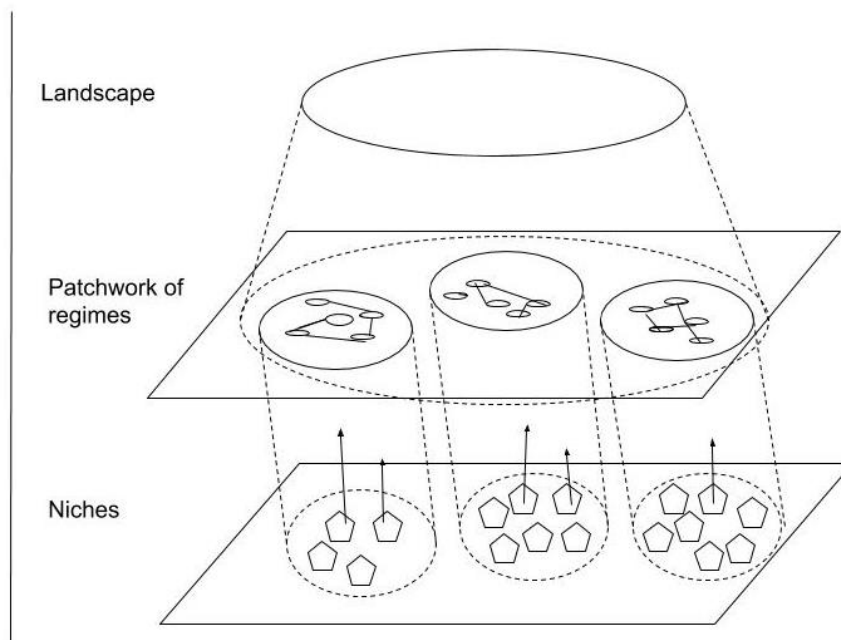


Figure 2 illustrates the multi-levels in a nested hierarchy. (own figure, adopted from Geels, 2005 [a]).

The meso-level is formed by the socio-technical regimes (see figure 1) which represent the stability of the existing systems at large-scale. The ‘socio’-part of the understanding is relating to the shared cognitive routines and the influence of multiple stakeholders and actors shaping the development. The previous understanding as only being ‘technological’ regimes was referred to as the cognitive routines within an engineering community and the explained patterned development was following a ‘technical trajectory’. (Schot & Geels, 2008) A regime is understood as the organisations and the actors who manage the system and the regulatory frameworks as well as practices, processes, policies, and influences. (Mguni et al., 2015) The construction of the regime determines the choice of technology and the ‘normal’ development trajectory. (Smith et al., 2005) However, a criticism of the conceptualisation of regimes is concerned with the empirical levels. A regime may consist of multiple empirical levels and what seems to be a regime shift in one regime may just be an incremental change in inputs for a broader regime at other levels. (Geels & Schot, 2007) In the context of this project, this corresponds to the sustainable management of water, with a focus on stormwater in an urban setting. Stormwater management can be viewed as a regime with certain practices, actors and values within the broader regime of water management including wastewater, drinking water, natural water elements among others. Changes in the practices of this regime might also affect an overall transition of the water regime but the long term

planning for stormwater management is a separate sewage system (Københavns Kommune, 2018), and using SUDS is still implemented as pilot projects and experimentation rather than common practice. (Qiao et al, 2018)

The micro-level is understood as the level where the radical novelties arise (see figure 1) and actors within the niches hope to effect the regimes or eventually transform them - but the regimes are to some extent stabilised and well-established in many ways. (Schot & Geels, 2008) Niches consist of technologies and the associated networks and users and the purpose is generation and development of (radical) innovations. Niches play as ‘incubation rooms’ for innovations and this makes room for nurturing the early development of the niche. This also provides spaces for building up social networks that support niche innovations. (Geels, 2005 [b]) Niches can have the form of small market niches, where there are different selection criteria than in the existing regime. Niches can also have the form as technological niches which are supported by public subsidies or private investments. The technological niches are often played out as experiments or pilot projects, involving users. (Geels, 2005 [a]) There are three important niche-internal processes 1) to create a working configuration, learning and co-construction processes 2) Building social networks that support and invest in the innovation and 3) articulate the visions and expectations. In niches, the social networks are often small and unstable, and the networks often work in different directions. (Geels, 2005 [a])

The macro-level of society is the landscape which is shaped by the broader societal elements (see figure 1) and are not easily or directly influenced by either regimes or niches, but consist of deeply rooted cultural patterns, macro-economics and macro-political developments among others. (Schot & Geels, 2008) The landscape is an external context or structure for interactions between actors. (Geels, 2002) Transitions in this level take decades but it is argued that the emerging threats concerning climate change are pressuring this societal level as well. (Mguni et al., 2015)

The distinction between the levels can be viewed as the extent of structuration they provide to local practices. In the regime level, there are dominant trajectories and it is difficult for the actors to deviate from these. On the niche level activities go in many different directions and

the expectations and visions are vaguer. The landscape provides an even stronger structure for local practices and local actors are not able to change this. (Raven, 2005)

Transitions emerge through interactions between processes at various levels. It is not a result of dynamics at one specific level, the linkage and timing between the dynamics are important for the change to occur. (Raven, 2005) Rotmans et al., (2001) suggests that “*A transition can be defined as a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms*” (Rotmans et al., 2001, p. 016).

The transition can be influenced from beneath when niches have matured and have built up internal momentum. But niches making the changes are aligned with processes going on at multiple levels through mutual adaptation and co-evolution between and within the layers. Changes in the landscape such as climate change and increasing amounts of stormwater creates pressure on the existing regime. This might also cause a destabilisation of a regime which creates windows of opportunities for radical niche innovations. (Schot & Geels, 2008)

As mentioned above, the key point of MLP is that system innovations are developed through interaction between dynamics at multiple levels. The work in niches is often developed in order to fix problems within the existing regimes. Niches are considered in the theory to be crucial for innovation, as they provide the seeds for change, however, the transition can first occur when e.g. the landscape pressure destabilizes the regime and thus, create a “window of opportunity” for niche innovation (Geels, 2005 [a]). According to Geels (2005 [a]), there are four phases in a transition. It is an interplay between dynamics at the multiple levels that make system innovations possible. (Geels, 2005 [a]). The phases are as follows.

First phase: The novelty emerges in niches in the context of landscape development and the existing regime. Actors experiment and investigate user needs. The niches are geared to the problems of the incumbent regime. (Geels, 2005 [a])

Second phase: The novelty is used in small market niches in order to form the technology to the market. A dedicated community will arise to further improve the technology. Users within the market will then interact with the technology, incorporate them into their practices, and explore new functionalities. This phase is part of articulating the users’ preferences. (Geels, 2005 [a])

Third phase: The third phase is characterized by a breakthrough in new technology. A breakthrough can be caused by internal drivers or external circumstances. Internal drivers can be actors with interest in pushing for further expansion of the new technology. External circumstances can be changes at the landscape level, which effects and puts pressure on the regime which creates a “window of opportunity”. (Geels, 2005 [a])

An external circumstance could for instance be climate change. An example is the cloud burst that occurred in Denmark in 2011, which resulted in floodings, combined sewage overflows (CSO's), breakdown in the infrastructure and serious damages that contributed to huge sums of insurance money (Mørk, 2016). Events like this challenge the current technology in the regime. There may occur technical problems that cannot be met with the available technology. Furthermore, the event can have caused a change in user preference or the degree of regulation, which can create problems for the current technology. This level underlines the interaction between developments at multiple levels. (Geels, 2005 [a])

Fourth phase: In this phase, the new technology will contribute to a replacement of the existing regime. However, it would not happen from day to day, as incumbent regimes tend to stick with the old technology as there are already interests and investments bound to them. The new regime may eventually influence wider landscape developments. (Geels, 2005 [a])

The phases provide an understanding of the interplay of the different levels and how this affects niche development. Furthermore, it gives an understanding of the external circumstances, that besides internal drivers, can affect the transition and create the ‘window of opportunity’. Dynamics between the multiple levels in the MLP will make changes possible. Changes in the landscape will lead to pressure on the existing regime. The regime must respond to these changes in the landscape and if the regime is no longer adaptable it creates a potential for the niches to emerge. (Geels, 2005 [a])

The key notion of MLP is that transitions can happen through dynamics and interactions in processes at different levels. The theory contributes to a way of understanding why systems are locked-in and that these dynamics must happen in order to change the regimes. The theory does not tell anything about how niche formation should be managed to mature and influence the existing regimes. (Schot & Geels, 2008) Strategic niche management (SNM) contributes with a tool for managing the transitions through niche development. The ‘early’

SNM approach was too focused on the internal drivers and neglected that external drivers were necessary as well for the success of a technology. These perspectives were added in the 'later' SNM approaches and contributed with a more thorough analysis of niches broader environments and the interaction between niches. Furthermore, MLP tends to focus on one regime whereas niches may be influenced by several regimes or influence several regimes. (Schot & Geels, 2008)

5.3 Strategic Niche Management as a Tool for Change

The MLP does not provide an understanding of how to promote transitions and it points to a more haphazard explanation of why transformation happens. (Hoogma et. al, 2017) That is why we supplement the MLP with strategic niche management (SNM). Strategic niche management is developed to strengthen the understanding of how transitions can be induced or accelerated by niche formation. (Kemp et al, 1998)

According to this theory, strategic niche management is valuable when sustainable technologies must be put forward to guide the overall transition. Kemp et al., (1998) propose the following definition:

“Strategic niche management is the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technologies and (2) enhancing the further development and the rate of application of the new technology”. (Kemp et al, 1998, p. 186)

Kemp et al. (1998) suggest that strategic niche management (SNM) can be used as a tool for transition to sustainability. Niches can be used strategically to guide the transition in a more sustainable direction by introducing new technologies that contribute to new alternatives to the regime. The niches become platforms for interaction and they emerge out of a process shaped by many actors. (Kemp et al, 1998) However, there is a distinction between experiment and niches. Niches are a set of rules, norms, and preferences and they provide structuration to some extent to the local practices. Experiments consist of local practices where the actors learn under local circumstances and the experiments are part of the niches. (Raven, 2005) Strategic niche management consists of five steps; *the choice of technology*,

the selection of an experiment, the set-up of an experiment, scaling up the experiment, and the breakdown of protection by means of policy. The steps are supplemented with a process that includes coupling of expectations, experiments, and formation of new networks and markets that support the niche and help it gain momentum to change the regime. (Kemp et al, 1998)

The Choice of Technology

The technology supported through SNM will exist outside the regime but possess a great potential for mitigating problems inside the regime, such as solving flooding challenges at a fair price. The theory suggests that technology must meet four aims besides solving a problem inside the regime. It must have major technical opportunities embedded in it and have sufficient scope for extension and branching. It must show increasing returns or learning economies. It must be consistent with feasible or actual forms of organisation and it must be compatible with values and user needs. Finally, it must already be attractive for particular use in which the advantages count more than the disadvantages. (Kemp et al, 1998)

The Selection of an Experiment

The setting in which the technology should be used must be chosen after selecting a technology. The choice of setting must accommodate the advantages of technology. (Kemp et al, 1998) In the context of this project, the spaces chosen for the solutions are roads that have problems with flooding or have the potential to combine stormwater management with other aspects by using nature or permeable surfacing.

The Set-up of the Experiment

This step should be shaped by policies regarding the barriers for the experimentation, use, and further development of a certain technology. These barriers may be economic, technical, institutional, or social. The institutional barriers include existing laws, practices, perceptions, norms, or habits. An integrated and coordinated policy is required to deal successfully with these barriers. It is also affected by the extent of protection and this must be balanced. (Kemp et al, 1998) Protection can enable exemptions from the dominant regime rules temporarily and this creates a space for new rules to emerge. (Raven, 2005) If there is too much protection the developers are not necessarily forced to take care of user requirements and avert negative side-effects but too little protection might also lead to other development paths. (Kemp et al, 1998) Possible elements of a policy regarding the set-up could include a

creation of an actor-network, formulation of long-term goals, coordination of strategies and actions, and use of subsidies and taxes. (Kemp et al, 1998)

Scaling up the Experiment

Scaling up the experiment by means of policy is the next step and this step is concerned with the question about whether authorities should bear the costs or also let others take part in the financial circumstances. Even though the experiment is highly successful it may still need support from public policy-makers. (Kemp et al, 1998)

The Breakdown of Protection

Once the technology is adequately developed in terms of user requirements and broader use is obtained through learning processes and adaptations, a breakdown of protection can happen in a controlled way. (Kemp et al, 1998)

In this context, technology is not restrained to only consist of physical, technical elements. The technology is shaped by political, social, and economic factors. (Smith et. al, 2005) According to Geels (2005[a]), technology is heterogeneous and not just a material contraption and the function of the technology depends on linkages between heterogeneous elements. Geels (2005[b]) furthermore, describes the sociology of technology to have three important dimensions: 1) the socio-technical system which consists of the tangible elements needed to satisfy the functions of society, 2) the social groups who reproduce and maintain the linkages and elements of the systems and 3) the rules that orient and guide activities of social groups and actors. (Geels, 2005 [b]) Technology in the context of this project is then understood as SUDS and the new practices brought forward. The niches include socio-technical alternatives (Smith et. al, 2005), and the term ‘technology’ in this context refers to new ways of managing stormwater using SUDS and the potential values and network of actors included in the processes.

5.3.1 The Process of Niche Formation

The strategic management of niche development then becomes a concentrated effort to present new technologies and use protected spaces for such activities. A ‘protected’ space is referred to as the spaces where the experimenting and learning can take place. (Kemp et al,

1998) Niches emerge from an unmanageable process of interaction shaped by different actors. The development process of the niches is bringing knowledge and expertise of users and actors into play and it generates interactive learning processes and contributes to institutional adaptation. The creation of a space for experimentation with technology facilitates a possibility for the technology to mature and be adopted in the long run. (Kemp et al, 1998) Using real-world experimental projects then serve as an important device to foster 'proto-markets'. These can be exploited to explore the possible alignments of user demands, technology, and sustainability issues. (Schot & Geels, 2008)

The aims of strategic niche management are an articulation of changes in the institutional framework and in the technology, to gain knowledge about feasibility and environmental gains of different options, to stimulate further development of a certain niche, and to create support for the technology by actors. Their semi-coordinated actions are essential to foster shifts in practices and technologies. (Kemp et al, 1998)

In order for a technology to be supported through strategic niche management, it must exist outside the regime but has a great potential to alleviate certain problems in the regime e.g. climate change. The technology must meet four criteria to be able to affect the existing regime; 1) possess major technological opportunities embedded in it, 2) prove to have temporal returns or learning economies, 3) be consistent with forms of organisation and be compatible with values and user needs, 4) already showing attractive use for certain applications where the advantages of the technology count more than the disadvantages. (Kemp et al, 1998)

The strategic niche management must allow for a variety of technological options in a transition context while simultaneously striving towards anchoring of the options. (Kemp et al, 1998)

When the expectations of the technologies are coupled with the societal problems it opens up for a sharing of translations between actors and creates an arena to engage in cooperation. (Kemp et al, 1998) The barriers to niche development involve uncertainty and perceptions, however, a learning process regarding needs, problems, and possibilities should then be an important part of the management policies. (Kemp et al, 1998) The learning process will be shaped as an articulation process of the different aspects of the technology. Articulation of technical and design aspects, articulation of policies and the institutional changes necessary

for anchoring of the technology, articulation of psychological and cultural meaning, articulation of the users and the needs and requirements together with the production network, articulation of infrastructure and maintenance and articulation of the environmental and societal effects. (Kemp et al, 1998)

5.3.2 Learning Outcome

The learning processes are very important aspects of SNM, however the level of learning also has an impact on niche development. The learning should not only be directed at the accumulation of data and facts. The learning processes should also contribute to enabling changes in the cognitive frames. (Schot & Geels, 2008) Grin & Van De Graaf (1996) distinguish between two orders of reflection. The first-order reflection is shaped by considerations regarding the definitions of problems and evaluation of the solutions. The second-order reflection is delving into the general perceptions and values that generate the objects and contribute to a reflection of the background theories and systems that affect the situation. (Grin & Van De Graaf, 1996) Schot & Geels (2008) have related the first and second-order reflections to the learning outcomes of SNM and they explain that first-order learning is focused on the efficiency of a certain technology in the context of supporting the visions and goals. The second-order learning contributes to a broadening of the cognitive frames and networks. The inclusion of multiple actors helps strengthen the second-order learning because they contribute with different views and voices, especially if the network involves relative outsiders. (Schot & Geels, 2008) However, independent outsiders do not exist but Schot & Geels (2008) found that the SNM suggests that researchers play a role in the processes by acting as mobilisers, mappers of change dynamics, advisors, and change agents when it comes to sustainable development. This is important in order to promote sustainable development and not only ‘fixing’ problems within the regimes. (Schot & Geels, 2008)

5.3.3 Network Formation

The different steps in SNM are affected by the different actors involved in the processes. The SNM is not just a governmental tool but can also be steered from within or be enacted from

private actors and citizen groups. (Schot & Geels, 2008) It depends on who is the best qualified for the task and who takes the initiative. (Kemp et. al, 1998 p. 188) However, strategic niche management is also concerned with a process of governance with formations of networks, Kemp et. al. 1998 states:

“It should be noted, however, that just like normal management, niche management is not the purview of a single actor but a collective endeavour. Niche management policies are the collective (negotiated) outcome of different interactions at different levels.” (Kemp et. al. 1998 p. 188)

The niches emerge through collective enactment and new constellations may be necessary to generate the changes. Network formation then becomes an important element in the SNM as a development of a niche can require a new actor-network in order to succeed. Many established actor networks within the regime may already be invested in available technology and may therefore not have an interest in stimulating competitive technology. That is why it is important to involve ‘outsiders’ in the networks as they might bring in new ideas because they are not vested in the incumbent regime. (Schot & Geels, 2008)

Public authorities can help to create and facilitate new actor networks. The public authorities can also help to articulate the vision for either the sector or the society in order to coordinate strategies of the technology developers, regulators, investors, and users. The network formation emphasises that the development of new technology is not only dominated by the industry, but also by users and actors who are affected by the results of the technology. (Kemp et al, 1998)

5.4 Governance

Schot & Geels (2008) suggest that SNM is a process of governance as well. It is characterised by steering enacted by many actors and that they are assumed to emerge through collective enactment as aforementioned. SNM is not assumed to be created by governments in a top-down manner but the authorities play a crucial role. (Schot & Geels, 2008) However, SNM is limited to the governance within the networks of the niche. We supplement SNM with elements of governance in a Danish context. The policy practices in Denmark are moving towards a more network-oriented mode of steering though still affected by the traditional hierarchical structures. (Sehested, 2003) The Planning Act represents a

traditional planning system where the responsibility is stated on the different levels; state, region, and municipality. Municipalities hold most of the responsibility for urban planning, but the state still provides the framework (Erhvervsministeriet, 2018). That is why "The Shadow of Hierarchy" is providing the institutional framework for the network governance to work within. (Sehested, 2003)

According to Van de Meene et al. (2011), governance is the management of collective issues, it includes the involved actors and processes used. (Van de Meene et al. 2011) Governance is relevant when dealing with the problems facing our society. (Loorbach, 2010) A new balance between market, state, and society is implied and this makes room for informal network processes where alternative ideas and agendas are generated and this contributes with new definitions for the problems, ambitions, solutions, and agendas. (Loorbach, 2010)

Governance is a structure or pattern that emerges as an outcome of the interacting intervention of involved actors in a socio-political system. It cannot be reduced to one single actor or one group of actors in particular. (Rhodes, 1997) The actors are dependent on each other and each actor contributes with relevant knowledge or resources and no one possesses all the resources or knowledge needed in a certain context. (Rhodes, 1997) Some of the characteristics of governance are:

"1 Interdependence between organizations. Governance is broader than government, covering non-state actors. (...)

