The barriers a design and consultancy company encounters in its efforts to create climate-proof cities

So close, yet so far?

Arcadis

3 JUNE 2019

Contact

NADI LUITEN-MODDERMAN
Master student

M 06 - 21 62 67 92
E nadi.modderman@arcadis.com

Arcadis Nederland B.V.
P.O. Box 220
3800 AE Amersfoort
The Netherlands

The barriers a design and consultancy company encounters in its efforts to create climate-proof cities

SO CLOSE, YET SO FAR?

N.E. Luiten-Modderman

In partial fulfilment of the requirements for the degree

Master of Science

In Civil Engineering, Water management

at the Delft University of Technology,

to be defended publicly on 18 June 2019.

Thesis committee:

Dr. Ir. Frans van de Ven
Dr. Ir. Jeroen Langeveld
Dr. Ir. Jos Timmermans
Ir. Michel Moens

PREFACE

Before you lies the thesis "The barriers a design and consultancy company encounters in its efforts to create climate-proof cities", the basis of which is a survey on knowledge, approaches and organisational issues related to climate-proof cities that was conducted among twenty-four colleagues within the design and consultancy company Arcadis. I wrote this thesis to fulfil the graduation requirements of the Water Management master programme at Delft University. I was actively engaged in researching and writing this thesis from August 2017 to May 2019 next to my fulltime (32 hours) contract at Arcadis.

The study was undertaken at my own initiative and formulated together with my supervisor at Delft University Frans van de Ven. I found the study difficult but conducting extensive interviews has allowed me to answer the question that we identified. Fortunately, everyone was always available and willing to answer my queries.

I would like to thank my supervisors for their guidance, patience and support during this complete process. Although it was sometimes struggling on my own, you were always there to help me get further when needed. Despite my stubbornness, you even motivated me to fulfil an extra step at the end. I also wish to thank all the respondents; without whose cooperation I would not have been able to conduct this analysis.

To my other colleagues at Arcadis: I would like to thank you supporting me to continue with my master. You've always put my personal stakes above company stakes, even if I didn't see or do that myself. Sometimes an hour at the coffee machine and a kick to the butt was needed to keep me going, but you saw and acted when that was necessary.

A special word of thanks to my husband Jaap Luiten. Together for ten years already. We've got married along the way and are expecting our first family extension this year. Without your everlasting faith in my capabilities and comforting me when I felt completely lost, I would have never made it to where I am now. You deserve more attention than you've received due to the never-ending nights and weekends of thesis efforts, but I'll make that up to you! Love you!

Last but certainly not least. Eva Kunst en Lianne van der Vorst: my rocks! The struggles you've helped me through mean the world to me. Always willing to help me write, review the stone-coal-English paragraphs and brainstorm about structures and possible methods. When I was tearing down my own research results, you were always there to see the positive side and make me see it as well. Next to my thesis I've enjoyed our relaxing days of shopping (jeans 😉), having high-teas and spending time together. My thesis is finished, so the reviewing stops here, but I hope we never stop having nice trips and dinners together!

So close, yet so far. This thesis is just a baby step in my career, but I feel victorious… My thesis is FINISHED but learning never ends! I hope you enjoy your reading. For readers with little time, I recommend starting with the summary, but I hope it will invite you to read it all!

Nadi Luiten-Modderman

Amersfoort, June 2019

SUMMARY

Urbanization and climate change challenge our lives in urban areas. The increase in urbanization was also presented by projections of the United Nations. These projections demonstrated that 68% of the world's population will live in cities by 2050 [16]. In the Netherlands an average population growth of 15% is expected for the four[1] largest cities between 2015 and 2030 [17]. The consequences of urbanization, such as an increased need for buildings, roads and other infrastructure, are often at the expense of the natural environment [18].

The Dutch government has raised awareness for climate change and adaptation of urban environments through the Delta Decision on Spatial Adaptation [11]. The spatial adaptation knowledge portal, under authority of the ministry of infrastructure and the environment, emphasizes the importance of joining forces (domains, public and private sector) to prepare for and deal with climate change.

Although climate adaptation concerns a challenge related to the water domain [3], other domains are working on future cities from their perspectives. Rotmans et al. [9] framed main transitions for Dutch cities and society, amongst being circularity, energy transition, mobility, climate change and smart cities. Cities around the world are introducing concepts and "initiatives aimed at upgrading urban infrastructure and services, with a view to create better environmental, social and economic conditions and enhance cities' attractiveness and competitiveness" [33].

While these complex concepts require an integral approach [2], they are generally approached vertically (sectoral) [3, 9]. Hoppe et al. [3] argue that the current vertical policy is not in line with the apparent need for an integral approach and knowledge sharing. These issues require a whole-system approach.

Despite the interdependency of transition, these seem to be handled vertically (sectoral) not only by governmental organizations, but also within design and consultancy companies as Arcadis. Arcadis possesses knowledge on all domains and transitions due to the wide range of backgrounds, knowledge and specialisms of the almost 27.000 employees worldwide. Still climate-proof cities are not being considered consistently within projects. The question rises whether the main transitions for our future cities are known and if these are known, why aren't these implemented in Arcadis' projects? Barriers indicated by literature (vertical approach, lack of knowledge development, transition pathways) are found within governmental organisations. This thesis aims at identifying the barriers at the design and consultancy company Arcadis.

Evaluating the different transitions, e.g. energy, circularity, climate, and policy approaches, e.g. vertical, horizontal, results in the question how design and consultancy companies could deal with transitions while keeping a focus on the integration and use of climate-proof cities. Although current policies are (being) developed to stimulate creation of climate-proof cities, the implementation and execution of policy by stakeholders is staying behind. Although, the focus of this thesis are the barriers of design and consultancy companies for the implementation of climate proof cities, stakeholder's analysis demonstrated that design and consultancy companies are a part of a larger chain. For the activities Arcadis executes for its clients, there are processes in which the firm could encounter barriers, being policy, regulation, implementation and finance, maintenance and the organisation.

The ministry of Infrastructure and Water management proposed a chain model to improve policy approaches for the implementation and result of policies [43]. The chain-model (Figure 6) is called PRIMO which stands for Policy, Regulation, Implementation & finance, Maintenance and Organisation [43]. This chain-model suggests that if one of the components of the chain is not executed successfully, the applicability of the policy or measures should be questioned. The model aims to increase clarity and coherence between the different layers and actors involved. This chain-model is used to structure, analyse and understand the results of the study.

Interviews were conducted with 24 colleagues representing the departments involved in the design and maintenance of public areas. Literature study combined with the PRIMO chain revealed six themes that helped to identify the barriers in the approach of climate-proof cities with respect to transitions. The interview

---

[1] Amsterdam, Rotterdam, the Hague and Utrecht

data showed a representation of the perception of specialists, advisers and project leaders within the various departments of Arcadis NL.

The aim of this research was to identify the barriers a design and consultancy company encounters in its efforts to create climate-proof cities. Besides these barriers, a few barriers are identified that exist specifically due to the relation of Arcadis with clients (Table I) or because of the organisational structure of Arcadis (Table II). Most design and consultancy companies execute assignments for governments. They encounter several barriers related to the organisation at the clients' sides. The specific barriers are related to the Organisation part of the PRIMO chain. The barriers were also acknowledged by the expert-group, which was used to verify the results.

Table I Identified barriers and consequences that are considered as external influences

Barrier external influence	Consequence
Election terms of governments	limit long-term approach, since election terms pressurize the outcome of policy implementation in order to achieve concrete results.
Policy depends on type and size of organisation	Lack of policy on transitions impedes the implementation of measures and reduces opportunities for design and consultancy firms to share expertise.
Projects from clients are often focused on one domain	• Assignments are procured fragmented, so that overview on complete programme lacks for design and consultancy companies. • Competition in tenders results in low priced offers. • Low priced offers result in limited time to execute projects properly.

Table II Identified barriers and recommendations that concern the Arcadis' Organisation

Barrier Arcadis Organisation	Recommendation
Role & responsibilities towards transitions are unclear	• Communicate clearly and propose specific role structure • Include expectations, roles and responsibilities in Arcadis' strategy - growth priority climate adaptation • Provide examples of good practice by Urban Design • Implement philosophy of programme leader climate-adaptation
Financial system is not applicable for integral projects (sectoral organisation structure)	• Form new department/ group climate-proof cities (following the pilot executed by business line Infrastructure • Provide bonus structures to increase involvement in climate-proof cities and increase number of integral project teams.

Overall governmental organizations as well as design and consultancy companies struggle with similar barriers in knowledge gaps, uncertainty of the outcomes and the sectoral approach. Knowledge is developing on climate change aspects and feasibility of measures. Small steps are taken in the execution of the Delta Programme Spatial adaptation, currently working on the risk dialogue. Small steps to get closer to the final goal: climate-proof cities.

This study shows the barriers of design and consultancy companies in its efforts to achieve climate-proof cities. Working together and sharing experience instead of end of the line advisory is identified as a major barrier for these companies. If these cooperation and financial structures don't change, we are likely to keep on doing the same as we have done for sectoral projects. **So close yet so far? Maybe. We are getting closer in our separate efforts, but together - internally and externally - we may get further!**

CONTENTS

TABLES

FIGURES

APPENDICES

1   INTRODUCTION

1.1   Problem statement

In 2007, the Intergovernmental Panel on Climate Change (IPCC) provided evidence in the Fourth Assessment Report [1] that climate change is happening. In the Fifth Assessment Report (2014) [4] the IPCC elaborates on the causes and effects of climate change in different emission scenarios. Under all assessed scenarios, the surface temperature is expected to rise. As a result, heat waves will occur more often and last longer, resulting in heat stress and drought problems for cities. Other projected effects are sea level rise and the occurrence of more intense and more frequent extreme precipitation events leading to flooding issues in the urban environment [5].

While the IPCC report of 2007 aimed at mitigation only with the goal to reduce effects, the report of 2014 aims at both mitigation and adaptation strategies. Over the past few years the focus is shifting towards synergy of both strategies, but there seems to be lack of attention to adaptation [2]. Hoppe et al. [3] noted also a sizeable difference in adoption of the two strategies. He [3] concludes that the difference can be explained by *vertical policy integration approach,* also known as the sectoral approach, of the central Dutch government. Furthermore, he mentions the embedment of mitigation strategies as an 'energy' issue and *adaptation strategies as a 'water' issue.*

In the Netherlands urgency of climate change adaptation led to the ambition of establishing a climate-proof environment by 2050 [6]. The national Knowledge for Climate research programme conducted a research on climate-proof Cities (CPC) [7]. The research group defined climate-proof cities as "making cities more resilient to the impact of climate change by improving their adaptive capacity". For the urban environment, large municipalities and water authorities are developing their own adaptation strategies. Although these adaptation strategies are depending on the size and conditions of the municipalities, formulation of SMART goals and targets seems to be difficult for every municipality. While the vertical policy approach (sectoral) [3] and the lack of responsibility for the issues are often mentioned as main cause, this difficulty may be caused by differences in norms and criteria used by domains involved in climate adaptation issues. Different current norms and criteria, targeting possibly the same goals, could result in unacknowledged and unambiguous goals. This may hinder implementation and working towards the goals, in other words: decrease the action perspective regarding the adaptation goals (authors' observation based on information from experts in the field).