2 Continuing interactions between network members, caused by the need to exchange resources and negotiate shared purposes.

3 Game-like interactions, rooted in trust and regulated by rules of the game negotiated and agreed by network participants.

4 A significant degree of autonomy from the state. Networks are not accountable to the state; they are self-organizing. Although the state does not occupy a sovereign position, it can indirectly and imperfectly steer networks." ([Rhodes, 1997, p. 53)

The transition processes involve a flow of resources and interaction between actors through coalitions or networks. In order to strongly influence the development towards a sustainable future, powerful actors are needed in these coalitions and on the other hand, it can also cause inertia when the change diverges from the norms and rules in the nested regime. (Smith et al.,

2005) Governance will include “(...) *processes of consent, dissent, inclusion, exclusion and power relations between the different actors involved*” (Smith et al., 2005, p. 1498).

According to Sehested (2003), urban politics underpins the cooperation between the public and private actors. There has been a shift from the traditional planning, which is mentioned as government, where the urban politics were formed by the politicians with input from planners, where the outcome was strict frameworks that the society and related actors needed to follow. This way of planning was to a high degree imprinted by a hierarchy form of government. Now the urban politics are imprinted by participation by the city's stakeholders, which include politicians, citizens, organisations, and private companies in order to create urban politics across different sectors and stakeholders. It is through these networks that new knowledge and solutions can appear. Urban politics will be created through formal and informal platforms like project groups, partnerships, boards e.g. The outcome will be a fragmented and multicentral city governance. (Sehested, 2003) Different modes of governance co-exist but this thesis focuses on the network governance perspective because networks contribute with dialogue, knowledge sharing, and new learning. (Lund, 2018) Network governance is an articulation of operationally, but interdependent actors. They interact through negotiations under a normative, regulative, cognitive, and imaginary framework. This framework is self-regulated within the limits decided by external agencies. Network governance contributes to a public purpose. The interdependency is crucial and it is created through mutual recognition of the actors and their resources. Resources in the context of spatial planning are political authority, technical knowledge, public participants, the local knowledge from citizens, and ownership and legitimacy. (Lund, 2018) Network governance creates a new form of coordination and management when exploiting the synergy effect in the collaboration between the actors and public sectors in cities and societies. (Sehested, 2003). One of the factors that have changed from government to governance is the involvement of citizens. From the citizens just being end-users, they are now becoming partners and the local stakeholders participate in the local governance processes through their involvement. It opens up for a political process where different stakeholders meet across interests, political culture, work, roles, preferences, and institutional frames. (Sehested, 2003) The engagement of participants in an open and free dialogue and sharing of knowledge is dependent on the actors being more or less equal in power in order to be able to trust each other. (Lund, 2018) Governance processes are based on a political system that is formed by multi-stakeholders from both the market and the civil society and they have achieved a more

crucial role (Sehested, 2003). It is the governance processes that shall create the framework and facilitate the collaboration between the stakeholders, the learning processes and assemble the consensus between the different preferences from stakeholders that are affected by the political decision making. Governance should be seen as a platform where local citizens, politicians, companies, and planners go together to articulate preferences and visions as the foundation for collective steering of a local area's development. This forces a reflexive process in order to assemble consensus. Hereby, arises an opportunity to develop alternative solutions which to a high degree is based on all stakeholders' preferences and opinions. Another value that occurs when involving the stakeholders is a bigger ownership and affiliation to the projects or politics. (Sehested, 2003)

Sehested (2003) explains that even though the network governance has appeared as a response to the hierarchy structure, it must still be understood as something that works in the "shadow of the hierarchy". (Sehested, 2003) Many stakeholders and preferences can shape the network, however, the level of power still plays a crucial role and the rules and regulations are still managed by the state and the municipalities. (Lund, 2018).

5.5 Summary

The theory of MLP consists of different empirical levels - the meso-level describes the regimes and all the practices, norms, and rules embedded within this level. The MLP is in this project used to understand the regime within water management and which factors in the landscape that fosters the need for a transition in the regime. Regimes exist on different scales as well and there can be regimes within the regime. What might seem to be a radical change in one regime would only be incremental changes at another regime. The micro-level consist of niches, these niches function as incubation rooms for development and maturing of novelties. The niches include actors, rules, norms, and user preferences at a very local scale. When a regime is no longer adaptable to the changes in the landscape it opens a 'window of opportunity' for the niches to affect the regime and potentially create a new one. The landscape consists of the exogenous factors, it is shaped by the broader societal elements and deeply rooted cultural patterns and norms as well. Transitions on this level are argued to last for decades but emerging threats like climate change put pressure on this level as well. (Geels, 2005 [a]) The MLP however, only provides an understanding of lock-in and what makes transitions possible but it does not provide us with any tools to guide this transition.

Strategic niche management is argued to be a tool for a transition that niche managers can use strategically to induce or accelerate the transition. A tool that is used in SNM is experiments, and the process of developing experiments and maturing of the niches is shaped by network formation, a coupling of expectations, policies among others. (Kemp et al, 1998) There is a great emphasis on learning in SNM and the theory distinguishes between first- and second-order learning. First-order learning includes evaluations of the efficiency of the technology and how it supports the stated goals and visions. Second-order learning is focused on understanding the underlying norms and practices. The ‘early’ SNM was only focused on the internal drivers but ‘later’ SNM acknowledges the interaction between the dynamics at the different levels and how they affect the potential for a transition. (Kemp et al, 1998) The SNM is used to analyse the cases in order to understand how the development of the niche affects or accelerates the transition of the water regime in regards to stormwater management on roads.

Because SNM emerges out of a process of network formation and coupling of expectation, it shares characteristics with governance models according to Schot & Geels (2008). This is the reason behind the choice of network governance, to analyse and understand the political system in a Danish context, where these experiments and processes of the implementation of SUDS takes place. The danish practice is moving towards a more network-oriented mode of steering, though is the governance still affected by the traditional hierarchical structures, which is understood as something that works in the “shadow of the hierarchy”. Governance is the management of collective issues, and it is through new networks that new knowledge and solutions can appear. Network governance creates a new form of coordination and management when exploring the synergy effect in the collaboration between the actors and public sectors in the sector and society.



6 The Analysis

This chapter will deal with the analysis of the cases. The first section will include an explanation of the landscape factors and the composition of the regime in relation to stormwater management in the City of Copenhagen and Frederiksberg. An exposition of the concerned niche and the choice of technology will follow. Each case will include an introduction to the hydraulic solutions and the initiation of the project. The framework for the analysis of the cases is the steps ‘selecting’ and ‘setting up’ an experiment from the process of strategic niche management. Each case will end with an analysis of the network formation.

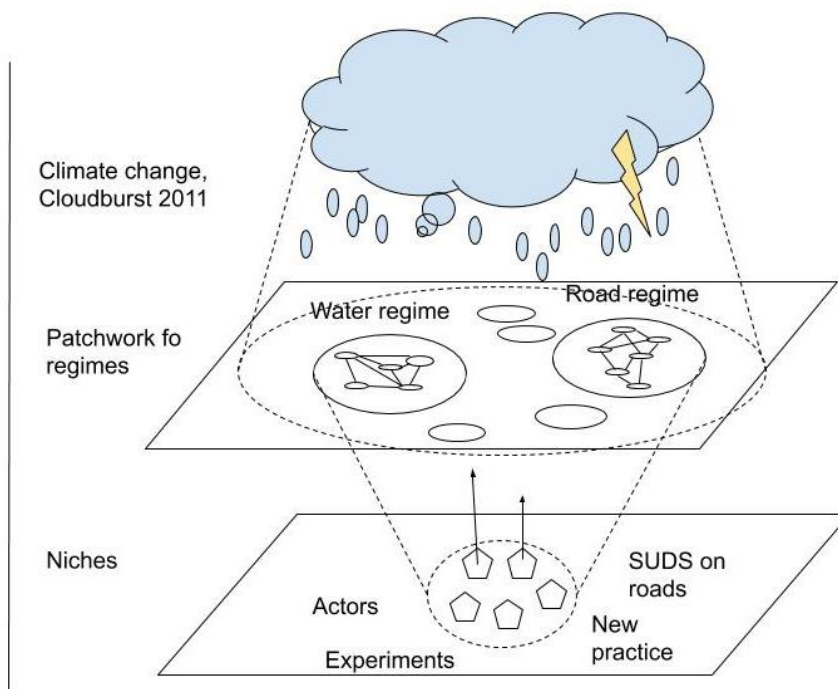


Figure 3 illustrates the MLP in the context of this project (own figure, adopted from Geels, 2005 [a]).

6.1 Landscape

In this study, we will focus on climate change which has formed the landscape level (see figure 2) for the three cases. Throughout the decades, the earth's climate has been in a state of constant change (Københavns Kommune, 2019). Copenhagen is also affected by global changes in the climate. Warmer weather with more extreme rainfall events has been predicted. (Klimatilpasning, 2015). In the summer of 2011, a huge rain event occurred, which

got the City of Copenhagen, the City of Frederiksberg and the citizens to realise how urgent and pressing this problem with stormwater runoff is. Flooding causes numerous problems for the economy, society, and citizens. The extreme rain events cause numerous challenges that cannot be solved by a single solution like upgrading the sewage system (Københavns Kommune, 2012). Humans, animals, and plants have to adapt to the changes in the landscape, which can involve the need for developing new technology (Københavns Kommune, 2019) that is geared towards the problems of existing regimes caused by the change in the landscape (Geels, 2005 [a]).

6.2 The Water Regime in Denmark

Since 2013, the Danish municipalities have been obliged by national authorities to analyse flood risks and prioritise adaptation actions in plans. EU regulations also require that the municipalities act in order to reduce the risk of flooding. Climate adaptation actions and flood control are the responsibility of the municipalities, climate adaptation is envisioned to be carried out through spatial planning. The utility companies are obligated to handle the drainage of the

stormwater. The government does not finance the climate adaptation actions related to stormwater and cloudbursts, it is the responsibility of the utility companies. Securing private property is the responsibility of the property owners.

Even though the development of SUDS is, to a higher degree, happening through network formation, the hierarchical bureaucracies remain in place and affect this development because the state and municipality still maintain their authority over the regulations and laws (Lund, 2018).

As mentioned above, the landscape is changing in relation to climate change. In the future, there will be an increase in the amount of precipitation which will create greater volumes of stormwater runoff in Denmark as the current sewage system within the water regime is not

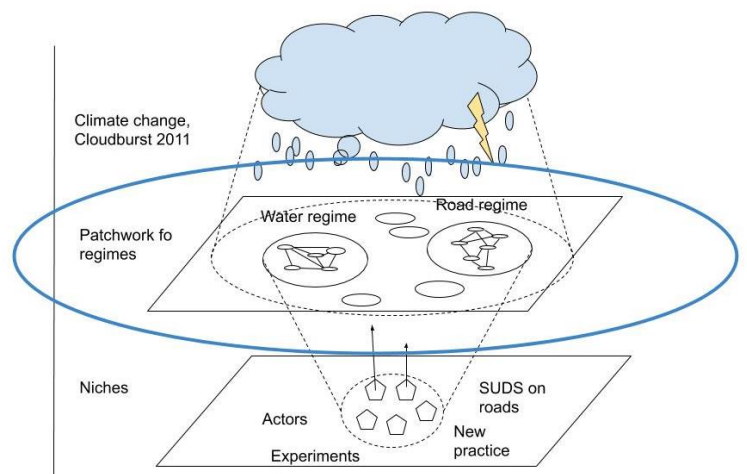


Figure 4 shows the MLP. The blue ring indicates the level of the water regime. (own figure, adopted from Geels, 2005 [a]).

dimensioned to the future amount of water. (Qiao et al., 2018) According to the Cloudburst Management Plan 2012, the current water regime has problems adapting to the changing landscape, and there is a need for a coordinated and joint action when combining the multiple initiatives that shall form the solutions approach for each area. (Københavns Kommune, 2012)

In order to climate adapt Copenhagen, the City of Copenhagen adopted the Climate Adaptation Plan 2011. This plan sets the overall framework for working with climate adaptation in Copenhagen. From the Climate Adaptation Plan, the Cloudburst Management Plan was created with a focus on direct methods and priorities in order to adapt Copenhagen to the changing climate. The Cloudburst Plan was produced in 2012, but is not legally binding but has to be approved as an autonomous plan. The plan must be integrated into the additional plans in the municipality, e.g. the municipal plan, the wastewater plan, and the local planning as well. (Københavns Kommune, 2012) The Cloudburst Management Plan has been coordinated with the City of Frederiksberg, as precipitation in Frederiksberg during an extreme rainfall event has to be led into a sewage treatment plan or be led into the sea through Copenhagen. (Københavns Kommune, 2012) The deadline for the implementation of these initiatives is around the year 2035. (Københavns Kommune, 2012) The City of Copenhagen has been assigned to attain a level of resilience which limits potentially damaging floods from extreme rainfall events that statistically occur once every one hundred years. That means that the City of Copenhagen must secure the roads from not exceeding ten centimeters of water. The Cloudburst Management plan analysis shows that although there is ten cm of water on the roads it is still possible to drive, cycle, and walk. This is the reason behind the service levels on roadways. (Københavns Kommune, 2018) The wastewater management plan is the legally binding plan that is concerned with stormwater management, the municipality must produce the cloudburst plan and the climate adaptation plan, but they are not obligated to follow them. There are some requirements for the content in The Waste Water Management Plan (Spildevandsplanen) regarding goals, status, and actions. The plan is a ten-year framework for the planning and management of wastewater. (Københavns Kommune, 2018) The Waste Water management plan has its legal basis in the *Environmental Protection Act* (Miljøbeskyttelsesloven) and is also regulated through the legislation regarding ‘planning of water’ (Lov om vandplanlægning). (Københavns Kommune, n/a [a])

The City of Frederiksberg is governed by the same principles but they are dependent on the City of Copenhagen in relation to the discharge of the stormwater and water supply. (Frederiksberg Kommune, 2011)

The hydro-social contract in this project consists of an agreement between the utility companies and the municipalities and the consumers. Besides the expectation of access to clean water supply, the hydro-social contract now includes stormwater management as well. The service level for management of stormwater is stated in the Waste Water Management plan and includes a maximum of ten centimeters of water on roads and public areas. However, the corresponding expectation from the utility company to citizens is that they implement measures for protecting their private areas. Furthermore, the implementation of SUDS is also expected to include co-benefits and increased value. (Københavns Kommune, 2019)

6.3 The Niche

As explained in Section 5.3 niches are shaped by networks of actors. They function as incubation rooms for novelties to develop and mature (Geels, 2005 [b]). The approach to SUDS is viewed as a niche because it is not yet common practice (Qiao et al, 2018) but it is still carried out as pilot projects at different locations in the city of Copenhagen and Frederiksberg (Copenhagen, 2011). However, all three cases are affected by external circumstances as well. Both the niche formation

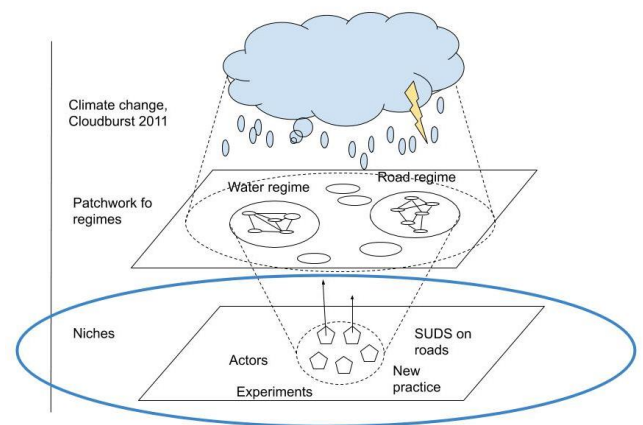


Figure 5 shows the MLP. The blue ring indicates the level of the niche. (own figure, adopted from Geels, 2005 [a]).

and development is strongly influenced by the major cloudburst in 2011, which also has affected the regulations and policies regarding stormwater management. (Westphall, March 2020a; Bay, March 2020, 2020; Grøndahl& Andersen, April 2020) Climate adaptation needs to be an integrated approach where nature-based solutions are used to manage the stormwater. (Copenhagen, 2011) The three chosen cases are analysed through the lens of strategic niche management because they are all examples of a new way of doing things and consist of new network constellations. Each case is viewed as a *selection and setting up of an*

experiment and the process for network formation and coupling of expectations affects the projects as well.

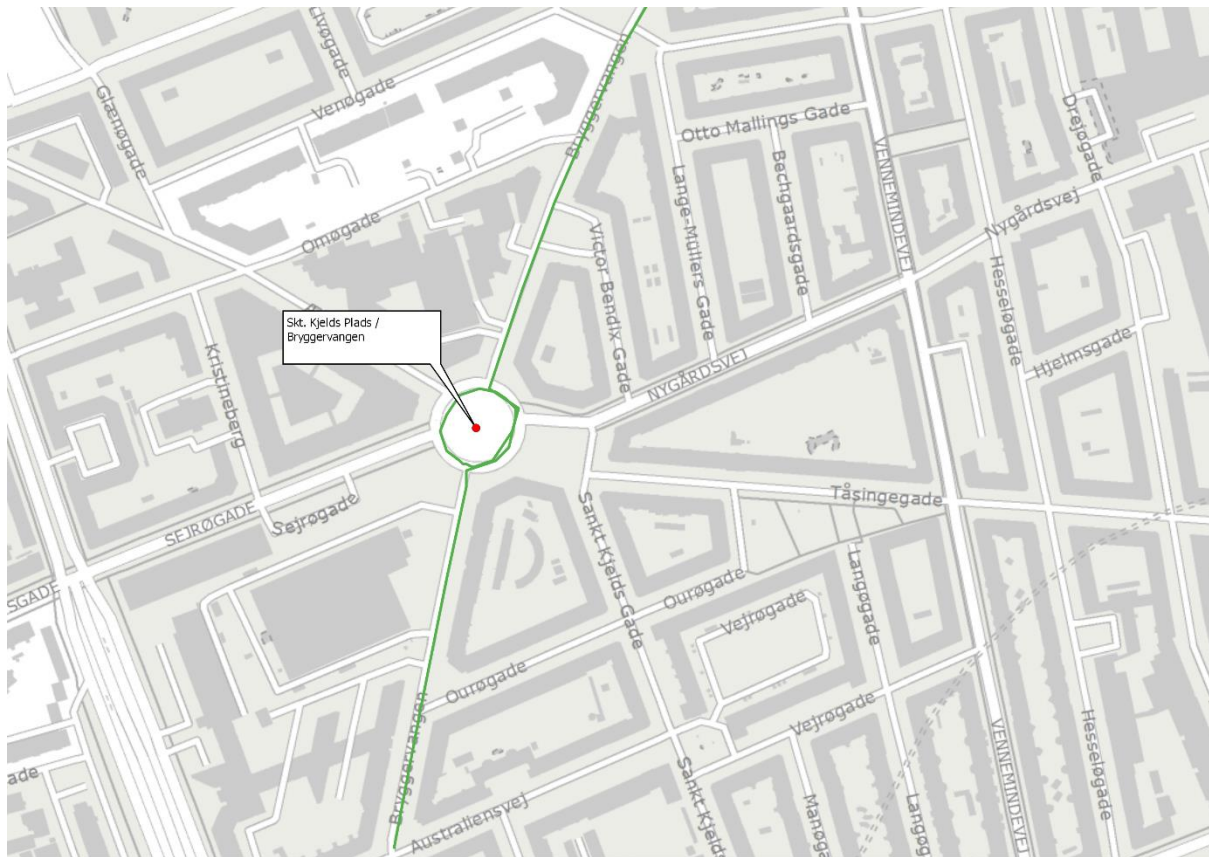
6.3.1 Choice of Technology

There are many different technical solutions in regards to SUDS but this project will not dive into the specific technology. The chosen technologies for the cases are surface solutions including rain gardens, other kinds of infiltration trenches, and permeable surfacing. Rain gardens delay the water to relieve the pressure on the sewers but also allow the water to infiltrate and in the long run add to the groundwater volume. (WSUD in Denmark, n/a [b]; Environmental Protection Agency, 2016) Permeable surfacing also allows the water to infiltrate and a specially designed base layer functions as detention. This solution allows for infiltration as well but is depending on the level of pollutants from the pollutant. (WSUD in Denmark, n/a [a]; Kayhanian et al., 2019)

As before mentioned in section 5.3, there is a difference between niche and experiment. The niche in this context is water management with the use of technologies other than conventional pipe systems and each case becomes an arena for experimenting with a certain technology under local circumstances. (Raven, 2005) The *Selection of Experiment* is the three cases with their specific testing of technology and all three are a part of the niche development.

6.4 Skt. Kjelds Plads / Bryggervangen

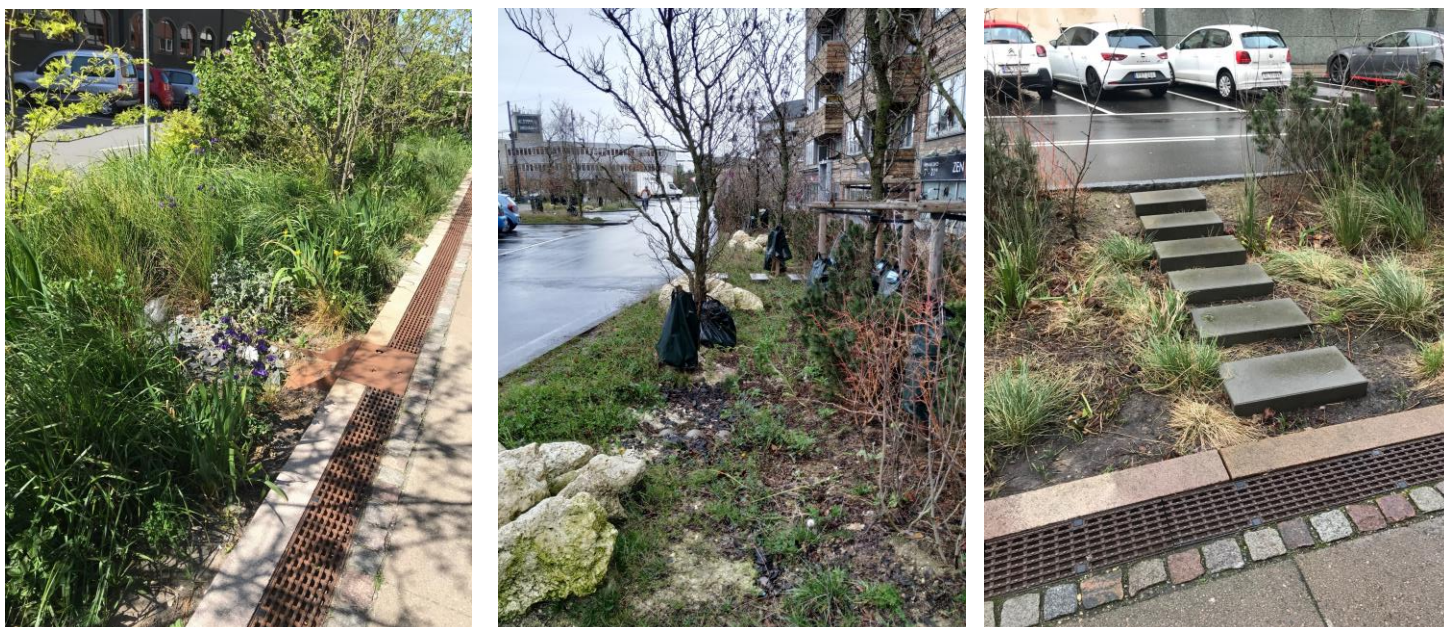
This case covers an area of approximately 35.000 square meters in the Climate Neighborhood at Østerbro, in the City of Copenhagen (see map 2). In the spring of 2015, the architectural office SLA won the project competition and the final project outline was finished in 2016. The project was put out to tender in 2017 and the physical implementation began in spring 2018 and the final result was finished at the end of 2018. (Technical & Environmental Department, n/a [a]; Technical & Environmental Department, 2019)



Map 2 shows the location of Skt. Kjelds Plads / Bryggervangen. (Own map, GIS)

6.4.1 The design and function of Skt. Kjelds / Bryggervangen

The case shows how SUDS can support a green, social, and active living style. SLA who is the landscape architect behind this urban area wanted to characterize the project with wild nature. (see picture 2) All the vegetation in the rain gardens is inspired by the natural area in Copenhagen, such as Utterslev Mose, Amager Fælled, and Kongelunden. (Eye, n/a). The technical solution used in the project is to handle the stormwater on green areas where 30 percent of the stormwater is supposed to infiltrate. In the event of a cloudburst, the excess water will be piped to the port. Because the goal is to infiltrate the stormwater, alternative deicing methods are used instead of salt. Furthermore, the "First Flush" method is used to pipe the first stormwater on the road, then the second flush will lead to seepage in the green areas. (Technical & Environmental Department, n/a [a])



Picture 2 shows different elements of the SUDS on Skt. Kjelds Plads / Bryggervangen (Own pictures).

6.4.2 Introduction to the project development

The project for Skt. Kjelds Plads / Bryggervangen began as part of the Urban Renewal Group (Områdefornyelsen), and their involvement with the locals started in 2010, as a start-up for 'District Plan' (kvarterplan). The main vision for the area was to develop green high street projects. The Urban Renewal Group wanted to remake Skt. Kjelds Plads / Bryggervangen, and the reason for this was because they saw an opportunity to upgrade the urban area and urban life. (Stender, March 2020) Furthermore, the area around including Skt. Kjelds Plads / Bryggervangen, was very grey, which the Urban Renewal Group wanted to upgrade from grey to green. The vision was to create an area that could support recreational purpose, urban life, and urban nature. The vision was to create green, inclusive, and well functioning meeting places. Furthermore, it was the intention that the area should be designed to encourage more walking and biking. (Områdefornyelse i Skt. Kjelds Kvarter, 2011) The project was developed to provide the framework for movement and exploration through flora and fauna in a microclimate of different types of Danish nature. Furthermore, it was a priority that the road became safe for soft road users. (Stender, March 2020). The Urban Renewal Group created a strategy that involved close cooperation with engaged citizens, companies, associations, and institutions. In 2011 the big cloudburst occurred and, together with the climate adaptation plan, changed the way municipalities work with climate adaptation. This event refers to phase three in MLP in a transition (Chapter 5). The cloudburst in 2011

occurred with such an enormity, that it showed which future we are facing. As described in Chapter 5 events like the one in 2011 destabilised the regime and created a "window of opportunity", as changes at the landscape level will put pressure on the regime. This was one of the reasons why the municipality started to work more actively with climate adaptation and selected the area at Østerbro to be the climate neighborhood. From 2011 until around 2014 the program for Skt. Kjelds Plads / Bryggervangen was developed. When the project changed character new expectations arose but the new foundation could be coupled with the 'old' visions as well. The area was supposed to solve problems with flooding and still encourage physical activity and by using nature these visions could be combined. The new vision for the project at Skt. Kjelds Plads / Bryggervangen was to show how a whole neighborhood could manage the future volumes of stormwater and the heavy cloud burst at the same time contain new green areas to support a liveability. (Københavns Kommune et al, 2014).

6.4.3 Selection of Experiment

At first Skt. Kjelds Plads / Bryggervangen needed to be renewed, as it was an obsolete area which did not match the quality of the rest of Copenhagen. This was the reason behind the Urban Renewal Group in 2010, where the vision for the area was to strengthen the physical, cultural, and social aspects of the area through activity and movement.

In 2012, a year after the new requirements emerged in relation to climate change, involving initiatives that could manage the stormwater whilst simultaneously creating new green spaces. (Julskjær, 2019) Skt. Kjelds Plads / Bryggervangen was pointed out to be part of Copenhagen's Climate Neighborhood. The actor-network behind Skt. Kjelds Plads / Bryggervangen now needed to create a project that could live up to this new identity ([71] Københavns Kommune). Furthermore, it needed to interact with the users' visions and requests from the participation processes in 2010 (Stender, March 2020). As mentioned in Section 6.3.1 the technology used for Skt. Kjelds Plads / Bryggervangen were surface solutions, which both HOFOR, Technical and Environmental Department, and the Urban Renewal Group could see great potential in. HOFOR was involved as a strong actor, after the cloudburst in 2011 because the project changed to focus on climate adaptation. However, this technology challenged the road regime, as the water shifted from being managed

traditionally, below the surface in sewers, to being managed at a surface level. Therefore arises a need from the Technical and Environmental Department to have a constant dialogue of values and compromise between the actors in order to establish the project's goal and vision.

“Even though there is an overall purpose for the project, there will still be different interests in the urban area. It can be between the urban area, cyclist, pedestrians, car traffic, etc. so there is a constant balancing between the different interests” (Stender, March 2020).

The project at Skt. Kjelds Plads / Bryggervangen wanted to include many different elements, which was at the expense of the traffic-related considerations. The area is safe for traffic, however, many users, especially cyclists, feel that it is unsafe. According to Stender (March 2020), this is a clear example of where the project has been balancing between the different visions. The final result shows that it has been a higher priority to create space for nature and for SUDS, which affects the accessibility for cars, cyclists, and pedestrians (Stender, March 2020). According to Kemp et. al. (1998), there are areas for which the new technology is attractive, in which the disadvantages countless and the advantages are valued higher. Creating space for nature and SUDS at Skt. Kjelds Plads / Bryggervangen was valued higher than the accessibility for both cars and cyclists. (Stender, March 2020)

6.4.4 The Set-Up of Experiment

When developing Skt. Kjelds Plads / Bryggervangen, there were some barriers bound to the technology which required experiments when developing the new technology. According to Stender (March 2020), the project was established as a pilot project, where the involved actors experimented with and learned from different concepts. For example, The Technical and Environmental Department of the City of Copenhagen chose new kinds of plants and trees, which The Technical and Environmental Department had not worked with on other projects. It was a learning process for the operational staff, regarding how to maintain the selected plants and trees. This resulted in an institutional barrier that the Technical and Environmental Department needed to accommodate, as the operating staff needed to change their practice in order to maintain Skt. Kjelds Plads / Bryggervangen. According to Stender (March 2020), it was necessary to rethink what they normally planted and how to tender the

plants, as this project allows some self-replanted plants and weeds to stay, in order to increase and reinforce biodiversity.

Another experiment that was done when developing Skt. Kjelds Plads / Bryggervangen was the “First Flush” method. HOFOR implemented a “First Flush” cord in the south of Bryggervangen. The idea behind it was, that the ”first flush” of precipitation on the road goes to the sewage, following a closing of the sewage, and the ”second flush” of precipitation that hits the road will then be led to rain gardens. There is a sampling well installed at Skt. Kjelds Plads / Bryggervangen, that check how clean the ”second flush” of precipitation on the road is, as the water needs to have a certain quality in order to be led to the rain gardens for infiltration (Stender, March 2020). Because of the “First Flush” and the sampling well, it is possible to take samples at Skt. Kjelds Plads over the next couple of years, in order to analyse the degree of pollutants in the stormwater runoff from the roads.



Picture 3 shows different elements of the SUDS on Skt. Kjelds Plads / Bryggervangen (Own picture).

This is very useful work, as calculations are mainly based on theoretical empirical data regarding this, and not that much practical empirical data (Stender, March 2020). The analysis of the data can now provide information for future road projects with the same traffic load for when the precipitation will be clean enough to lead it into more vulnerable areas and not just lead into the sewages. This data can be used as evidence when the water is intended to be reused. (Klimatilpasning, 2019)

6.4.5 Formation of Networks

From 2010 to 2018 where Skt. Kjelds Plads / Bryggervangen was developed, different actors were involved to a varying degree (Stender, March 2020). Stender (March 2020) explains that some of the actors were just obeying orders from the Technical and Environmental Department, like the entrepreneurs and SLA landscape architects. Last-mentioned had to work within the program, but were expected to come up with their visions and ideas for the project that could embrace the overall vision for the area. The Technical and Environmental Department was a major actor in the project as they facilitated the process, as well as financed everything related to the recreational aspects. The Technical and Environmental Department also consists of a network that contributed to the development which consisted of traffic-actors, actors with knowledge about trees and landscaping, and actors related to urban life. (Stender, March 2020) In addition, the Urban Renewal Group was an important actor as they had a network with the users. The last major actor was HOFOR who was in charge of implementing the technical elements related to hydraulics and they financed everything related to the hydraulics as well. As the project was implemented on municipal roads (kommunevej), there were not any private investments included in the financing. The Technical and Environmental Department facilitated workshops placed at the office of The Urban Renewal Group, in order to invite actors to come and comment on the project. According to Stender (March 2020), the Technical and Environmental Department was aware that one actor would not have the competence to develop Skt. Kjelds Plads /Bryggervangen alone. The development had to be done through a network of actors, who all had different competencies and resources they could contribute to the project.

Besides the actors mentioned above, actors such as SLA Architects, Alecia, Jens Rørbech, NIRAS, Entrepreneur Ebbe Dalsgaard A/S, local citizens, local companies, and associations were involved in the process. Furthermore, Kildevældskirken was involved and two foundations which have two properties in the area (housing associations), Statistics Denmark (Danmarks Statistik), a car dealership, Ø-bro wood, Meny, and Pelican Self Storage. (Stender, March 2020)

When forming a new network in relation to Skt. Kjelds Plads / Bryggervangen, there were different sets of goals and visions for each actor. However, according to Stender (March

2020), there was an overall understanding that the project should be implemented through cooperation between the actors. Within The Technical and Environmental Department there is a guideline for how to cooperate with actors and which parties have which resources. However, in a project, there are some common goals and purposes but also some different goals and responsibilities regarding utility companies and municipalities.

“There will therefore always be a different practice between the two actors, but with certain elements, we need to cooperate, and we need to do it well” (Stender, March 2020). Regarding the different area of responsibility Grøndahl & Andersen (April 2020) elaborate that HOFOR is assigned to The Co-Financing Act (Medfinansieringsbekendtgørelsen) and they need to substantiate the cost in relation to the specific projects for the Utilities Secretariat (Forsyningsekretariatet) and constantly make sure that it is cheaper than a traditional solution *“After all, that is a cornerstone, that makes it possible for our projects to get through”* (Grøndahl & Andersen, April 2020) Thus, it is important to remember that HOFOR is obligated to fulfill the efficiency demand and it becomes their precondition rather than the goal. (Grøndahl & Andersen, April 2020).

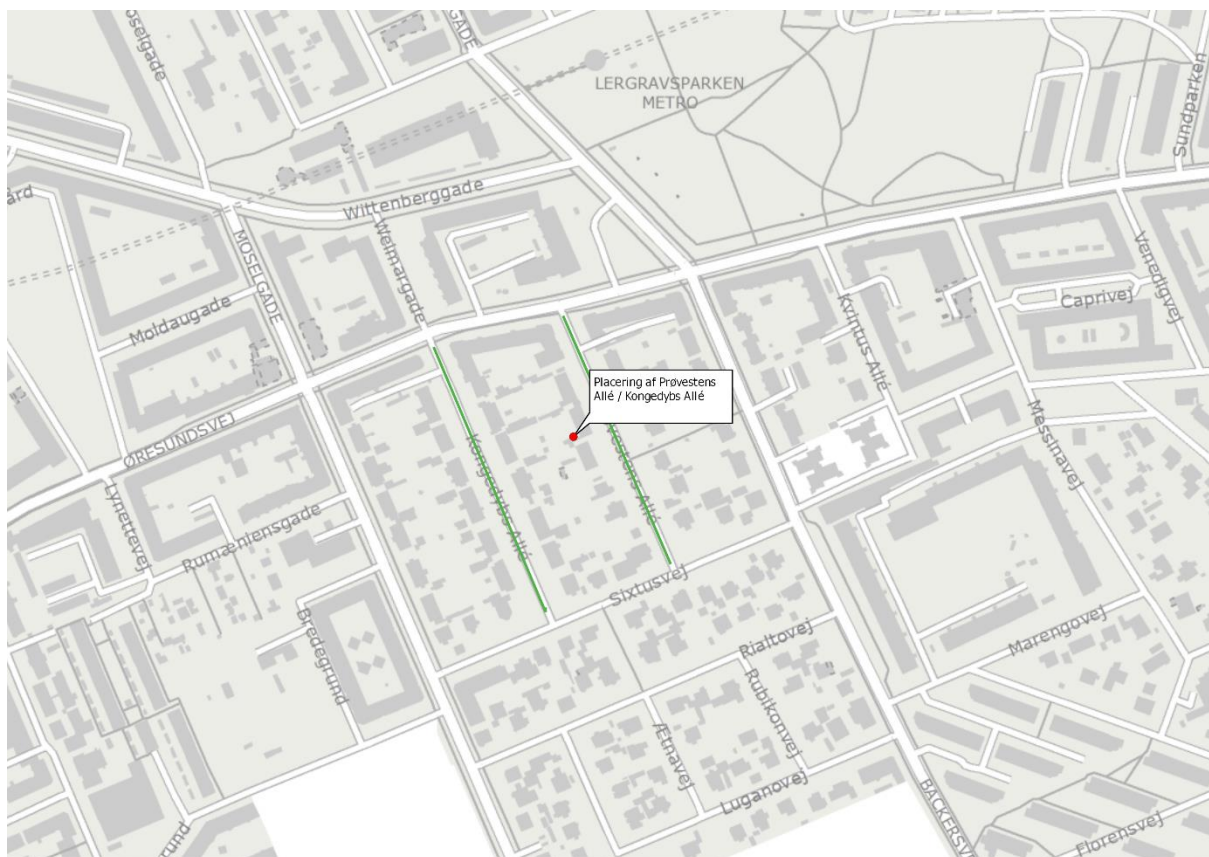
In order to encourage ownership and affiliation for the locals to the project, there was an experiment where the Urban Renewal Group and the Technical and Department encouraged interested local residents to maintain the road and squares. However, despite the intention, it was not a success in this project as 1) it was difficult to get people to sign up, as many of the local residents already had green backyards connected to their property and 2) if the locals cannot manage to maintain the roads properly, the operating staff still need to do it themselves, and all in all still need to keep certain supervision with the project. According to Stender (March 2020), the size and design of the project can play a role in why it did not work out, and in her mind, there would probably have been more involvement in the project if it was smaller and more manageable. (Stender, March 2020)

According to Stender (March 2020), there was a great focus on involving actors and their visions for the area throughout the process. However, having the Urban Renewal Group involved helped when mapping the actors' visions, as they might be more in touch with what is going on locally and their work is focused on involving the residents and mapping their interests. Furthermore, their time frame is a minimum of four years which allows them to delve into the area and thoroughly map the interests and visions of the actors. (Stender,

March 2020) However, Stender (March 2020) is aware of the framework that the Technical and Department is working within

“The degree of involvement is often affected by the amount of resources and the timeframe, as the Technical and Department (including Center for Climate Adaptation) has a timeframe and a budget they need to stick to” (Stender, March 2020).