The CPC research group [7, 8] reports the challenges for city governments regarding implementation of climate adaptation by policy approaches. Apart from policy approaches, climate-proof cities concern not solely the water management domain, but numerous others such as urban planning and infrastructure. For each domain different criteria and design guidelines apply. Biesbroek et al. [2] stresses the importance of knowledge development between domains and an integrated approach to tackle the climate adaptation issues for the urban environment. In practice, both issues being addressed as 'water' challenges [3] and the vertical policy approach seem to result in a fragmented and unclear approach carried out by the different domains involved in climate adaptation issues.

Although climate adaptation concerns a challenge related to the water domain [3], other domains are working on future cities from their perspectives. Rotmans et al. [9] framed main transitions for Dutch cities and society, amongst being circularity, energy transition, mobility, climate change and smart cities. While these challenges are multidisciplinary and complex, they are generally approached vertically [3]. In another paper Rotmans et al. [10] described transition management to deal with the complex problems society is facing. The key in transition management lies within long-term thinking and involvement of multiple domains, actors and levels. Long-term thinking is applied by Dutch governmental organisation in the Deltaplan [11] and derived policy documents for climate change by water managers, but these document lack relevancy on intertwining transitions. The challenges all affect the public spaces of our cities. If the development path of the energy transition or smart cities changes, this may lead to a different development path for climate-proof cities and vice versa.

Despite the interdependency of transition, these seem to be handled vertically (sectoral) by all parties involved, also within design and consultancy companies as Arcadis. On the one hand activities of such a company in the achievement of long-term goals is often limited by the assignment formulated by the clients.

On the other hand, Arcadis also has growth priorities on certain transitions (climate and energy) and strives to fulfil their mission "Designing a world for the next generation".

Arcadis possesses knowledge on all domains and transitions due to the wide range of projects and clients. Still climate-proof cities are not being considered consistently within projects. The question rises whether the main transitions for our future cities are known and if these are known, why aren't these implemented in Arcadis' projects? Barriers indicated by literature (vertical approach, lack of knowledge development, transition pathways) are found within governmental organizations. Could these barriers also be found within the design and consultancy company or are differences noticeable? Which barriers can be identified within the Arcadis organisation and which recommendations could be given to deal with them?

1.2   Scope

The view on climate adaptation of the urban environment as a solely water related issue combined with the vertical policy approach, lack of standards and lack of knowledge on transitions per domain is not in line with the apparent need for integral adaptation strategies.

Different parties are involved in the design of public spaces. Municipalities are responsible for the result of the design and maintenance of these spaces. While some large municipalities have their own engineering department most municipalities rely on design and consultancy firms for the development and implementation of policy and strategy. Arcadis, the largest design and consultancy company of the Netherlands [12], can partly influence the direction in which climate and other transitions are implemented.

This master thesis aims at identifying the barriers within a design and consultancy firm by evaluating internal approaches, knowledge and differences in domains to increase the action perspective in the approach of climate-proof cities.

The study is limited to the barriers that are identified with the domains concerned with design and maintenance of public spaces. These domains can be found at the following departments within Arcadis NL:

- urban planning
- infrastructure
- water management (coastal, rural & urban)
- greenery
- project development

1.3   Research questions

The overall research goal of this thesis is: to identify the barriers within a design and consultancy firm by evaluating internal approaches, knowledge and differences in domains to increase the action perspective in the approach of climate-proof cities.

The following five research questions support in achieving the overall research goal. The third research question shows similarities with an action type of research, while the fourth can be characterized as comparative.

1. Which transitions do we see for Dutch cities and society?
2. Which barriers are identified by literature in the approach of climate-adaptation?
3. Which barriers are identified by interviewees from different domains in the approach of long-term transitions as climate adaptation?
4. Are there differences in barriers between governmental organizations and Arcadis?
5. What can be improved within Arcadis to improve the action perspective?

2   LITERATURE STUDY

In this chapter current climate change projections and transitions are described, which answers the first research question. Apart from these findings, the framework for structuring and analysis is presented. Furthermore, the second research question is answered by the literature study about governmental barriers in the approach of climate change.

2.1   Transitions

2.1.1   Projections climate change

Urbanization and climate change challenge our lives in urban areas. The increase in urbanization was also presented by projections of the United Nations. These projections demonstrated that 68% of the world's population will live in cities by 2050 [13]. In the Netherlands an average population growth of 15% is expected for the four[2] largest cities between 2015 and 2030 [14]. The consequences of urbanization, such as an increased need for buildings, roads and other infrastructure, are often at the expense of the natural environment [15]. A change of the natural environment due to urbanization changes the morphology of the surface compared to the natural surface resulting in modification of energy and water exchanges and airflow [15].

Climate change is defined as substantial change in measures of climate over a period of decades or longer [16]. Whereas climate has changed over the history of our planet, the (rate of) changes now observed are primarily caused by human activities [16]. Climate change poses more treats to these natural conditions. The Intergovernmental Panel on Climate Change (IPCC) provided evidence in the Fourth Assessment Report [1] that climate change is happening, yet some scientist and high ranked persons (amongst whom President Trump of the U.S.A.) deny climate change from happening [17], [18], [19].

In the Netherlands, climate scenarios are modelled by the Royal Netherlands Meteorological Institute (KNMI). These climate scenarios are generated based on two driving forces: global temperature change and change of mean seasonal regional atmospheric circulation [20]. Based on the two driving forces, the KNMI composed four scenarios based on the temperature and circulation patterns (Figure 1). The range of possible effects on temperature and rainfall is summarized in table 1.