Many projects have emerged from a project package that politicians decide for, so the projects are to a certain point bound to this package, and there can be some limitations for the project and how much it can be developed. (Stender, March 2020) The process and the final project was therefore to a large extent also affected by ‘The Shadow of Hierarchy’ (Sehested, 2003) as the Technical and Department is, by the politicians, bound up to a certain framework that the project must be developed within (Stender, March 2020).



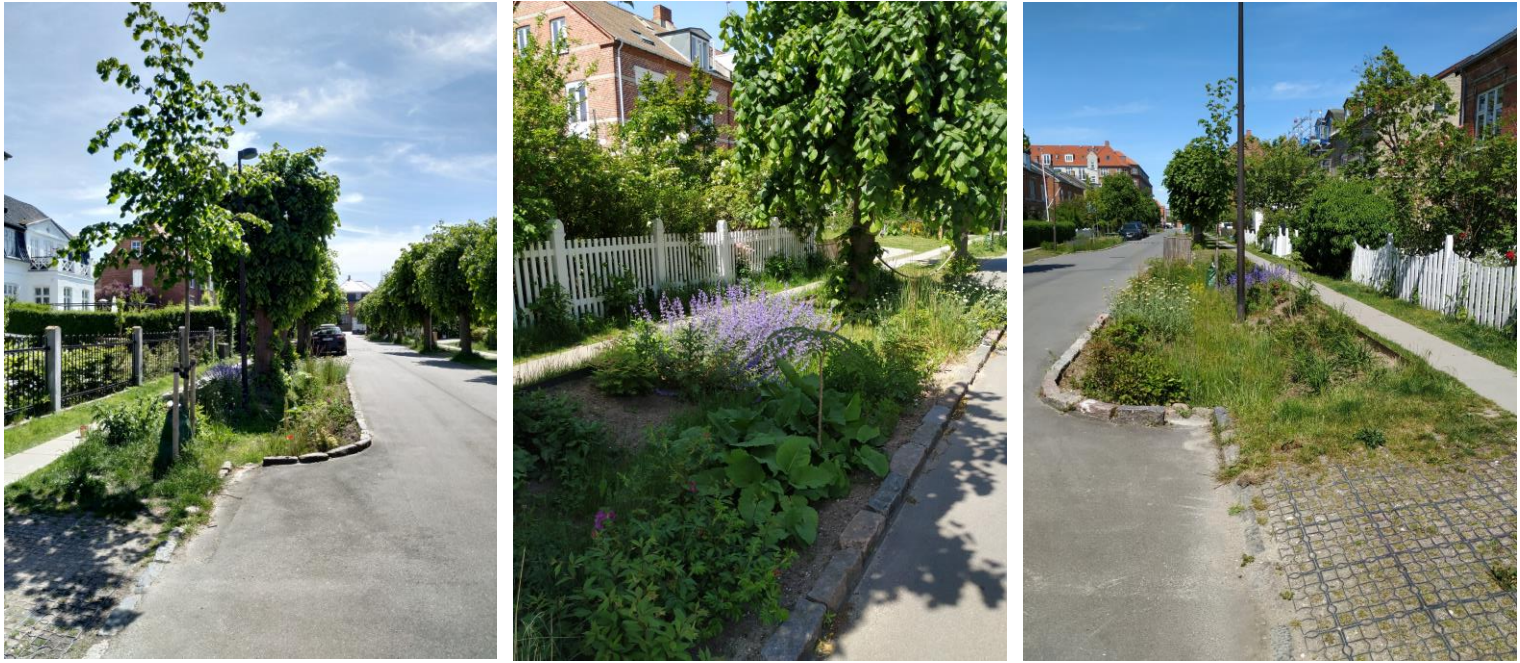
Map 3 shows the location of Prøvestens Allé / Kongedybs Allé. (own map, GIS).

6.5 Prøvestens Allé / Kongedybs Allé

This case consists of a Homeowner's Association called Grundejerforeningen Øresund (GF Øresund) and includes the two roads Prøvestens Allé / Kongedybs Allé located in Amager (see map 3). The two roads are private roads. The project was according to Vogt-Nielsen (March 2020) initiated around 2009 by request from students from The University of Copenhagen, Faculty of Life Sciences (later SCIENCE) (Grundejerforeningen Øresund, n/a [a]). The first draft for the design of the road was produced in 2010. (Thing & Wainø, 2010) The contract in regards to the collaboration with HOFOR was signed in 2014 and the final decision of choosing a 'green' solution was according to internal documents carried unanimously on a General Assembly in 2016. (Grundejerforeningen Øresund, n/a [b]) The actual implementation began in the beginning of 2017 and was finished in late summer 2017. The vegetation was completed in November 2018 (Grundejerforeningen Øresund, n/a [b]). The next step is to decide the final design of the road and the activities. (Vogt-Nielsen, March 2020)

6.5.1 The design and function of Prøvestens Allé / Kongedybs Allé

The technical solutions on the two roads consist of eight rain gardens shared between the two roads (see picture 4). The rain gardens are comprised of 30 centimeters of filter soil allowing the water to infiltrate. The gardens are managing the water from the road itself and are dimensioned for a five-year event. (Klikovand Sekretariatet, 2017; Årstiderne Arkitekter, 2016).



Picture 4 shows different elements of the SUDS on Prøvestens Allé / Kongedybs Allé (Own pictures).

6.5.2 Introduction to the project development

The network at Prøvestens Allé / Kongedybs Allé consists of a homeowner's association called Grundejerforeningen Øresund (GF Øresund) and a 'road guild' (Vejlav). The 'Road Guild' takes care of the maintenance of the roads. The homeowners pay a certain amount of money per household to the association and per metre of footway that belongs to each house to the 'Road Guild'. A household does not necessarily have to be a member of the 'Road Guild', but in case of renovation or maintenance, they have to pay a certain amount of money up-front. (Vogt-Nielsen, March 2020; Grundejerforeningen Øresund, n/a [c])

They have established different task groups in order to ease the workload of the board and because of personal interest. The task group that is relevant in this context is the 'Climate Group' (Klimagruppen). The 'Climate Group' was established in 2007/08 and consists of local residents with a special interest in climate problems. They wanted the association to act responsibly and help prevent or mitigate the consequences of climate change. The 'Climate group' worked with different precautionary measures such as the possibility for energy optimisation and a car-sharing settlement. (Grundejerforeningen Øresund, n/a [c]) In 2009 the Climate Summit was taking place in Copenhagen and the 'Climate Group' hosted different activities in order to gain more insight into how they could 'act local, think global' and a

professor from KU-Life took part in a tour around the neighbourhood and she suggested that the roads had great potential for development. (Vogt-Nielsen, March 2020)

The next section will explain the different steps for the development of the climate road at Prøvestens Allé and Kongedybs Allé and the reasons behind the choices and the involvement of actors.

6.5.3 Selection of Experiment

The two roads in the area became the focal point of implementing SUDS in the homeowner's association. The point of departure was a project made by a group of students from KU-Life regarding climate adaptation on roads in collaboration with Water in Cities (Vand i Byer). In order to promote the slogan "Act local, think global" (Handle lokalt, tænk globalt) they made a small video about the project. The video was made with financial funds from The Environmental Protection Agency (Miljøstyrelsen). (Vogt-Nielsen, March 2020) This was the starting point in 2009 for choosing a solution for the roads that could manage the stormwater. The chosen solution had to be a combination of stormwater management and making the road more inspiring and creating room for recreational purposes as well in order to meet the requirements of the users. According to Kemp et. al. (1998), the technology must be compatible with the users' needs and values and the homeowner's association already wanted to increase the social activities going on on the road (see picture 5), so the solution had to support this. (Vogt-Nielsen, March 2020)



Picture 5 shows examples of the possibility for social activity at Prøvestens Allé / Kongedybs Allé (own pictures).

The first draft included a collection of water from the roofs as well as water from the road but it turned out to be too expensive in contrast to the budget. (Vogt-Nielsen) Here the disadvantage of the selected solution was limiting the application (Kemp et. al. 1998) because it was not in accordance with the budget and the ‘Climate Group’ had to be less ambitious in their choice of solution. However, they wanted it to be stormwater management with co-benefits as well. (Vogt-Nielsen, March 2020)

“It was greater volumes of stormwater, right. We make a less ambitious, not with the houses nor finish it all at once, we have to do it in phases. So we begin with making the holes and then we must wait and see what we can do because the idea was that the entire road will be more creative with spaces for playing and so on. The holes also had to have a function, and example could be that it could be covered and benches could be placed on top - they should just manage water underneath” (Vogt-Nielsen, March 2020)

As mentioned before, the ‘Road Guild’ is responsible for the maintenance of the roads and they received an enforcement notice concerning the condition of the curb and the asphalt.

The idea about using the roads for climate adaptation turned up before the enforcement notice however, this notice contributed to the continuing work of the ‘Climate Group’ of investigating the possibility to implement SUDS on the roads. According to Vogt-Nielsen (March 2020), it turned out to be a big hurdle to overcome this enforcement notice and get a dispensation or postponement. (Vogt-Nielsen, March 2020; Grundejerforeningen Øresund, 2010)

This beginning of the process corresponds with the first phase of the transition process (Chapter 5) because the work in this niche is geared towards the challenges in the current regime but they also have to overcome institutional and economic challenges (Geels, 2005 [a]). Aspects such as postponement of renovation projects and downscaling of scope for the project affect the success of the niche. However, the involved actors are supporting the project and they are hosting a lot of different workshops in order to get input from the involved residents. (Vogt-Nielsen, March 2020) Furthermore, the project at Prøvestens Allé / Kongedybs Allé was initiated before the big cloudburst in 2011, but the event affected the process as well. Vogt-Nielsen (March 2020) explains *“It was not what initiated it, no, I just think it was an eyeopener to say, okay, this is a good project we’ve got rolling.”* (Vogt-Nielsen, March 2020) The cloud burst event gave the experiment more momentum and this relates to the third phase in the transition. (Section 5.2)

6.5.4 The Set-up of Experiment

The implementation of a sustainable urban drainage system at Prøvestens Allé and Kongedybs Allé included many different barriers such as economic deficits, social challenges, and clashes with the road regime. The social challenges included the persuasion of a few residents in order to accept the proposed design. (Vogt-Nielsen, March 2020) When the water is supposed to be managed closer to the surface and then takes up space on the streetscape, it challenges the way the road is viewed. To make room for the rain gardens, they had to further abolish parking spaces. They had been through a process of turning the road into a ‘play street’ (leegade) in accordance with regulations on parking spaces and speed limits on such streets. (Transport-, Bygnings- og Boligministeriet, 1978),

“I also want to add that one of the preconditions we really had here was that many years ago we turned it into a ‘play street’ and that meant that parking spaces on the whole were removed, there only had to be a few”. (Vogt-Nielsen, March 2020)

Vogt-Nielsen (March 2020) explains that GF Øresund already had a changed mindset about the road - they did not perceive the road as the domain of the car but as a social space for the residents. (Vogt-Nielsen, March 2020)

The utility company (HOFOR) is only allowed to pay for the technical solutions which are directly connected to the management of the stormwater, (Klima-, Energi- og Forsyningsministeriet, 2019) the recreational aspects must be paid by the ‘Road Guild’ and this meant that HOFOR had to implement all the technical elements first without considering the recreational aspects. The roads are currently under further development and they have established an ‘Activity Group’ that takes care of the recreational and social aspects. (Vogt-Nielsen, March 2020) The set-up of the experiment was then mainly focused on the management of the stormwater on the road and the implementation process is happening in phases. According to Raven (2005), characteristics of the network are important in this step due to a possible change in expectations and learning outcomes. This may lead to a new composition of actors and the production of results affect the learning outcome. (Raven, 2005) Because the development and set-up of this experiment are happening in phases the network formation may change and other task groups take over. (Vogt-Nielsen, March 2020) The utility company was not experienced in collaborating with a private homeowner’s association and all the legal aspects were challenging. (Vogt-Nielsen, March 2020) However, HOFOR and the City of Copenhagen are currently working on a pilot project, where the goal is to learn about implementation processes on private roads and trying out different solutions. (Grøndahl & Andersen, April 2020) There should already be information and knowledge to gain from GF Øresund because they have been through the same process. They were also very focused on sharing their experiences and learning outputs. (Vogt-Nielsen, March 2020) The residents at Prøvestens Allé / Kongedybs Allé are taking care of the maintenance of the roads themselves. They now have two ‘workdays’ a year where the residents meet and attend to the roads, the trees, and other vegetation. These workdays contribute to the strengthening of the community feeling on the road. Vogt-Nielsen (March 2020) explains *“But then there is, well the community feeling has grown bigger in the road guild, the homeowner’s association, right. Because now we also have this (red. climate roads) to take care of, right”*

(Vogt-Nielsen, March 2020) This will not necessarily be the case for the other pilot projects and this might affect the public support for the projects.

“It is technical facilities and they have to function as intended. That is why our operation staff are very hesitant about having people running around and planting or removing stuff, when there is a certain purpose in relation to the maintenance. There are certain requirements as to how it should be, it should look neat and it must function according to the hydraulics. All things considered, there are elements that entail they have to be professional. That is why we have discussions about it, also internally, because some would like to make larger agreements with some of the private associations, and they will feel engaged and that is also true.” (Grøndahl & Andersen, April 2020)

In the new pilot projects, the utility company will play a stronger role in the implementation and the initiatives come from above with a voluntary sign up. (Grøndahl & Andersen, April 2020)

6.5.5 Formation of networks

Different actors have been involved in the process of implementing SUDS on the two roads Prøvestens Allé and Kongedybs Allé in Amager. Some actors are more directly involved in the process, whereas others just contribute with financial resources or take part in a bigger network. There are two different boards in the area, The Board of the ‘Road Guild’ who make decisions about the maintenance of the roads and ‘The Board’ of the Homeowner’s Association that make decisions regarding homeownership and everything in relation to this. The ‘Climate Group’ have been the main drivers in the development and implementation of SUDS but they do not possess any decision-making authority so they had to confer with either The Boards or the General Assembly (a union of all the homeowners) in order to realise the project. (Vogt-Nielsen, March 2020)

The ‘Climate Group’ were the ones who took care of the communication with the department in the municipality who is responsible for the maintenance of the roads (Center for veje) and contacted HOFOR and invited offers for the design. Every time they made progress and new aspects were brought into play they had to get authorisation from the General Assembly. (Vogt-Nielsen, March 2020)

The process and development of the climate roads involved some financial funding in the initial phase of the project from The Environmental Protection Agency and from the local environmental organisation called Miljøpunkt Amager. They used the money from The Environmental Protection Agency to make small films regarding the project, and the money they received from Miljøpunkt Amager was used to hire an advisor that could take care of all the planning and coordination between actors. The advisers were from the company Højgaard, and it was not coincidental that they got involved. They had a project regarding climate adaptation of 40 roads in a residential area like the one at Prøvestens Allé / Kongedybs Allé. However, the roads included in the project were not as far ahead as GF Øresund. Højgaard agreed to engage in their project and use them as inspiration for the other roads. (Vogt-Nielsen, March 2020) The architects, Årstiderne Arkitekter were involved when the sketching of the design was carried out.

During the whole process, the local residents were being involved through workshops and general assemblies. These workshops contributed to brainstorming and sharing of ideas and knowledge and the general assemblies had a more formal purpose. They had to make decisions about solutions and make changes in the articles of association (vedtægter) in order to satisfy doubtful residents and get all onboard. (Vogt-Nielsen, March 2020)

Vogt-Nielsen (March 2020) explained how new networks of actors emerged throughout this project and they worked rather autonomously. The new networks consisted of the utility company and the different task groups set up by the Boards and General Assemblies. Moreover, representatives from the different departments in the municipality took part in the network, as well and the project at Prøvestens Allé / Kongedybs Allé was also a part of a research programme in collaboration with KU and Water in Cities (Vand i Byer). The collaboration between the utility company and GF Øresund emerged through a financial contract. The project needed money to proceed. (Vogt-Nielsen, March 2020) A representative from HOFOR also expresses an interest in the project to gain experiences with a collaboration with private associations. He also explains that they have used the project to look deeper into the underlying processes in order to optimise the process and make it easier for future projects. (Vester, n/a)

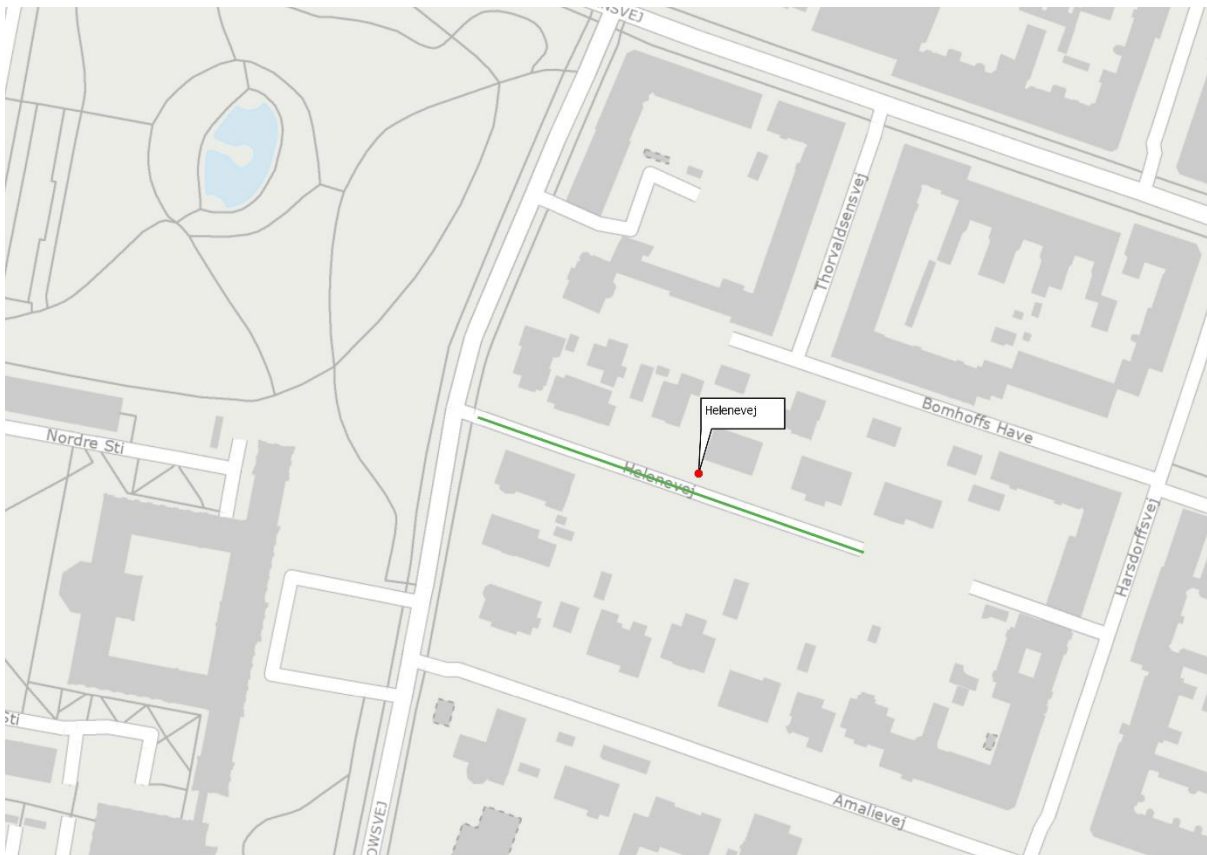
However, the process was still affected by ‘The Shadow of Hierarchy’ (Sehested, 2003) because they had to deal with the enforcement of notice they had received. Vogt-Nielsen (March 2020) explains that it turned out to be a difficult process to get it postponed and this delayed the progress of implementation. (Vogt-Nielsen, March 2020)

“(...) we attended a meeting with the municipality and we had to explain to them that we did not want to cheat and ignore the enforcement notice (red.) we just wanted something different. But it takes time and that’s why we couldn’t meet the enforcement notice, and the municipality would not budge. In the end, we had to get some politicians involved to decide whether they should lift the enforcement notice, so we could get permission to try this out. (...) so that is why we consider ourselves, to have been some sort of frontrunners (...)” (Vogt-Nielsen, March 2020)

The ‘Road Guild’ was also dependent on funding from HOFOR in order to carry out the project and this affected the outcome of the project as well. (Vogt-Nielsen, March 2020) As mentioned before, the idea about using the roads for climate adaptation came from an employee at The University of Copenhagen who took part in the tour around the neighbourhood. According to the theory, it is important to involve actors from outside the regime as well, because they contribute with other aspects that are not necessarily tied to the current practices in the regime. (Raven, 2005) Research institutes play an important role in the transition processes by contributing to new knowledge or ideas. (Vogt-Nielsen, March 2020)

6.6 Helenevej

This case consists of a single road in the City of Frederiksberg (see map 4). The road went from being a private road to being a public road and the utility company is responsible for the maintenance of the road. The road was the first ‘climate road’ in Denmark. The project was initiated in 2012 with pre-studies and re-organisation of the pipes. The actual implementation began in the summer of 2013 and the road was ready to manage stormwater in May 2014. (Klimatilpasning, 2017; Frederiksberg Forsyning, 2014)

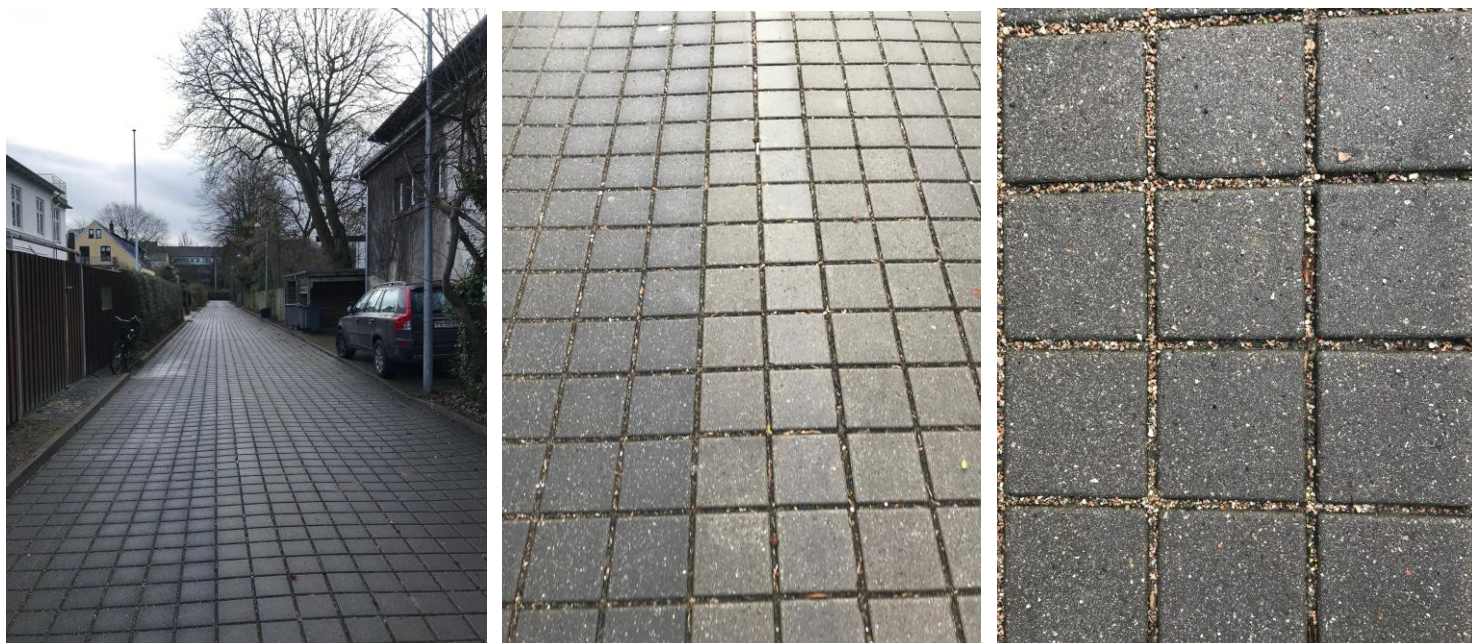


Map 4 shows the location of Helenevej. (own map, GIS).

6.6.1 The design and function of Helenevej

The hydraulic elements of the road are permeable surfacing with a 40 centimeter specially designed baselayer. It is not the stones themselves that are permeable but the joints between. The purpose is infiltration through an aggregate layer to the subsoil. The aggregate layer has a porosity of 30 percent. To prevent the water from accumulating at the lowest level it

consists of transverse water barriers every 20 meters underground. The road has an emergency overflow to the sewage system in the lowest-lying end. The hydraulic capacity of the road is 75 cubic meters corresponding to a 100-year event. The road has an estimated lifetime of 25 years. (Klimatilpasning, 2017)



Picture 6 shows permeable solution at Helenevej (Own pictures).

6.6.2 Introduction to the development

The sewage system was outdated and in need of renovation. They received an enforcement notice in 2009 (Appendix 9). This was the starting point for the whole development of the road. The area was also vulnerable due to a low and sloping terrain resulting in water accumulating in the low end of the road. There are no adjacent green catchment areas so the water had to be managed locally. The road is managing stormwater only from the road itself. It was on request from a resident in the area that the road should be paved with the permeable surfacing. (Klimatilpasning, 2017)

6.6.3 Selection of Experiment

In 2009 the residents at Helenevej were required to renovate the road as it was a private road at that time. It was the City of Frederiksberg who notified the residents and said it would cost around 500,000 DKK, with around a third of that amount allocated for a sidewalk. According to Nielsen (March 2020), the residents tried to go into a dialogue with the municipality, as the residents could not see the sense in spending money on a short sidewalk on a small road, where no one, besides the residents, is walking. However, the municipality was not very responsive to the residents' suggestion. (Nielsen, March 2020)

In 2011 the cloud burst hit Frederiksberg and most of the city was flooded, including Helenevej and the residents' basements. This meant that the municipality needed to change practice in order to adapt the city of Frederiksberg to climate change. (Westphall, March 2020a) The City of Frederiksberg hosted a meeting about the consequences from the cloud burst, and what effects it would have for Frederiksberg following this rain event. Nielsen (March 2020) decided to participate and talked to the representatives from the City of Frederiksberg and the utility company of Frederiksberg. Nielsen (March 2020) presented the case of Helenevej and informed them about the enforcement notice. However, Nielsen (March 2020) described a scenario for the City of Frederiksberg and the utility company of Frederiksberg, where Helenevej could be used in order to accommodate the issues that the City of Frederiksberg are facing with climate change. The outcome of the discussion turned out to be very constructive and it was decided to look further into the possibilities at Helenevej. (Nielsen, March 2020)

6.6.4 The Set-up of Experiment

The project at Helenevej was considered to be a good opportunity to experiment with new technology by the utility company and the municipality (Nielsen, March 2020). The set-up of the experiment is affected by the extent of protection, which must be well balanced (Kemp et al, 1998). However, when Nielsen (March 2020) first approached the City of Copenhagen around 2010 he was met with challenges regarding the development of the road, but then the cloudburst occurred in 2011 and this changed the perspectives and the City of Frederiksberg acknowledged that climate actions were necessary. This major event changed the point of

view for the City of Frederiksberg and it was easier to push the development of Helenevej through. (Nielsen, March 2020)

The technology used at Helenevej was the very first in Denmark. It became Denmark's first climate road where the water will infiltrate through permeable surfacing. Because of the relatively small size of the road, it was a good project to use as a pilot project. The size of the road had influenced the possible outcome, as there are some practical measures that a road needs to comply with. That is for example, that the road needs to be wide enough e.g. fire fighting vehicles, and renovation trucks. (Westphall, March 2020a) This point of origin that Helenevej was subject to, influenced the outcome, as the size of the road meant deselection of rain gardens.

“I personally would have liked to include some more nature in the final solution. However, it was simply not technically possible as the road also had to comply with safety and traffic. There should have been some more space.” (Westphall, March 2020a)

Helenevej was used to gain experience with this new type of permeable surfacing for future reference in climate projects within the municipality (Frederiksberg Forsyning, 2014). Already in 2014 when another big rain event occurred, the road had managed the stormwater as it should, which meant no flooding in the basements in the houses. (Nielsen, March 2020; Westphall, March 2020a).

6.6.5 Network Formation

The actors involved in the development of Helenevej include the City of Frederiksberg, the utility company of Frederiksberg, and the residents of Helenevej. The role of the municipality in the development was mainly to transform Helenevej from a private road to a municipal road, which is a general desire regarding the roads at Frederiksberg. The utility company of Frederiksberg was responsible for the hydraulic aspects. In addition, there were other companies that provided the elements to the solutions. (Nielsen, March 2020; Klimatilpasning, 2017)

Strategic niche management highlights the influence of the network on a transition. New network relations should be developed in which the new technology can function as desired (Kemp et al, 1998). For Helenevej a new network arose when Nielsen (March 2020) decided to look into how Helenevej could be turned into a climate road. At the beginning of the process, Nielsen (March 2020) explains that he did not believe that the residents at Helenevej could effect the design of the road, *“I only spoke about the possibility of creating a climate road with my wife, and my neighbor over the hedge (...) I did not think it had a chance to go through.”* (Nielsen, March 2020). Thus it was only Nielsen (March 2020) who participated in the meeting at Frederiksberg City Hall in 2011. At that meeting, he decided to talk to the City of Frederiksberg and the utility company of Frederiksberg. After the presentation at the city hall, the City of Frederiksberg and the utility company of Frederiksberg agreed to work with Nielsen (March 2020) on Helenevej in 2011. From here the public authorities helped Nielsen (March 2020) to create a network regarding the development at Helenevej. The public authorities helped to create and articulate a vision of the role Helenevej could have in a bigger picture. From there, there was one concept meeting with a representative from The utility company of Frederiksberg, a representative from the City of Frederiksberg and Nielsen (March 2020) as a representative for the residents at Helenevej. (Nielsen, March 2020) The meeting was held in Nielsen's' (March 2020) private home, where the three representatives discussed different ideas for developing a climate road, which was a relatively new concept at that point. After the meeting, the representative from the utility company of Frederiksberg and the City of Frederiksberg decided to continue working on the project. According to Nielsen (March 2020), the two representatives were the main drivers in developing Helenevej. Nielsen (March 2020) became coordinator between the municipality and the residents. The municipality talked to Nielsen (March 2020), who then communicated it to the residents. It was quite easy for Nielsen (March 2020) to be the coordinator as every resident approved the project. According to Nielsen (March 2020), it was because of the big rain event they experienced in 2011 that every resident at Helenevej was keen to develop Helenevej into a climate road. (Nielsen, March 2020)

Sometime after the first meeting, the utility company of Frederiksberg invited the residents to a meeting at the utility center. Almost every resident from Helenevej participated. Besides the Utility company and the residents, the other companies involved in providing elements of the solution chosen for Helenevej were also present. There had not been a discussion with the

residents about exactly which solutions were chosen. The meeting was rather a presentation of the design for Helenevej and the chosen solutions. (Nielsen, March 2020) According to Nielsen (March 2020), the solution was not the most beautiful one from his point of view, however, it was an upgrade of the road. The design of the solution was not a problem for the residents, as the main value in upgrading Helenevej according to the residents, was that the residents were protected against future cloud bursts. (Nielsen, March 2020) According to Nielsen (March 2020), there were a couple of residents, who in the beginning had certain expectations about the look of the road but the function seemed to be more important than the looks. The main vision for the residents was that the new road could manage similar rain events like the one they experienced in 2011. According to Nielsen (March 2020), the residents were satisfied with an upgrade of the road, and that it could reduce any possible inconveniences from future cloud bursts. (Nielsen, March 2020) However, a mismatch in expectations appeared because some residents experienced flooding even though the road was well-established. They thought it would solve all the flooding problems but the utility company was only responsible for the road itself and the residents had to install a backflow blocker at their own houses in order to profit by the development of the road. Not all residents were aware of this and it meant that their expectations were not being met. However, this was based on failed communication. (Klimatilpasning, 2017)

According to Kemp (1998), the development of technology is not only dominated by the industry but to a large extent also by third parties like citizen groups, who can contribute their ideas (Kemp et al, 1998). This was the case at Helenevej, as it was Nielsen (March 2020) as a citizen and resident at Helenevej, who came up with the idea about transforming Helenevej into a climate road. Though it is interesting to emphasize Nielsen's (March 2020) comment "*I only talked about the possibility of creating a climate road with my wife, and my neighbor over the hedge (...) I did not think it had a chance to go through*" (Nielsen, March 2020). This shows that it was not clear to Nielsen (March 2020) in the beginning that he could play a role in leading the development of technology. According to Sehested (2003), there was a shift from traditional planning with hierarchical structures to a more governance-based structure that to a high degree is imprinted by very direct participation by the city's actors. (Sehested, 2003) With governance follows network steering, which became a crucial element for developing Helenevej. The new network created a platform for collaboration between the City of Frederiksberg, the utility company of Frederiksberg, and the residents at Helenevej.

Sehested (2003) explains that there has been a shift from the citizens just being end-users to now being involved actively and they are becoming partners. (Sehested, 2003). This was the case with Helenevej, Nielsen (March 2020) who played a vital role in the development of Helenevej and he served as the link between the utility company, the municipality, and the residents. He participated in the local governance processes for developing the road. (Nielsen, March 2020) This could also indicate a change in the hydro-social contract from the citizens being ‘unknowing’ end-users to playing an active part in the development of the SUDS (Brown et al, 2009).

However, Nielsen (March 2020) recognised the change in the way the City of Frederiksberg interacted with Nielsen and his idea before and after the rain event in 2011. According to Nielsen (March 2020), the rain event in 2011 accelerated the progress in turning Helenevej into a climate road. The City of Frederiksberg needed to show action as a response to all the inconveniences and economic disasters from the cloudburst in 2011. (Westphall, March 2020a) The MLP suggests that dynamics on multiple levels makes transitions from one socio-technical system to another possible. According to Nielsen (March 2020), the dynamics that are initiators of the breakthrough was the external circumstances.

“In 2011 the big cloudburst occurred, so the City of Frederiksberg needed to show action, which is why I think that it made it easier to come through with a project like this. It fitted quite well after the cloudburst.” (Nielsen, March 2020)

The cloud burst in 2011 changed the landscape level, which affected and pressured the water regime and created a “window of opportunity” for developing Helenevej into a climate road.

6.7 Summary

Overall for the three cases, a change in the landscape caused by the cloudburst in 2011, was a game-changer for the development of the projects. Before 2011 the visions for Skt. Kjelds Plads / Bryggervangen and Prøvestens Allé / Kongedybs Allé in particular were green places that should be inviting. However, the cloudburst in 2011 made it crucial for the networks, for all three cases, to integrate SUDS in their solution. That the projects should include climate adaptation became a trigger for conducting experiments with new technologies. From forming new networks between associations and utilities, implementing “first flush” or

experimenting with the permeable surfacing. All three cases have adjusted to the new challenges within the water regime. However, managing the stormwater on the surface is, in all three cases, done in interplay with other regimes. A major barrier to stormwater on the surface is the clash with the road regime. The water regime challenges the road regime because they now are fighting over the same area, as the water is brought to the surface. The development of the experiments is very much affected by the embedded norms and rules in the road regime. The initiative and motivations for the projects emerged in different kinds of networks. The actors ranged from residents, local institutions, and associations to local authorities and utility companies. New networks emerged throughout the processes and the municipality was not always the major player. In some of the cases, they became a source of delay and frustration, especially in the case of Prøvestens Allé / Kongedybs Allé, because they were not geared for the request and development. (Vogt-Nielsen, March 2020) The three cases are characterized by an eagerness to conduct experiments and to inspire others to try out innovative solutions in relation to stormwater management.

Another point from the analysis is that there has been a change in the hydro-social contract following the cloudburst in 2011. The cases have shown that the residents show a lot of commitment to the projects and in the case of Helenevej and Prøvestens Allé / Kongedybs Allé the roads have been developed thanks to the residents and their drive. The technology for SUDS is available but the experience and the practice of implementing these solutions seem to be a challenge.