Table 1 Range of effects for scenarios on rainfall and temperature [20]

	1981-2010	Projections for 2050
Yearly average amount of rainfall	851 mm	Between +2% and +5%
Yearly average maximum amount of rainfall per hour	15 mm	Between +12% and +25%
Average temperature	10.1 °C	Between +1°C and +2.3°C
Average hottest day of the year	32.0 °C	Between +1°C and +3.8°C
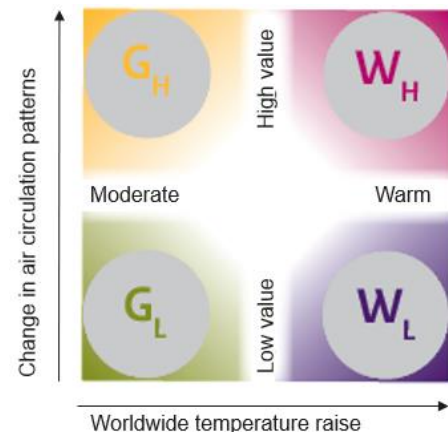
Figure 1 Climate change scenarios [20]

While the four scenarios span most possible future climates it remains uncertain how the Dutch climate will change. Therefore, all scenarios should be considered in developing policy and measures [21]. To this end, the Deltaplan [11] was developed. The Deltaplan [11] framed four main climate change themes for urban areas: pluvial and fluvial or coastal flooding, heat stress and drought.

- Fluvial or coastal flooding: the city should be protected from flooding.
- Pluvial flooding: the urban area must deal with extreme rainfall events.
- Heat stress: the city should minimalize the effect of the urban heat island.
- Drought: the urban area is prepared for periods of extreme droughts.

---

[2] Amsterdam, Rotterdam, the Hague and Utrecht

While a lot of attention is given to water related issues such as pluvial and fluvial or coastal flooding, climate change projections also show extremes in heat and drought situations for which we could and should prepare [20]. In July 2018 heatwaves and the driest period ever measured in the Netherlands struck Dutch society, resulting in higher usage of drinking water, lower water quality of open water, higher risk for collapse of peat dikes [22], salinization of the ground [23], water shortage [24] and subsidence of properties [25]. Prior to the recent drought situation in 2018, the last serious drought situation dates in 1976 [26], society and our cities are not accustomed to these events. Periods of droughts ask for a strategy to ensure all vital and societal structures keep functioning properly. In the Netherlands the Management Team Water Shortage (management team watertekorten) [27] is responsible for securing the vital functions, but the public spaces can also be designed to make it adaptable for serious effects caused by droughts.

2.1.2   Climate Adaptation & transitions

While the IPCC report of 2007 [1] aimed at mitigation only with the goal to reduce effects, the report of 2014 [4] makes clear that solely mitigation efforts are not enough. Next to mitigation, adaptation is necessary [4]. The Paris Agreement 2015 [28], adopted under the United Nations Framework on Climate Change, signed by 195 state parties committed their participation to "substantially reduce the risks and effects of climate change". The commitment exists of determining, planning and reporting on the contribution that these countries undertake to mitigate global warming. One of the mitigation efforts is known as the energy transition: the transition from the use of fossil fuels towards renewable energy sources in order to reduce the output of greenhouse gasses [29]. The energy transition, with its mitigation efforts is categorized as an energy 'issue' [3]. Adaptation, for urban areas also known as climate-proof cities [4], is a trajectory recognized at the expertise of water managers [3].

In addition to climate-proof cities and the energy transition cities around the world are introducing concepts and "initiatives aimed at upgrading urban infrastructure and services, with a view to create better environmental, social and economic conditions and enhance cities' attractiveness and competitiveness" [30]. De Jong et al. [30] studied the use of different concepts in literature and the co-occurrence with other concepts, referring to energy transition and climate-proof cities respectively as low carbon cities and resilient cities. Next to these transitions, cities worldwide struggle with the implementation of other transitions, such as smart cities and mobility, digital cities and eco cities. De Jong [30] found which transitions are referred to most in literature (Figure 2).
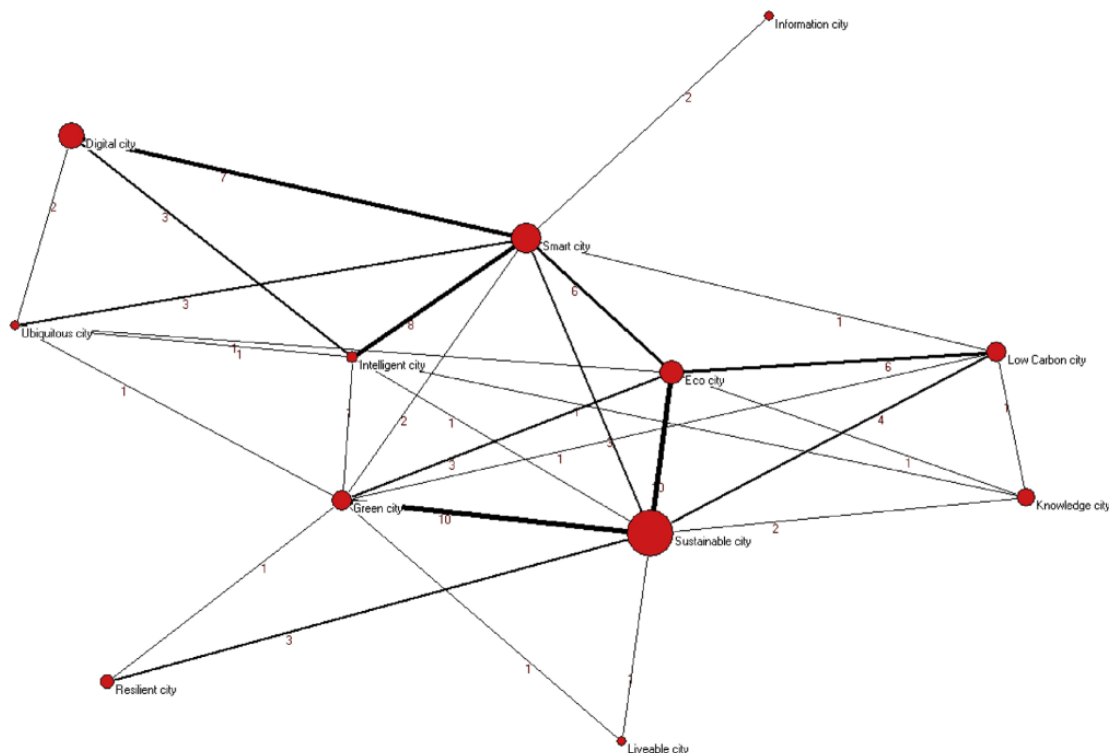
Figure 2 Co-occurrence of twelve concepts in titles, abstract and key words [30].