7 Discussion

In this chapter, we will discuss the issues in relation to the development of SUDS in the three cases. We found in the analysis that the SNM interacts with different regimes - including the water regime and the road regime. We furthermore discuss the importance of the dynamics at the different levels in MLP for the transitions. SNM adds another perspective by investigating niche development, the use of experiments, and how these processes affect the transition. The chapter will conclude with a discussion about how network governance influences the transition and which barriers it poses.

7.1 Clashes with Other Regimes

This section will deal with the clash between the water regime and the road regime. It will look into what this clash consists of and some suggestions as to how it can be dealt with.

There are a lot of factors that influence the niche development and transitions and hereby the way the regime is formed (Chapter 5). In continuance to both the Climate Adaptation Plan and the Cloudburst Management Plan, the water management can no longer be limited to being managed underneath the surface. As stated in the previous Chapter 6 there is a need for an integrated strategy including green and blue solutions, if Copenhagen and Frederiksberg shall be prepared for the changing climate by the year 2035. This generates a clash with other regimes, especially with the road regime, as the water regime now demands the use of the surface, including roads. (Copenhagen, 2011) The concerning niche is the surface solutions and the networks, user preferences, and practices related to this. The technologies vary between rain gardens and permeable surfacing but all the solutions have in common, that they bring the water above the surface or change the design of the road. Bay (March 2020), Westphall (March 2020b), Grøndahl & Andersen (April 2020) and Freudendal-Pedersen (May 2020) inclusively recognize a clear clash between the water regime and the road regime because of parking lots and requirements for the width of the roads in relation to e.g. renovation trucks, ambulances, and firetrucks.

It became clear through analysis of the cases, that the development of these roads was challenged by the maintenance requirements of the roads and that parking lots played a crucial role. (Section 6.7) The development of the SUDS in the three cases showed that the road regime had a major influence when planning for climate adaptations projects, and to a

large degree set the starting point for the development of the project. (Bay, March 2020, Westphall, March 2020b; Lund, 2020 & Grøndahl, 2020) Furthermore, Grøndahl & Andersen (April 2020) also point to the issues about the requirements for a certain volume in order to manage the water properly. The water will interfere with roads and parking lots, however, the cables and pipelines underneath the roads pose a challenge as well. This dictates more space on the surface for the water and a compromise on the extent of the solutions. (Grøndahl & Andersen, April 2020)

When talking to Bay (March 2020) and Westphall (March 2020b) it is clear that there is a challenge integrating the water regime and the road regime, as they articulate the difficulties when climate adapting Frederiksberg. This comprises the lack of space when roads have to be shared with climate adaptation projects including rain gardens and other solutions that take up too much space. However, according to Bay (March 2020), they have found a loophole by using the trees in climate adaptation projects.

“We focus on the trees as they do not take up as much space above or below the surface. (...) They are put in a box where the water will flow, creating a hydraulic volume. They furthermore have a heat island effect (red. mitigating effect), a long lifespan, and positive outcomes for Frederiksberg as it becomes increasingly green.” (Bay, March 2020)

Frederiksberg is a dense city and because of that, the City of Frederiksberg is prioritising the planting of trees, instead of implementing rain gardens. *“The primary problem is the lack of space. The roads are narrow and the parking lots have a high priority. If you implement a rain garden, then you take away a parking lot”* (Westphall, March 2020b) They use trees in the management of stormwater as they take up less space on the surface compared to e.g. rain gardens. As Westphall (March 2020b) mentions, making room for rain gardens will compete with the space for parking. According to Bay (March 2020) and Westphall (March 2020b), it is a difficult task to change people’s minds about parking and the convenience of having the car nearby. (Bay 2020; Westphall, March 2020b)

According to Freudendal-Pedersen (May 2020), we need to redefine the urban space, as asphalt right now is perceived as reserved for cars. Bay (March 2020) agrees that right now it is challenging to replace parking lots with something more green, but it is something that in his mind could change politically over the next 15 years. (Bay, March 2020) However, Bay

(March 2020) is a bit cautious as he also mentions that cars are getting a lot of attention; with the focus being on types of cars rather than car reduction.

“I have to say that Denmark in general does not have a great focus on decreasing the number of cars. If I shall be honest, there it is more likely the opposite focus. To get self-driving cars, electrical cars, but not fewer cars.” (Bay, March 2020)

In relation to this Grøndahl & Andersen (April 2020) point to the municipality as being the hurdle because they are the ones to receive all the complaints from the citizens when parking spaces are eliminated. (Grøndahl & Andersen, April 2020)

For many years the roads and the asphalt have been reserved for cars. The cars and the road regime have been part of society for many decades, and making room for cars has shaped the planning of cities - cars have, to a high degree, been prioritised in the urban space. SUDS leads to a collision with the aesthetics and functions of roads. (Chapter 6) The ruling perception of roads is that they are only reserved for traffic with no consideration of other vulnerable road users, such as cyclists and pedestrians. (Kanger & Schot, 2016) It is therefore very difficult to change the role of the car from one minute to another. (Urry, 2004)

Freudendal-Pedersen (May 2020) underlines the importance of not aiming at getting rid of cars. Planners need to think strategically across the sectors *“You cannot go ‘hetz’ on the car traffic, as it is a battle you will lose.”* (Freudendal-Pedersen, May 2020). Instead, we should try to show all the benefits and values that come with the use of SUDS on roads. Especially in the design concerning nature-based solutions, thus permeable surfacing can contribute to positive effects as well. In the case of Helenevej, the permeable surfacing has been stated to have a friendlier expression and thereby encourage slower driving. (Frederiksberg Forsyning, 2014) This is also supported by Nielsen (March 2020). The perception of the roads was also being challenged in the 1970s where an amendment in the traffic regulations contributed to a change in prioritisation of road users by turning some roads into ‘play streets’ (legegader) where the vulnerable road users have the right to use the roads for playing and the cars must yield (Transport-, Bygnings- og Boligministeriet, 1978). This was the case of Prøvestens Allé / Kongedybs Allé and contributed to valuable preconditions for entering the project. They already had another mindset about the use of the roads as mentioned before. (Vogt-Nielsen, March 2020)

The SUDS takes up space on roads and interferes with the surface as well as what is beneath. A big hurdle is the mindset about parking and that roads are mainly reserved for cars. However, SUDS can contribute by challenging the road regime and the embedded norms and practices. There is a need to show that things can be done differently and in SNM this is presented as experiments in the development of the niche (Schot & Geels, 2008).

7.2 The Use of Experiments

This section will discuss the relevance of using experiments in relation to SNM and how experiments contribute to the promotion of surface solutions. The experiments serve to make the benefits more visible and encourage positive stories.

Freudental-Pedersen (May 2020) points to the use of experiments being a good tool to clarify which possibilities SUDS can provide and create. (Freudental-Pedersen, May 2020) This is also what strategic niche management is using as a tool to mature and promote niches. Using experiments as a strategy is applicable when investigating the user needs and the viability of the technology is required in order to induce transitions. (Section 5.3)

All three cases have been analysed through the lens of SNM and are therefore viewed as experiments. They are formulated by the interviewees as being pilot projects to act differently than the current practice within the water regime. (Stender, March 2020; Westphall, March 2020a) Furthermore, the analysis has shown that Skt. Kjelds Plads / Bryggervangen and Prøvestens Allé / Kongedybs Allé challenged the road regime as, through the development of their area, they demonstrated that the roads were no longer only reserved for the cars.

(Section 6.4 & 6.5) However, according to Bay (March 2020), Westphall (March 2020b) and Grøndahl & Andersen (April 2020), it became obvious that it is difficult for the utility companies from their point of view to stand up against the road regime because the projects are dependent on authorisations from the municipalities. (Bay, March 2020; Westphall, March 2020b; Grøndahl & Andersen, April 2020) Based on this, one of the challenges for climate adaptation projects is that they have to be adapted to the road regime. In order to oppose this practice, Freudental-Pedersen (May 2020) points out the potential in experimenting. Both citizens and politicians are more likely to set up an experiment if they know it is temporary or on a small scale. (Freudental-Pedersen, May 2020) The actors in SNM also use experiments as a tool for pushing the transitions in order to investigate if the technology is socially desirable and serving long-term goals. (Schot & Geels, 2008)

Freudendal-Pedersen (May 2020) suggests that it is through the experiments that it becomes possible to show the benefits in recreating an area and showing a new type of urban space. (Freudendal-Pedersen, May 2020). In relation to this Schot & Geels (2008) suggest that an important reason for governments to nurture or subsidise innovations that are not yet profitable is that they expect that it will become important in realising specific collective and societal goals. (Schot & Geels, 2008)

7.2.1 Valuable Preconditions in Prøvestens Allé / Kongedybs Allé

This subsection will explain the valuable preconditions they had at Prøvestens Allé/Kongedybs Allé in relation to entering a project and how this contributed to challenge the use of the road.

The implementation of SUDS in Prøvestens Allé/ Kongedybs Allé resulted in fewer parking lots on the road as well, but as Vogt-Nielsen (March 2020) explains, the residents in GF Øresund had already been through a process that challenged the number of parking lots because they prioritised turning their road into a ‘play street’ (legegade) 20 years ago.

“Well, I think, because we previously have been through a process of making ‘play streets’ and (...). That is, parking is also a very big hurdle, right. So, in this respect, I am certain that our preconditions for having a collaboration about this are much better than other homeowner’s associations. They would have to build it from scratch.” (Vogt-Nielsen, March 2020)

Vogt-Nielsen (March 2020) states that they had good preconditions at Prøvestens Allé/Kongedybs Allé for entering such a project, but they also had to be patient and have a certain drive. Vogt-Nielsen (March 2020) furthermore explains that they kept running into challenges such as the issue with the enforcement notice and the financing issues. However, they still managed to keep their head up high and continue the process and stay engaged. And according to Vester (n/a) it is important to sustain this drive and engagement in order to inspire others and succeed with such a project. (Vester, n/a)

They managed to challenge the road regime to some degree by integrating rain gardens into the streetscape and Vogt-Nielsen (March 2020) explains that it was because they already had

a specific mindset about the roads. They are using their roads to strengthen the community and climate awareness. (Vogt-Nielsen, March 2020; Mundt, n/a)

Experiments are used to investigate user preferences and practices in relation to the specific technology and to demonstrate other options for development. But in order for the experiments to matter in a broader perspective, the learning outcomes are important elements. (Chapter 5)

7.2.2 Knowledge Sharing and Learning Outcomes

In SNM there is a great focus on the learning outcomes of niche development. (Kemp et al, 1998) This section is concerned with the learning outcomes from the three projects and the importance of second-order learning in relation to potential transitions. The section will also touch upon the challenges with steering networks and evaluations.

It seems like the effort involved with the project at Prøvestens Allé/Kongedybs Allé has fallen into oblivion even though it was successfully implemented. They tried to reach out to other homeowner's associations and the utility company gained a lot of knowledge from the projects as well (Vester (n/a); Vogt-Nielsen, March 2020) However, Grøndahl & Andersen (April 2020) are talking about projects in private roads as well, but they talk about them like it is a new collaboration.

“(...)At the moment we have a three-year pilot programme regarding the implementation of green roads, which again is a wish from the cloud burst program in the City of Copenhagen. We are in the process of converting a raft of roads into green roads in the City of Copenhagen, on private roads. Then we obtain experiences with the processes, which is the process of collaborating with the private homeowner's associations, and that is not something that the utility has great experiences with. And then we gain experiences with surface projects on a big scale. There are a lot of considerations when implementing surface solutions. Space is scarce, there are traffic-related challenges and stuff like that.” (Grøndahl & Andersen, April 2020)

A lot has changed since GF Øresund entered the process in 2009 and Vogt-Nielsen (March 2020) discussed their experiences and the learning outcomes the association gained from the process. However, based on the case study at Prøvestens Allé / Kongedybs Allé there could be an indication that communication and knowledge sharing are big challenges despite the same utility company, HOFOR, being part of the network in both these cases. It could indicate that knowledge is lost because evaluations fail to appear or when changes in staff occur. Grøndahl and Andersen were both hired after the initiation of the project (Grøndahl & Andersen, April 2020). Thus Grøndahl & Andersen (April 2020) and Bay (March 2020) are talking about different knowledge networks and steering committees respectively in HOFOR and The Utility of Frederiksberg. They explain that these are focused on ‘resource networks’ with different actors and disciplines regarding how to develop solutions and integrate them with urban development. (Grøndahl & Andersen, April 2020; Bay, March 2020) However, Bay (March 2020) and Grøndahl & Andersen (April 2020) explain that evaluation and knowledge sharing of completed projects is not currently on the agenda only in regards to the hydraulics (Bay, March 2020; Grøndahl & Andersen, April 2020). Bay (March 2020) suggests that it could be a question of the distribution of roles and that it is difficult to evaluate on the more intangible perspectives. (Bay, March 2020)

Freudendal-Pedersen (May 2020) questions the incentives for making evaluations, and whether they are avoiding the evaluations on purpose due to fear of what learning outcomes may eventuate and whether it might be inconvenient to talk about all the traffic-related outcomes. She explains:

“It is not something they (red. municipality) talk about, but I think it is an intentional strategy (red. Evaluations about the effect on traffic). They are aware that if they are jumping right to the conclusion that we should cut down on car traffic or that it has been positive because there are fewer parking lots, then they are aware that too much trouble will follow. There is a difference in the official evaluations and if you talk to the involved people. But there might also be a chance that they don’t consider it, that is another possibility. Some don’t, but I also think that it is a strategic move.”(Freudendal-Pedersen, May 2020)

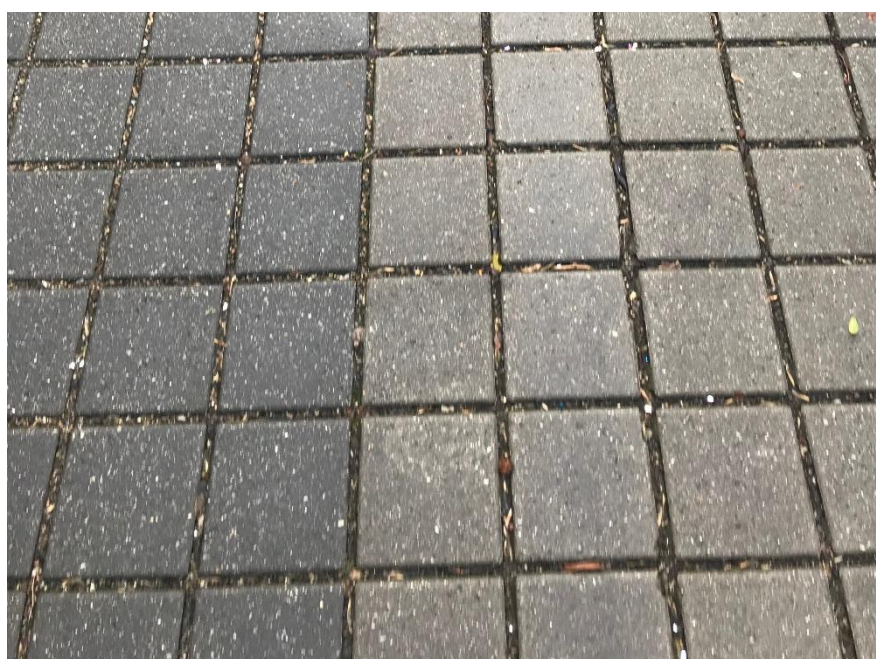
Freudendal-Pedersen (May 2020) might have a point here, thus an evaluation process could also focus on other aspects of the solutions such as the co-benefits and the added value.

Especially because Freudendal-Pedersen (May 2020) addresses the importance of changing the structural narratives and bringing forward the positive stories. She says, “*There is no doubt about it. To create good stories about what the urban spaces can contribute, it is totally idiotic not to do it*”. (Freudendal-Pedersen, May 2020) Furthermore, according to the theory of SNM these evaluations, depending on the content, are important for the learning processes of strategic niche management to gain knowledge about the viability of the technology. The evaluation of the process is also relevant in order to gain deeper insight into the norms and values that actors contribute and how this leads to second-order learning (Schot & Geels, 2008). Ultimately it comes down to how this contributes to the transitions and the contesting of the road regime.

Second-order learning from the SUDS in the three cases is contesting the road regime as well because it shows how the roads can be used in alternative ways with multiple functions. Experimenting and learning from these show that things can be done in other ways than just the ‘traditional’ solutions - both with regards to the design of the roads and the SUDS.

(Chapter 6)

It is also about creativity and choosing other options. A good example is the case of Helenevej, where the municipality had imposed upon the residents to make a footpath on the road. The road is very narrow and the inclusion of a footpath would occupy a lot of space. Instead, they found a solution where the permeable surfacing at the side of the road had another colour than the ‘rest’. (see picture 7) This is one way to be creative and ‘shirk the issue’. (Westphall, March 2020a)



Picture 7 shows the colour difference in the permeable surfacing at Helenevej (own picture).

At Skt. Kjelds Plads / Bryggervangen biodiversity has been prioritised and traffic issues are of secondary importance. It meets the demands for traffic safety but they have been more experimental in the choice of vegetation and tree species. Furthermore, they have educated their operation staff to take proper care of the area because they needed new skills due to the new sorts of vegetation and trees. (Stender, March 2020) They have also managed to tell the positive stories about Skt. Kjelds Plads / Bryggervangen and the area is well-known on a national and international scale. The focus on climate adaptation has also become of very big branding value for Skt. Kjelds Plads / Bryggervangen. (Stender, March 2020)

This section has explained that second-order learning and evaluations are important in order to understand the underlying dynamics and structures and to promote the positive stories'. However, external circumstances, as well as the actors involved in the process also play a role in the transition.

7.2.3 Destabilisation of The Regime - Potential for Change

All three projects were influenced by the major cloudburst in 2011 which also affected the practices of the utility companies and the public authorities in relation to stormwater management (Grøndahl & Andersen, April 2020; Vogt-Nielsen, March 2020 & Westphall, March 2020a). This also shows that regime-niche interaction is important for the maturing of the niche. According to the theory (Section 5.2 & 5.3), it can be easier for the niches and the underlying network to push for a change within the regime when external effects like the cloudburst destabilised the regime. The water regime was not adaptive to the change in landscape and this stimulated the niche-innovations. his (Schot & Geels, 2008) The City of Copenhagen had formulated a climate adaptation plan before the cloudburst but the utility companies were involved in stormwater management in earnest after this event in 2011. (Grøndahl & Andersen, April 2020) According to the interviewees from both utility companies, the cloudburst was a turning point regarding the general involvement and interest. The utility companies got to play a bigger role in climate adaptation and they have experienced an increased interest from the citizens who form networks in order to be a part of the climate adaptation of the city. (Grøndahl & Andersen, April 2020; Bay, March 2020) The issues with the increasing amounts of stormwater became very prominent with the cloudburst in 2011 and it accelerated the development and maturing of the niche. But Grøndahl &

Andersen (April 2020) explain that the implementation is still carried out as a series of pilot projects which are compared with the expenses of traditional solutions as mentioned earlier. Freudendal-Pedersen (May 2020) points to the need for another cloudburst to evoke people's awareness and to show that the matter of the already implemented solutions. (Freudendal-Pedersen, May 2020)

On private roads, the residents play a big role in the development of SUDS, and according to Grøndahl & Andersen (April 2020), these roads are important in order to achieve the goals of turning Copenhagen (and Frederiksberg) into climate-resilient cities. (Grøndahl & Andersen, April 2020)

The integrated development of SUDS on roads requires the involvement of different actors. The niches are not just inserted by governments but emerge through these coalitions and networks of actors (Schot & Geels, 2008). Hoffmann & Jensen (2015) empower the citizens as well and explain that they play an important role in the alliances and they represent the places specific qualities and potentials. (Hoffmann & Jensen, 2015) Moreover, the process of SNM is shaped by a wide palette of actors as well and the 'niche managers' do not necessarily have to be governments or local authorities. (Kemp et al, 1998) One example is the strong role that Nielsen (March 2020) played in the development of Helenevej. He came up with the idea of turning the road into a climate road. (Section 6.6) Schot & Geels (2008) suggests that SNM is a form of governance as well as it possesses characteristics due to the steering and development in collective enactment. (Schot & Geels, 2008) However, SNM is limited to only focus on the governance dynamics within the niches and that is why governance concerned with the political system on a regime scale is needed in order to guide the integration of the niche into the regime or the potential renewal of the regime. (Section 5.3)

7.3 The Impact of Governance

As mentioned in Section 5.4, network governance creates a new form of coordination and management when exploiting the synergy effect in the collaboration between the actors and public sectors in cities and societies. Governance should be seen as a platform where local citizens, politicians, companies, and planners go together to articulate preferences and visions as the foundation for collective steering of a local area's development. Many stakeholders and preferences can shape the network, however, the level of power still plays a crucial role and the rules and regulations are still managed by the state and the

municipalities. (Section 5.4) This section will look into network governance and how this affects the transition and discuss how actors and authorities have been part of the network.

For all three cases, new networks have been formed and actors from outside the regimes have been involved as well. This is important in order to let more radical innovations thrive, as new networks can be part of challenging the current practice within the regime with the use of radical innovations. (Raven, 2005) The three cases are all part of the niche of managing stormwater on roads and relieving pressure on the sewage system. The projects have been examples of *selecting* and *setting up experiments* to influence the transition from traditional piped-based solutions to sustainable urban drainage systems (SUDS). (Chapter 6) The case of Prøvestens Allé / Kongedybs Allé is a good example of an informal network of different task groups, research institutes, and the utility company. The initiative came from the residents on the two roads, however, the municipality was not a very strong actor until the residents received an enforcement notice that was difficult to deal with. It also shows that the municipality at that time was not ready to tackle the initiative from the residents. (Vogt-Nielsen, March 2020) The development could not proceed without getting dispensation from the enforcement notice because they had to spend money on repairing the asphalt and the curb before the implementation of the rain gardens could proceed. (Vogt-Nielsen, March 2020)

Kemp et al. (1998) suggest that the public policy-makers must act as enablers and assist the development of the niche in order to achieve a desirable outcome instead of posing a barrier to the development. (Kemp et al, 1998) The issue here is that one department within the municipality clashes with the implementation. ‘The Shadow of Hierarchy’ plays a role here, as the challenge of road reparation must precede any further work (Vogt-Nielsen, March 2020; Københavns Kommune, n/a [b]) Stender (March 2020) also explains that the development is also a matter of timeframes and budgets, and many projects are part of different pools as voted for by politicians. The projects are, therefore, to a certain extent, bound to these and they can set limitations for the project and how far it can be developed. (Stender, March 2020) It is also a question about how the network-based approach to governance should be organised without compromising the municipality’s authority and its ability to execute policies. Dynamic and ever-changing projects are not necessarily compatible with how the regime of public administration is organised because it is built to create predictability and stability. (Lund, 2018) However, it should be possible to initiate

projects and experiments within an acceptable time frame - implementation of SUDS should not last for ten years as in the case of Prøvestens Allé. There might be a risk of losing actors' engagement and interest. (Vogt-Nielsen, March 2020) In order to help integrate the niches into the regimes, the authorities could, according to Lund (2018) and Mguni et al. (2015) be more adaptable and supportive of the niche (Lund, 2018; Mguni et. al., 2015). According to Kemp (1998), the public authorities play a special role as facilitators or enablers in order to ensure action takes place. They also have a responsibility for the learning processes. Furthermore, public authorities could play a role in the constitution of networks and assist in articulating the vision. (Kemp et al, 1998) As mentioned in Section 5.2 the social networks in niches are often small and unstable, and networks often work in different directions (Geels, 2005 [a]). The local governance could, therefore, play a role in articulating the networks' visions and help with stabilising the networks in order to secure progress. (Section 5.4)

Based on the interviews with representatives from the utility companies there is a challenge, from their point of view regarding standing up against the road regime because the projects are dependent on authorisations from the municipalities. (Bay, March 2020; Westphall, March 2020b; Grøndahl & Andersen, April 2020). However, one challenge that became apparent in the analysis of both Helenevej and Prøvestens Allé/Kongedybet Allé was that the municipalities in 2011 were not geared to engagement and development. In the case of Prøvestens Allé/Kongedybs Allé, GF Øresund reached out to the utility company before reaching out to the municipality. (Vogt-Nielsen, March 2020) Mguni et al. (2015) point to the need for strong actors who function as 'front-runners' and possess some measure of authority within the various networks. They have a thorough understanding of the power dynamics and know how to point the agenda towards surface solutions. (Mguni et. al., 2015)

7.3.1 The Importance of Network Formation

When developing and conducting experiments with new technologies, new networks will arise. Within these networks lies the importance of governance as it is needed in order to guide sustainable development (Loorbach, 2010). Based on Helenevej and Prøvestens Allé / Kongedybet Allé there was confusion with some of the actors regarding which solutions were possible to implement on respectively Helenevej and Prøvestens Allé / Kongedybet Allé.

Every project has different preconditions, and it is important to inform the actors about these. For both Helenevej and Prøvestens Allé / Kongedybet Allé many of the ideas from the actors were tossed away, as the roads were not wide enough for the specific ideas. (Chapter 6)

However, the width of the roads should not necessarily be seen as a barrier, but rather, the involved actors should have been informed from the beginning what the preconditions were in order to avoid a lot of frustration between the actors. Knowing the existing preconditions creates a better setting for creative thinking. (Freudendal-Pedersen, May 2020) It is within the networks that solutions are formed, and it is important to underline that it is a network, and not a one-man job as Stender (March 2020) points out, *“a climate adaptation project has to be developed through a network of actors, who all have different competencies they can use in the development of the project.”* (Stender, March 2020) Networks are important in the development of niches because the different actors contribute to different resources such as skills, knowledge, or financial resources. This helps mature the niche especially if outsiders are involved in the processes as well. (Schot, & Geels, 2008.)

Bay (March 2020), Westphall (March 2020b), and Lund & Grøndahl (April 2020) support this approach, and further elaborate with an example of working in networks and steering committees when developing climate adaptation projects. They explain that The City of Copenhagen, The Utility Company of Frederiksberg, and HOFOR work with external actors like local residents, institutions from the area (e.g. schools), and internal actors within these municipalities. Bay (March 2020) states that they also have internal networks and that they try to engage as many disciplines as possible. Furthermore, The City of Frederiksberg collaborates with the City of Copenhagen and the respective utility companies because the City of Frederiksberg is dependent on Copenhagen in relation to the discharge of stormwater into the harbour (Bay, March 2020).

However, it could be questioned whether the networks facilitated by the municipalities and utility companies are working as anticipated. Freudendal-Pedersen (May 2020) explains that in order for the water regime to challenge the road regime the network behind the technology needs to be backed by different actors, approaches, and kinds of knowledge. (Freudendal-Pedersen, May 2020). Actors from ‘outside’ the regime are also important factors in the development of niches because they are not vested in the nested regime and bring forward alternatives (Schot & Geels, 2008). When talking to both Stender (March 2020) and Bay (March 2020) they emphasize the involvement across the administration which consists of hydraulic counselors, urban planners, engineers, traffic-actors, actors with knowledge about

biodiversity, actors related to urban life, and actors related to the economy. They explain that the purpose of this involvement is to secure the possibility of creating synergy between urban planning and the hydraulic. Bay (March 2020) also points out that they use student projects to examine certain areas of the sector that need to be enlightened. Thus there is no doubt from either Stender (March 2020) or Bay (March 2020) regarding the importance of supporting a cross-disciplinary involvement, which in their opinion is being practiced already. However, Freudendal-Pedersen (May 2020) is questioning the incentives behind the cross-disciplinary involvement and she expresses that the cross-disciplinary involvement in the municipalities and in the utility companies is too narrow.

“(...) there is a lot of it which revolves around steering committees and the cross-disciplinary, but it is pure legitimacy. I do not say everything is, but a lot of it is. Of course, it is because it is easier to get things to function when it stays within the silo. You can create some results... maybe it does not get the city to function better, but the things you do within your silo becomes easier to do, just because you keep it within the ‘silo’”. (Freudendal-Pedersen, May 2020)

According to Freudendal-Pedersen (May 2020) society and the decision-makers might overlook beneficial effects emanated from climate adaptations projects because it is due to the organisational silo (Freudendal-Pedersen, May 2020).

Individual budgeting sustains the subdivision into silos and the possibility to look into greater socio-economic beneficial effects fails to appear. In order to shed light on the beneficial effects, we need to break down the thought about working in silos and work across sectors when planning (Freudendal-Pedersen, May 2020). Although it is still a challenge to work across disciplines and sectors, Stender (March 2020) and Grøndahl & Andersen (April 2020) explain that each sector has its own budget and each project is bound to a “project package” which includes an economic framework. Moreover, Stender (March 2020) explains that the different politics and visions within the municipality sometimes are conflicting and it is then necessary to figure out which elements are important in the specific project. (Stender, March 2020) The development of the SUDS in the three cases are affected by this subdivision. Grøndahl & Andersen (April 2020) explain

“Unfortunately it is not a part of the co-financing act, you could say. It would call for a change of the legislation if you had to look at it more holistically, as you’re trying to articulate. (...) well, we are accountable for the utility secretariat (Forsyningssekretariatet) and we must substantiate for the expenses regarding a project (...) and how much a traditional solution would cost. That is the absolute cornerstone that we can get through with our projects. If it is cost-effective, well then we cannot add more value at the current moment at any rate.” (Grøndahl & Andersen, April 2020)

The municipality decides the point of direction (Bay, March 2020 and Grøndahl & Andersen, April 2020) but the utility companies can only pay within the limits of the “hydraulic money” as Bay (March 2020) puts it. The recreational elements are paid with the taxpayers’ money (Bay, March 2020). Sometimes it is also a matter of definition. Westphall (March 2020a) explains that it is not always clearly defined which elements contribute to the hydraulic function and when the function is ‘only’ recreational. *“And then, well, sometimes there are elements where we are profoundly in doubt, and then we go back and we discuss it with the jurists and find out what makes sense, right.”* (Westphall, March 2020a) This enlightens the challenges with the division in the development, as many of the elements chosen on the surface are both recreational and have a hydraulic function.

7.3.2 Articulation of the Beneficial Effects

The co-financing act does not leave room for value creation or the questions about added value. The equation regarding expenses is just about traditional solutions versus surface solutions with no regard to added value (Lund, 2018), although health benefits and other aspects regarding added value have gained an economic value (Hoffmann, et al., 2018). When making the intangible elements tangible by giving them an economic value it may be recognised by politicians and therefore become of greater economic importance. (Freudental-Pedersen, May 2020)

This was likewise evident in previous years when cycling was made more visible through a shift in the language used to promote the various values and benefits associated with it.

This new appraisal of cycling was promoted by the development of a methodology for cost-benefit analysis of cycle investment. (Jensen et al., 2017) Cycling now became part of the

socio-economic analysis and the benefits related to cycling were given a value. This meant that cycling became part of the greater socio-economic perspective. (Jensen et al., 2017) According to Freudendal-Pedersen (May 2020), the climate adaptation projects need to a certain extent to do the same. Freudendal-Pedersen (May 2020) states that much political discussion and decision making revolves around the economy, therefore it is important to be well prepared to come to the table with the necessary tools to take on those economic issues. (Freudendal-Pedersen, May 2020) An economic take on the climate adaptation project could show the importance of integrating the water regime and the road regime.

In order to create an interplay between the water regime and the road regime, it is important to communicate the beneficial effects that emanate from managing water on the surface. As mentioned above, it is not easy to go against the road regime and the roads are reserved for cars – with all that it entails like the socio-material technologies, practices, regulation, knowledge among others. Freudendal-Pedersen (May 2020) expresses the need for climate adaptation projects to speak into the socio-economic context in order to underline the importance of integrating the water and road regime. In order to do that, there needs to be a shift from working in isolation (within silos) towards a much more cross-disciplinary approach. (Freudendal-Pedersen, May 2020)

Freudendal-Pedersen (May 2020) underlines the importance of active involvement of citizens above an informational level. This would give the citizens a possibility to be part of the development of climate adaptation projects and part of how the urban spaces are shaped. Furthermore, the analysis of the cases has shown that new constellations of networks emerge and the transition cannot be guided by single actors but has to happen in collective enactment. (Section 5.3) The adoption of the niches in the regimes requires new practices and regulatory frameworks as well. (Schot & Geels, 2008) From the analysis of the cases, the diffusion of niches in the regimes were not necessarily led by governments but the initiative came from the citizens as well. (Chapter 6) There are many passionate locals present in society, who are engaged and curious about the benefits of new technologies and what they can do to the urban space. Freudendal-Pedersen (May 2020) stresses the importance of the involvement of different actors. Therefore it should not be only one actor that will take responsibility for the transition of the niche, on the contrary, various actors must start to see and do things differently for new practices to arise and for niches to be integrated into the regime. (Freudendal-Pedersen, May 2020) The governance becomes the platform where preferences

are articulated in collaboration with politicians, businesses, and communities (Sehested, 2003).

7.4 Summary

The development of SUDS in the three areas is being met with different challenges. One of the major challenges was that SUDS on roads led to a collision with the aesthetics and functions of roads. The clash with the road regime revealed to be the biggest hurdle in this development, as the SUDS now demands the use of roads in order to prevent flooding. For many years the roads and the asphalt have been reserved for cars and making room for cars has shaped the planning of cities, so the urban space needs to be redefined. For Prøvestens Allé / Kongedybs Allé this process of rethinking the use of the roads happened 20 years ago when they turned the two roads into a ‘play street’. By using experiments in the form of pilot projects, the actors, from the cases, managed to challenge the road regime to some degree and show that practices can change, and that SUDS on roads might contribute to multiple benefits. In SNM there is a great focus on the learning outcomes of niche development and depending on the content, evaluations are important for the learning processes of SNMin order to gain knowledge about the viability of the technology. Furthermore, there is a need to address the importance of changing the structural narratives and bringing forward the positive stories about the SUDS on roads, as it can contribute to the transitions and the contesting of the road regime. However, for all three cases, the road regime seemed to be a rather dominating precondition in the overall implementation of SUDS and it was difficult for the involved actors to stand up against this regime as they were met with the ‘shadow of hierarchy’, even though the networks seemed to work rather autonomously.

According to MLP, it can be easier for the niches and the underlying network to push for a change within the regime when external effects like the cloudburst in 2011 destabilised the regime. This event affected the practices of the utility companies and public authorities in relation to stormwater management. Furthermore, it addressed the importance of a regime-niche interaction when maturing of the niche. The utility companies got to play a bigger role in climate adaptation. It is the variety of the actors’ competence, skills, knowledge, or financial resources that constitute the development of niches. Governance becomes the platform where preferences are articulated in collaboration with politicians, businesses, and communities. Even though there is a focus on network governance, individual budgeting

sustains the subdivision and the possibility to look into greater socio-economic beneficial effects fails to appear. In order to shed light on the beneficial effects, we need to break down the thought about working in silos and work across sectors when planning. It is important to make the interplay between the water regime and the road regime visible and communicate the beneficial effects that emanate from managing water on the surface.



8 Conclusion

This project has answered the following research question:

How can we understand and support the ongoing transition of the water regime through the implementation of sustainable urban drainage systems on roads?

The study of the three cases has shown that the use of experiments with sustainable urban drainage systems on roads can contribute to the transition of the water regime by showing alternatives to traditional solutions and practices. We have viewed the cases through the lens of strategic niche management which has contributed to an understanding of how maturing of niches can induce a potential transition of the water regime. The niche in this project is concerned with sustainable urban drainage systems on roads and the network of actors and practices in relation to this. The three cases are viewed as experiments and analysed through the steps of SNM and the processes of network formation and coupling of expectations. Furthermore, the analysis of the cases has shown the importance of external dynamics. The cases were initiated before 2011, however, the cloudburst in 2011 became a game-changer for the development and accelerated the process of implementing SUDS on the roads in the three cases. It is stressed that the continuous dynamics between the three levels; niches, regimes, and landscape are important in order to understand how a transition occurs. SNM is shaped by a process of network formation and the involvement of different actors contribute to the development of niches that can contest and overcome the challenges in the destabilised regime. The case study has revealed new network formations and each actor contributes with different resources necessary to support and accelerate the transition. In addition to this, the case study has shown that citizens can play a vital role in the development of the niche and act as niche managers as well as the local authorities. Strong actors, such as local authorities, play a crucial role in the support of the niche. However, they can also be a barrier to the progress of the development because their steering is marked by 'The Shadow of Hierarchy'. Nevertheless, as the steering has moved from government to governance it has become possible for more actors to be involved in the decision-making processes. Furthermore, utility companies have gained a new area of responsibility in relation to climate adaption of the city and this has led to a change in the hydro-social contract as well. The cloudburst in 2011 became a momentum that changed the practice within the utility companies. The utility companies now play a bigger role in the development of sustainable urban drainage systems. Even though there is a network-oriented approach when

implementing SUDS, separated budgeting still becomes a barrier as it limits the possibilities to have a greater socio-economic perspective on the development and the associated results.

Besides, the study has shown that when the management of stormwater is brought to the surface it interferes with road regime. This interference can affect the development of the SUDS because the road regime now becomes the dominating framework. The perception of the roads plays a big role in the implementation because the road is thought of being reserved for cars and parking and making room e.g. rain gardens contest this perception. The road regime is locked-in due to the historical prioritisation of cars and the connected mindset. The roads are, therefore, a big part of the urban fabric and we, therefore, need the roads for climate adaptation in the dense city where scarcity of space is a challenge. In order to support the transition of the water regime, we need to contest the embedded perception of roads and show, through experiments, that SUDS on roads can contribute to climate-resilient cities.