Sustainable cities are mentioned most in literature, with 564 articles [30] followed by smart city concept with 222 hits and digital city with 166 articles. As Figure 2 displays sustainable cities is also associated most with other transitions, being an eco-city, a green city, a resilient city and a low carbon city. While these transitions are recognized worldwide, TNO [31] described the main transitions that the Netherlands must deal with until 2050. The most discussed energy transition, circular economy and vital cities are transitions that influence how our cities develop and indirectly on the development and effects of climate change. The energy transition is aimed at reducing greenhouse gases. By minimizing the use of fossil fuels and implementing renewable energies, emissions can be reduced. Circular economy aims to prevent finite raw material stocks from being exhausted and to reuse residual materials as much as possible. The achievement of vital cities is realized by creating attractive areas for living, working, transport, care and other services at a high level. This attractiveness is enhanced by a smart approach and solutions for sustainable design, maintenance and use of the areas.

For all these transitions the goals are to prevent a certain scenario from becoming reality. However, climate change is a fact that is irreversible, but the extent to which the climate change scenarios become reality can be controlled by the way we now deal with the current problems and transitions. Clear objectives have been described for the transitions [32], [33], [34]. However, it remains unclear how these objectives need to be achieved. As Suckall et al. [35] notice "Many countries are grappling with the possible contents of adaptation policy". One reason for the lack of clear steps in achieving the objectives in the transitions is the uncertainty in the effect of the measures to be used. Another reason for this can be the mutual dependencies in transition paths. An example is the replacement of central heating for district heating. This measure contributes to objectives for energy transition and the circular economy and influences the applicability of climate measures and thus the attractiveness of the cities. Implementation of one policy can delay, accelerate or maintain the impact of the other policy.

The Dutch government has raised awareness for climate change and adaptation of urban environments through the Delta Decision on Spatial Adaptation [11]. The spatial adaptation knowledge portal, under authority of the ministry of infrastructure and the environment, emphasizes the importance of joining forces (domains, public and private sector) to prepare for and deal with climate change. The UK Water partnership [36] concluded, in the perspective of transitions, that water related issues for cities cannot be solved as stand-alone issues but should be seen in context of drivers and impacts that originate beyond the field of water management. These issues require a whole-system approach. The questions how to develop an optimal integrated approach and how to link technological advancements, opportunities and interdisciplinary work to create future cities are still open for debate [36].

Because the complex and interconnected nature of the problem, Hoppe et al. [3] argue that the current vertical policy is not in line with the apparent need for an integral approach and knowledge sharing. Likewise, Bulkeley et al. [37] mentioned the fact that responding to climate change is not a matter of simply recognizing the role of municipalities and water authorities in mitigation and adaptation by a set of interventions. They underline the role of knowledge, politics and justice in stimulating and maintaining effective strategies for climate adaptation of cities. In addition, De Jong et al. [30] recognize the difficulty in defining transitions vs. policy application "When city categories (transitions) harbour more perspectives, then different processes and outcomes may be expected to result from each of them. The policy application of these city categories could be expected to be different too" [30].

2.2   Framework

Evaluating the different transitions, e.g. energy, circularity, climate, and policy approaches, e.g. vertical, horizontal, results in the question how design and consultancy companies could deal with transitions while keeping a focus on the integration and use of climate-proof cities. Although current policies are (being) developed to stimulate creation of climate-proof cities, the implementation and execution of policy by stakeholders is staying behind. While the focus of this thesis are the barriers of design and consultancy companies for the implementation of climate proof cities, stakeholder's analysis demonstrated that design and consultancy companies are a part of a larger chain. For the activities Arcadis executes for its clients, there are processes in which the firm could encounter barriers, being policy, regulation, implementation and finance, maintenance and the organisation. A framework proposed by the ministry of Infrastructure and Water management to improve policy implementation is the PRIMO chain [40]. This chain model (PRIMO) provides a possibility to categorize the barriers by these five aspects. Categorization offers more focus in the data analysis, by collecting the data per aspect and drawing conclusions based on the categories.

2.2.1 Playfield & chain-model

Rijsberman [38], [39] developed a model to identify the actors, issues and areas related to a playing field (Figure 3 left). A playfield can be defined in many ways and in all sizes. From a certain project location to transitions. In this case the playfield is defined as climate-proof cities. These three aspects help to define a starting point and problem definition. The actors are identified by questioning who must be involved, how and when. The area is the local territory which will be subject of development and issues are challenges actors must deal with in the playfield. Between the three aspects relationships exist that give context to the aspects.

- Interests: every actor is interested in a certain issue
- System: every issue is related to a spatial system or scale
- Territory: every actor covers a certain territory within the area
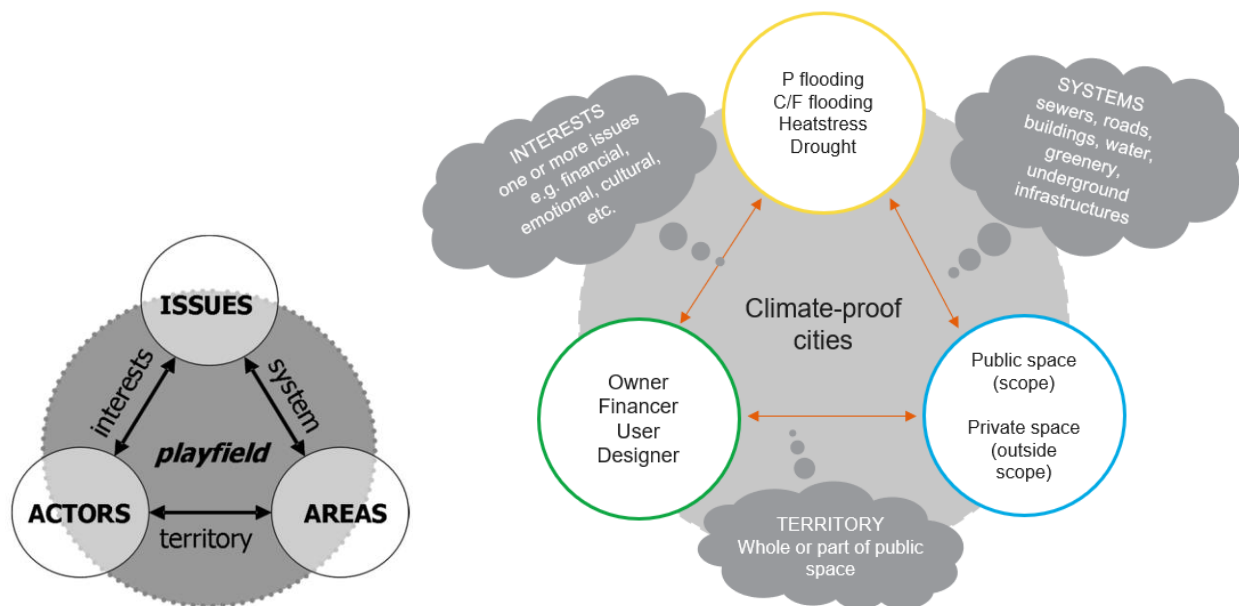
Figure 3 Playing field Rijsberman [39] (left) and playfield climate-proof cities [authors] (right)

By defining climate-proof cities as a playfield, the issues, actors and areas are identified (Figure 3 right). Although climate-proof cities cover both public and private territory, the scope of this study is limited to the public space. Therefore, the playfield is also limited to the public space. While in theory Climate-proof cities could be achieved if all actors are aware of the issues and their interests (or role), the influence of the issues on the systems and the limits and relation between different territories. However, in practice the issues are not solely restricted to technical challenges on the four climate change aspects, but also consist of transitions related to the design of public spaces and issues in the approach and organisation of these challenges, also called barriers. These barriers can be found during all projects steps from policy to maintenance [40], but barriers can also be encountered in the organisational structures.

The ministry of Infrastructure and Water management proposed a chain model to improve policy approaches for the implementation and result of policies [40]. The chain-model (Figure 4) is called PRIMO which stands for Policy, Regulation, Implementation & finance, Maintenance and Organisation [40]. This chain-model suggests that if one of the components of the chain is not executed successfully, the applicability of the policy or measures should be questioned. Although the chain-model is presented as a sequence, these activities do not necessarily have to be executed in the order presented. The model aims to increase clarity and coherence between the different layers and actors involved. While the first four initials P, R, I and M are related to the policy or project processes, the fifth emphasizes the importance of exchange in information, knowledge and experience between the actors [40]. Visschedijk [41] suggested in her study that this chain-model should be extended with the P of Politics. She stated that trends and events in the overall political environment, such as elections or shifts in public opinion influence the full chain.

Figure 4 PRIMO chain [40]

Transition management is a way to deal with complex problems society is facing [10]. The complex and interconnected nature of transitions requires an approach to avoid activities or processes being forgotten. The PRIMO chain model offers a systematic approach for structured analysis of activities related to every aspect of transitions, in this case climate-proof cities.

In the current study, this chain-model will be applied on climate-proof cities as a whole system covering all four climate change aspects (pluvial and coastal/ fluvial flooding, heatstress, drought). Although the role of Arcadis is not equally prominent for all four of these steps of the PRIMO chain. Like governmental organizations, these four project processes are the fields where Arcadis fulfils their core activities in the efforts to create climate-proof cities (Table 2). The majority of the activities contribute to the Policy and Implementation & finance steps. The Organisation represents the organisational structure of the company. This study focusses on the barriers encountered by the design and consultancy company in order to increase clarity and coherence in the approach of climate-proof cities.

Table 2 Example of activities executed by Arcadis within chain-model

Chain-model	Type of activities (examples)
Policy	Write municipal sewer plans Execute climate stress tests Develop spatial plans Advise on sustainability improvements Write risk-based maintenance plans
Regulation	Advise on use of norms and standards, such as guide design public space (LIOR or design bundles). Deliver expert judgement in lawsuits
Implementation & finance	Modell sewer capacity Advise on suitable measures for public space Investigate possibilities of subsidies and investments
Maintenance	*Actual maintenance activities are limited for Arcadis* Write contracts for renovation or renewal of public works Control of contractors during works

Within all the PRIMO processes barriers can be identified that stagnate the approach of climate-proof cities. The following paragraph provides an overview of barriers that governmental organisation encounter in their approach and organisation of climate-proof cities.