Climate adaptation and especially sustainable urban drainage systems on roads become an important means of supporting the transition of the water regime and simultaneously contest the road regime and the perception of roads. The increasing volumes of stormwater, runoff, and the associated consequences have become very apparent to many. The integration of SUDS on roads can support multiple functions by adding new elements to the roads which e.g. can encourage physical activity and improve health. The niche of SUDS does not only contest the road regime but it interacts with other regimes such as the nature regime and the health regime as well. Using SUDS on roads may, therefore, contribute to integrate a socio-economic perspective and thereby underpin greater incentives for changing the practice within the water regime.



9 Reflection

This chapter will reflect upon the methods used throughout this project and how this has affected the outcome. Furthermore, it will include some reflections on additional methods and approaches that could have been interesting to examine. We will reflect on the learning process in regard to the use of the theory and how this has affected our project as well.

9.1 Interview Methods and Interviewees

The corona crisis has affected this Master thesis by forcing us to conduct our interviews using online media instead of face-to-face meetings. We wanted to use a timeline in relation to each case and draw on this during the interview. When the circumstances changed we were not prepared to use this timeline in the online interviews and this might have affected the outcomes. Especially in regards to our discussions about the values in relation to the projects. This became a difficult theme to talk about without impacting the interviewees' answers with our interpretations. The online conversations also made it difficult to 'connect' with the interviewees on a more personal level because the video function was turned off. Sometimes we had challenges with technical circumstances and this created time pressures. It would also have been rewarding to visit the area together with the interviewee in the cases where they had a direct influence on the areas, e.g. Vogt-Nielsen and Nielsen in respectively Helenevej and Prøvestens Allé / Kongedybs Allé.

In this project, we have interviewed a selection of actors in relation to stormwater management and their interpretation, understanding, and knowledge about the three cases contribute to our way of understanding the transitions. We are aware that this group of actors only represents some perspectives on the cases and the objects, however, the selection of interviewees is chosen carefully in order to cover the cases from different levels of society. We selected representatives from the utility companies in order to gain insight into their practice and understand the barriers and drivers they are facing. We had a pre-understanding from some of the literature that the utility companies 'only' had economical incentives for entering the processes, however, the interviews revealed another reality. The economic elements showed to be a prerequisite rather than the goal of development. The representatives expressed wishes for moving towards a more sustainable future but with the economics being the limitation for their work. (Grøndahl & Andersen, April 2020) The interview with the

representative from the utility company of Frederiksberg turned out to be more rewarding than we had expected because we got an interview with the head of planning within the utility company as well. This contributed to more general perspectives on the practice within the utility company. We got the object covered from different levels within the organisation by talking to a project manager and the head of planning. Because each actor contributes with their specific perspective and knowledge and they are equally important in the investigation of the object. Moreover, the interviewees representing the residents in two of the cases turned out to be rather interesting because they had good preconditions for engaging in such projects. Vogt-Nielsen (March 2020) had a thorough insight into the political processes because of his career as a political counsellor and he knew how to run such a project and who to talk to. Nielsen (March 2020) works as an engineer in a traffic planning unit and he had background knowledge about surfacing and some interesting insights into the planning of roads as well. The interview with a researcher, Freudendal-Pedersen (May 2020), who has a critical view of the current car regime added another layer to the discussion. Especially because her research is concerned with the challenges in regards to private car ownership and the embedded storytelling - the 'structural stories'. The interview with Freudendal-Pedersen was characterised as being more of a fluid conversation rather than a structured interview with specific questions because we wanted her to contribute with some new and potentially critical insights and she did add new and interesting aspects to the discussion and she had some relevant and alternative perspectives on the development.

We reached out to other residents at the two roads to get their perspective on the development. However, some of the residents at Helenevej did not want to talk to us because they did not know 'enough' about the development of the road. Moreover, we contacted Helle Højgaard Jensen who is the executive director at The Danish Town Planning Institute (Dansk Byplan Laboratorium) and also resident at GF Øresund. We expected her to possess great knowledge about urban development and interesting insights into the planning of the road and being a resident at the homeowner's association would add another dimension. We also contacted Anna Asluag Lund who just finished her Ph.D. when we initiated our work with the thesis. Her research was concerned with SUDS on roads and she was especially interested in the climate adaptation of the dense city as well and in her Ph.D. thesis, she made some designs for the roads as well. It would have been interesting to interview her because she had just recently finished her work and because she could

contribute with another perspective on the project in relation to the design of such roads. We tried to lend her Ph.D. thesis but it was unfortunately not available.

9.2 Choice of cases

We selected the interviewees on based on the choice of cases. Working with case studies has provided us with a thorough insight into the processes related to specific cases. However, the procedural analysis could be complemented with a field study and evaluations of the outcome of the projects and which values it has resulted in. But in order to investigate how transitions can be induced or accelerated we found it to be most interesting to look into the implementation processes and the potential barriers and opportunities this leads to.

One of the reasons behind the choice of the cases is that the projects regarding implementation are finished but it could be interesting to look into some of the pilot projects that HOFOR is doing the next three years, in order to analyse how they are involving and pushing for working with stormwater on the surface, especially with the knowledge gained from the examination in this thesis. It would also be interesting to examine whether they have learned from the previous pilot projects or not and to follow the process of implementation and the potential emergence of new networks.

9.3 Learning process in Relation to the Theory

We have been quite challenged with the choices of theory because they have turned out to be more complex and we have been compelled to supplement the multi-level perspective with additional theory. It has been a learning process where the theories have been added along the way because we needed to delve into one theory at a time and figure out what it could do for our work. Strategic niche management was added when we needed a theory to provide us with an understanding of the internal processes of niches and how they could be used more strategically to guide the transition and because some of the cases were initiated before the ‘crack’ in the regime in 2011. In order to understand the dynamics of network formation and the broader political system within a Danish context, we looked into network governance because we learned throughout the process that the danish system is marked by the hierarchical structure even though it is moving towards a more network-oriented approach. Strategic niche management could not provide us with the right insights into this context.

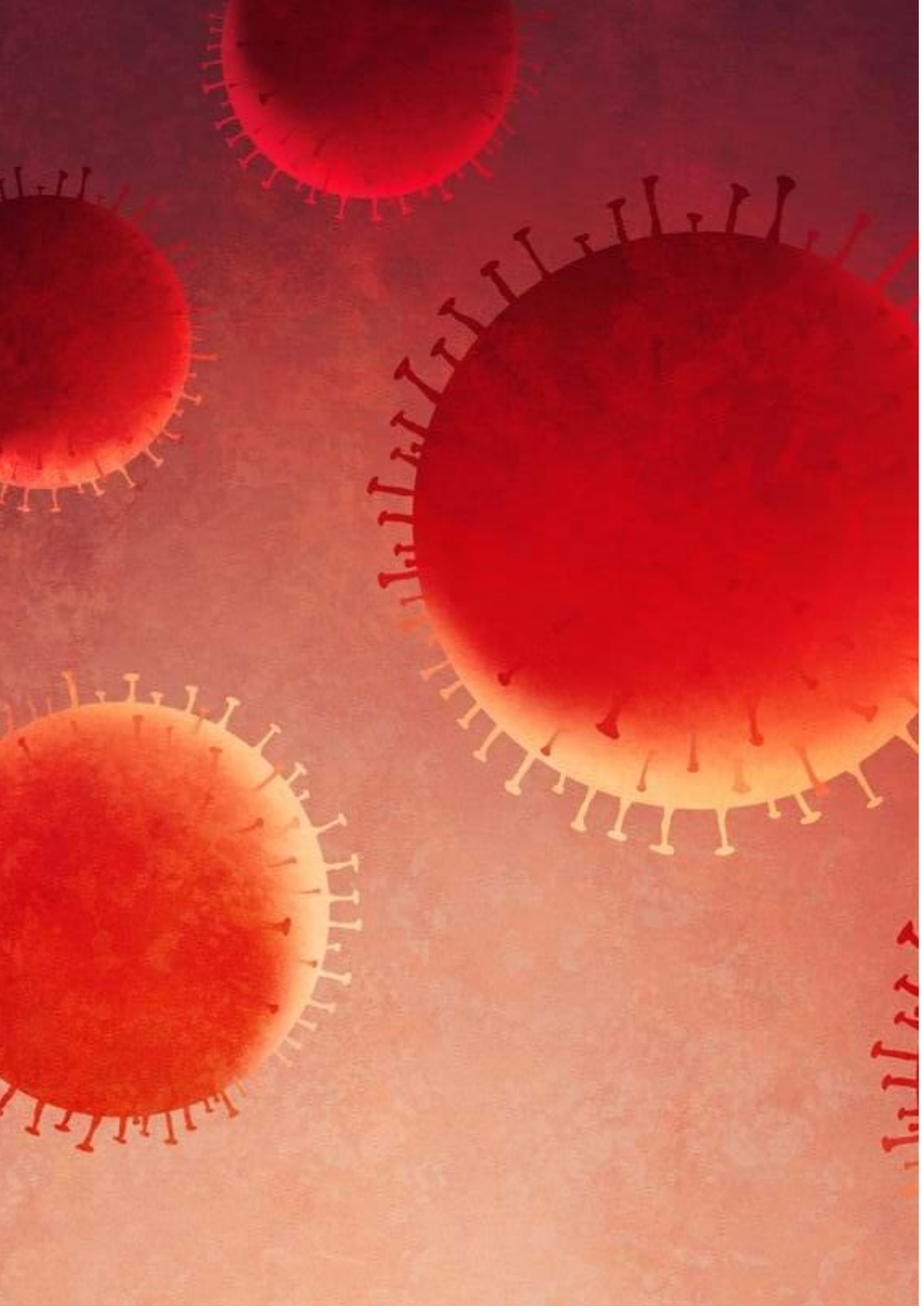
However, an examination of the power relations between the actors would have been appropriate in the analysis of the cases and the discussion. We have learned from the theory that influential actors are needed in the transitions (Chapter 5) so an examination would contribute with an analysis of who the strong actors might be and the challenges of the power relations and the issues with too dominant actors.

It has been a learning process to work with the theories and throughout the process, we have become more confident with the use of them.

9.4 What Does This Thesis Contribute to?

This thesis has contributed to an investigation of some of the issues and drivers related to the implementation process of SUDS on roads but we are aware that we have not uncovered the entire truth and the question is if this is even possible. However, the outcome of this thesis might contribute to implementing SUDS on roads in urban development and give an insight into the potential network of actors related to SUDS on roads. Furthermore, it can contribute with reflections on how the different regimes clash with each other when certain practices change and that other regimes, such as the road regime, have a bigger impact on the process than previously thought. Many of the needed solutions in order to manage stormwater on roads are available, however, it is to a high degree the road regime that interferes with the development. As the water regime is interfering with the roads, it is clashing with the road regime. However, as stated in this project climate change is happening, and to adapt the cities we need to use the roads, as it is one of the few places left in the dense city where we can adapt to the climate. But for the two regimes, and potentially many more regimes, to interact with each other, we need to use climate adaptation as a lever to show all the multifunctionele benefits that these types of projects can contribute to. There is a need for networks to push for experiments that can change our perception of the urban spaces and the use of roads.

Networks consisting of citizens, researchers, planners, utility companies, municipalities, politicians, etc. We need someone with the ideas, the visions, someone that can articulate them, and someone that can push for the change. And then we need some rain, preferably a major cloudburst, so we do not forget that there is a meaning behind our work.



10 The Effect of The Corona Crisis

In February 2020 when we started on our Master Thesis, Denmark was like we always have known it. People went to work, kids went to school, and students attended classes at the university and the main topic in the newspaper was how you could become the best version of yourself in 2020. However, on March 11th, life as we know it was turned around. Denmark was shutting down as a response to the virus COVID-19. Our everyday life was changed as a consequence of the new restrictions initiated by the national government. As mentioned in Chapter 5 regimes are relatively stable systems but they can be transformed. The change can happen if the regime is no longer adaptable to changes and conditions in the landscape. When the changes in the landscape create cracks in the regime and result in a national and international crisis an immediate response is needed. It has been interesting to follow the impacts that the virus has had on society and how regulations have changed from one day to another, especially because our thesis is concerned with transitions and we argue that they progress rather slowly. Furthermore, it has attracted our attention to see how fast the citizens have supported the restrictions initiated by the national government from one day to another. It is very suggestive of how fast we actually can change behavior when we know what is at stake. The crisis has resulted in huge economic cracks in the societies, however, the climate and nature have benefited from the crisis. Because we are so passionate about improving the climate we hope that the societies will learn from the crisis as well in relation to nature and environmental issues.

For many decades we have known that drastic changes were needed in order to accede climate change. However, these changes are slowly happening and in some cases, they fail to appear both in relation to politics and the behaviour of the citizens. But why is it that we are willing to change regimes for a ‘thing’ that suddenly occurred in comparison to a ‘crisis’ that has been the reality for many years?

We have seen from COVID-19 and the associated restrictions that it has had a positive impact on the climate crisis. The air quality has improved due to less traffic on the roads and in the air, the earth's background noises have been reduced with a third. It shows how significant human influence on the planet is. One thing is that we can learn something and that it is worth doing, but the question is how this learning can be maintained and transferred to the climate. (Brinkmann et. al, 2020 [a])

10.1 A Change in Our Practice

Through the last months of lock-down in Denmark, we saw excessive use of green urban spaces. The citizens were visiting, staying, walking, and doing workouts in nature to a much higher degree than before. This could indicate the importance of having nature and green spots both in and near dense cities, as we are drawn to nature, especially when our normal behaviour is limited. It seems like a new interest in nature has emerged out of the crisis and that nature is valued higher.

It could be interesting to investigate the possibilities for containing this interest and affection for nature and see if it could be transferred to climate projects. The investigation could include an examination of the increased use of the urban nature spaces and how this contributes to new formations of networks and if it increases the support for climate projects that brings nature closer to the people.

Another interesting effect from COVID-19 and the restrictions is the changed use of the asphalt. When the restaurant and cafés open May the 18th, they have the option to serve on urban squares, parks, pavement, and selected parking lots. This means that cars must give away to outdoor serving. (Dalgaard, 2020). This experiment with new use of parking lots could maybe play a role in changing the perceptions of asphalt from being the domain of the car to being reserved for social activity with the car being the second priority. It will be interesting to follow the experiment and see the results.

Another important point to be aware of is the role of public transport and the language used in this context. When Denmark was shut down, the Government urged to decrease the use of public transport as it could increase the risk of contamination (Mørck & Brandt, 2020). The perception of public transport and car-sharing posing a risk to public health could be feared to continue - also when Denmark reopens. Public transport and car-sharing are appropriate solutions in order to lower the number of cars in the cities and thus air pollution. However, this might be challenged by this changed perception.

10.2 The Consequence of Climate Change

The climate crisis and the corona crisis are not comparable because the corona crisis is an aggressive and hopefully only a temporary crisis whereas the climate crisis has been going on for quite some years now and it continues! However, the consequences of the corona crisis

with increasing death numbers become very apparent for people but these numbers are nothing compared to the numbers of death caused by air pollution. According to WHO seven million people die every year from diseases caused by air pollution (Dansk Industri, 2019) Furthermore, since 2008 there has been an average of 21,5 million people who are being forced to escape due to extreme weather events (DR Nyheder 2016). This will only increase if we proceed with business as usual. It is important to underline that both crises are serious, however, we are no longer in a position where we can pause the actions against climate change and only focus on the short term investments. We lost that position a long time ago. (Brinkmanns et. al, 2020 [a]). Even in Copenhagen, air pollution is a great problem as ten percent of early deaths in the City of Copenhagen were caused by air pollution in 2017 which corresponds to societal costs of 8,8 billion a year (Strangholt, 2020). We have adapted very quickly to the restrictions in relation to the corona crisis - people are willing to keep a distance of two metres in the supermarket. However, people are not willing to bike, walk or use public transport instead of driving their car even though we know it is a source of pollution and potentially causing a large number of deaths (Kanger & Schot, 2016)!

The corona crisis calls for kickstarting investments in the danish society in order to kickstart the economy. According to Fjorback (2020), urban blue-green climate solutions can help kickstart the economy and contribute to making our cities climate-resilient. Most important for blue and green solutions within urban planning is a political action. The political action has to insist that future investment has a focus on sustainability and climate adaptation. (Fjorback, 2020) According to Kemp (1998), the public authorities can help to articulate the vision for the society in order to coordinate strategies for the technology, developers, regulators, investors, users, and so on. They can create and facilitate new actor networks that can be part of making the cities climate robust. (Kemp et al, 1998)

10.3 View of life

When the COVID-19 erupted, people all over the world looked up from their separate worlds and everyday life and decided to pay attention to this new focus. This is something that we need to hold on to, also after the corona crisis. That we can acknowledge that we need to focus on the same crisis - corona crisis, or climate crisis, we are all part of the same world. We react collectively to good and bad, and this is a collective task we need to solve as a society. You realise that we are like an organism, which act collectively and help solve the

problem, also for the vulnerable groups in society. It is the joint community which gives us an outlook on life (Brinkmanns et. al, 2020 [b]).

But in order to remind people of the consequences of climate change and that the implemented solutions matter, one could argue that we need another cloudburst to evoke people's awareness of climate change and show the matter of the already implemented solutions.

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11.1 Interviewees

Andersen, Lotte Kau, April 2020. Responsible for the Green Roads, HOFOR. Interview conducted 13/04/2020, using Microsoft Teams online. Transcription in appendix 5.

Bay, Henrik, March 2020. Planchef, Frederiksberg Forsyning. Interview conducted 25/03/2020, using Skype for Business. Transcription in appendix 3.

Freudenthal-Pedersen, Malene, May 2020. Professor of Urban Planning. Aalborg University. Interview conducted 12/05/2020 using Skype for Business. Transcription in appendix 7

Nielsen, Jan, March 2020. Resident at Helenevej, Frederiksberg. Interview conducted 31/03/2020 using Skype for Business. Transcription in Appendix 4.

Grøndahl, Louise, April 2020. Head of Cloudburst Programme, HOFOR. Interview conducted 13/04/2020, using Microsoft Teams online. Transcription in appendix 5.

Stender, Dorthe, March 2020. Project Manager Skt. Kjelds and Bryggervangen, Center for Klimatilpasning. Interview conducted 23/03/2020, using Microsoft Teams online. Transcription in appendix 6.

Vogt-Nielsen, Karl, March 2020. Resident and member of 'The Climate Group'. Interview conducted 13/03/2020 at Prøvestens Allé 15, 2300 Københavns S. Transcription in appendix 1.

Westphall, Helle Rye, March 2020a. Hydraulisk planlægger at Frederiksberg Forsyning, Interview conducted the 23/03/2020, using Skype for Business. Transcription in appendix 2.

Westphall, Helle Rye, March 2020b. Hydraulisk planlægger at Frederiksberg Forsyning, Interview conducted the 25/03/2020, using Skype for Business. Transcription in appendix 3.

11.2 Pictures

Pictures from page 15 to 103 in the report are own photos taken in February and May.

Picture on page 104 is from Industriens Uddannelser, 2020. *Information om covid-19/corona*.

[Online] [Accessed 02/06/2020] Available at: URL<

<https://www2.iu.dk/skolervirksomheder/laerlinge/information-om-covid-19-corona/>>