2.2.2 Barriers

The CPC research group [7] reports the challenges for city governments regarding implementation of climate adaptation by policy approaches. Apart from policy approaches, climate-Proof cities concerns not solely the water management discipline, but numerous others such as urban planning and infrastructure. For each discipline different criteria and design guidelines apply. Biesbroek et al. [2] stress the importance of knowledge production between disciplines and an integrated approach to tackle the climate adaptation issues for the urban environment. As Bulkeley et al. [37] mentioned the fact that dealing with climate change effects is further complicated by the levels of participation and levels depending on geographical size. Focusing on the potential of an integral approach is needed to assess possibilities for mitigation and adaptation [42].

Although literature elaborates the need and importance of working interdisciplinary on climate adaption issues, the common approach however for climate adaptation in the Netherlands is sectoral (vertical policy [3]). Water related issues are dealt with by the water management department. The extent of issues, current systems and cost-effectiveness of integral solutions emphasize the importance of an integral approach. However, the characteristics of the problem [43], knowledge of climate science, uncertainty in effective measures and guidelines [44], traditional problem approaches [45] and different perspectives on the issues [46] seem to hinder the integral approach. Rotmans et al. [10] propose transition management as a strategy to deal with these barriers. A strategy based on long-term inspiring visions that offer collective benefits for the disciplines involved. The visions are used as a framework to set short-term goals and evaluate existing policy [10]. According to Loorbach et al. [47] frontrunners, visionaries with an overly amount of enthusiasm to get processes in motion and done within an entrenched organisation, need support and space for innovation.

Rotmans et al. [10] use long-term visions as a shared means to reach the (long-term) adaptation goals. Miedziński [45] foresees alignment with or divergence of long-term goals depending on the context of the disciplines. The context of disciplines (their role, knowledge, guidelines and perspective) involved in adaptation influences the engagement in and the progress of climate adaptation by different disciplines.

Climate change is often described as a wicked [43, 48] and even a super wicked problem [49]. Wicked problems are characterized by their multidimensional character. Due to their interaction with other issues, uncertain development path and different views on the nature and solutions they are difficult to resolve [43], [49]. Climate change is even described as a super wicked problem, meaning that "the longer it takes to address the problem the harder it will be to do so" [49]. Consequently, these characteristics are a barrier impeding adaptation. Basset and Shandas [50] address the difficulty in understanding climate science. In addition, the wicked climate issues being addressed as 'water' challenges in practice together with the current vertical policy approach [3] seem to result in a fragmented and unclear approach carried out by the different disciplines involved in climate adaptation issues. Apart from a vertical policy approach, the focus of policy making, and implementation of measures is shifting form a top-down to a bottom-up approach. Citizens want to interfere and contribute to implementation to have influence on their own living environments. On the other hand, participation of stakeholders is limited due to the lack of intrinsic motivation and hierarchal organisation structures in place [45].

Table 3 summarizes the barriers found in literature categorized in the PRIMO chain [40]. These barriers are encountered by governmental organizations in their approach of climate-proof cities. These barriers will be compared to the barriers encountered by Arcadis in chapter 5. To reveal barriers at the design and consultancy company themes were identified as guide for the interview.

Table 3 Barriers approach climate-proof cities by governments fitted to the PRIMO chain

Climate-proof cities	
Policy	• Lack of long-term vision and goals • Uncertain development paths
Regulation	• Lack of norms and guidelines
Implementation & finance	• Lack of action perspective • Uncertainty in effectivity measures • Lack of participation
Maintenance	• Lack of norms and guidelines
Organisation	• Limited knowledge production • Sectoral approach • Different perspectives "water"-issue and transitions / unclear ownership

2.3   Actors

In the playing field (Figure 3) actors are identified that have to deal with the issues related to the areas. Regarding climate-proof cities for the public space this research focusses on the actor 'a design and consultancy company'. Since no further research is done for other actors, the main roles that are fulfilled in the playfield are identified instead of specific actors. The four roles are presented below. This study is focused on the last role. Within Arcadis the study is limited to the departments that have to deal with the design of public spaces.

1. Owner: municipality
2. Financer
3. User:
4. Designer

Literature is mainly focused on the approach and organisation of climate-proof cities at governmental organizations. In the Netherlands, design and maintenance of the public space is the jurisdiction of municipalities (Figure 5 left: owner). People and companies (user) within the municipality boundaries often have their own private space, but make use of public spaces for transport, recreation and daily life. The parties responsible for financing design and maintenance are the users (trough taxes), municipalities and other financial institutions that want to invest in public spaces (private and public companies).

The fourth group is identified as the designer of public spaces. While municipalities are responsible for design of these spaces, they often delegate these tasks to design & consultancy companies such as Arcadis. Although these firms often work as an extension of the municipalities they have to deal with the other roles at the playfield and are in the position to greatly influence the achievement of climate-proof cities. However, research up till now has not paid attention to the role of design and consultancy companies in the approach of climate-proof cities.

3   METHODOLOGY

In general, the methodology of this research consisted of four main steps: literature study, interviews, data analysis, verification. These four steps are elaborated in the paragraphs below. The scheme displays the overall process and the aim of the steps. Table 4 shows the relation of the methodology with the research questions.

Problem

Problem statement and research questions derived from desk study *(Chapter 1)*

Literature study

Identify transitions and barriers in approach of climate adaptation in literature *(Chapter 2)*

Theoretical framework

Define theoretical framework for study backbone *(Chapter 2)*

Interviews

Collect data on current approach including barriers, knowledge and transitions by semi-structured interviews *(Chapter 3, 4)*

Results & comparison with literature

Analyse interview data and results. Compare results with literature *(Chapter 4, 5)*

Verification by expert-group

Verify outcome with other design and consultancy companies *(Chapter 6)*

Discussion and conclusion

Discuss and interpret results, conclude findings *(Chapter 7, 8)*

Recommendations

Recommendations for Arcadis *(Chapter 9)*

Table 4 Methodology and result for research questions

Question	Topic	Literature study & theoretical framework	Interviews	Data analysis	Verification
1	Transitions	X			
2	Barriers climate-adaptation (literature)	X			
3	Barriers climate-adaptation & transitions		X		X
4	Difference literature & practice			X	
5	Improvements		X	X	

3.1 Literature study

3.1.1 Desk research

The desk research initiated the literature study in the proposal phase on the research topic. This was the first step in identifying the research questions, challenges, context and introduction. The information was used as backbone for the thesis proposal and introduction.

3.1.2 Literature study

After the proposal phase the literature study was continued and extended, which resulted in the theoretical framework. This framework was used for analysis of the interview results. The literature results answer the first two research question. ScienceDirect.com [51], a search engine with unparalleled breadth in publications, was used as the main source for international literature. Using one search engine simplifies reproduction of the applied search method. Found literature was assessed by its relevance to the topic.

3.2 Interviews

3.2.1 Data collection and analysis

To obtain the data, the method of qualitative research was used. For the research objective, it was important to gain information on the level of knowledge on certain subjects, how projects are approached and what the needs of the target group are. By conducting qualitative research, interviewees could share their experience and shed light on the existing processes and interactions. The method below shows the steps that were taken in data collection and analysis by the interviews.

1. Theoretical framework as a guidance for the interview questionnaire.
2. Selection of interviewees.
3. Interviews, and analysis of the results following the steps below:
   1. Collecting the data that was needed to answer the research question. The first step was taken by analysing words, sentences, fragments or themes.
   2. Coding the found pieces of information that were relevant to answering of the research question. When coding - in order to be able to process the information properly - fragments and pieces were linked to data codes. These codes represented the subject of the fragment. Braun & Clark [52] introduced a method for thematic analysis: identifying patterns or themes within the dataset. The analysis was done by performing six steps. Bree & Gallagher described the way to use excel for this research method [53]. The themes summarized the main findings of the question.
      1. Familiarize with data (excel raw data);
      2. Create initial codes (excel coloured data);
      3. Find themes (excel themed data);
      4. Review themes (excel final data);
      5. Define themes (excel data overview and key points);
      6. Write-up (results).
   3. The third step was to make connections between the interesting / relevant pieces of information that have been found in the data.
4. Reflect interview results on theoretical framework.

3.2.2 Interview guide

The conducted interviews were performed semi-structured. Semi-structured interviews provide space for dialogue but also for repetition of the interview by other interviewers. Performing semi-structured interviews lead to a condensation of the available data; not everything has to be questioned with the respondent.

The interviews were recorded and directly afterwards transcribed in a verbatim transcription. A verbatim transcription means that everything an interviewee mentioned is copied, but repetition, errors and "uhms" are extracted from the transcript. The interview questions were equal for every interviewee, but not every time as relevant for every respondent. In case an answer could not have been formulated, the question remained unanswered. The transcriptions are not publicly available.

3.2.3   Interviewees

Interviews were conducted to verify the data with the information found from the literature study. The interview data showed a representation of the perception of specialists, advisers and project leaders within the various departments of Arcadis NL. Knowledge on designing and building public spaces is spread over the entire company of Arcadis NL. It was important to find the colleagues who could be of most value to the research topic and goals. Four department heads who hold a leading position on three different divisions Arcadis consists of (Figure 5) were asked to suggest names for interviewees. These heads weren't interviewed since their daily activities in leading positions are often different than colleagues working on the projects.
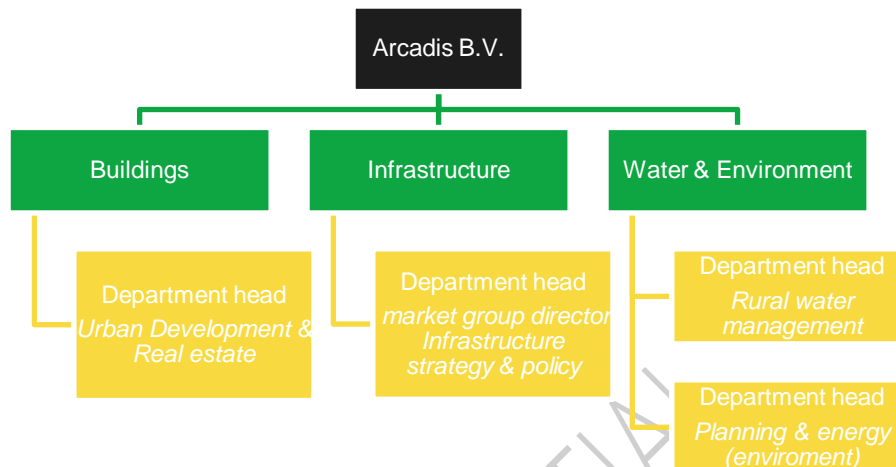
Figure 5 Business lines of Arcadis B.V. and relevant leaders for interviews

In total a number of 24 interviewees was interviewed.

- 10 persons were part of the Urban water management department. The focus of this group has shifted over the past two years from solely sewer modelling towards a wider scope that also takes part of climate related projects such as stress tests.
- 9 persons were suggested by the department heads based on their field of expertise regarding the design of public spaces.
- 5 persons were suggested by interviewees during the interviews.

A complete overview of the interviewees is added in Appendix A. Figure 6 displays the departments that were represented by the interviewees and their role within projects.

JOB TITLE
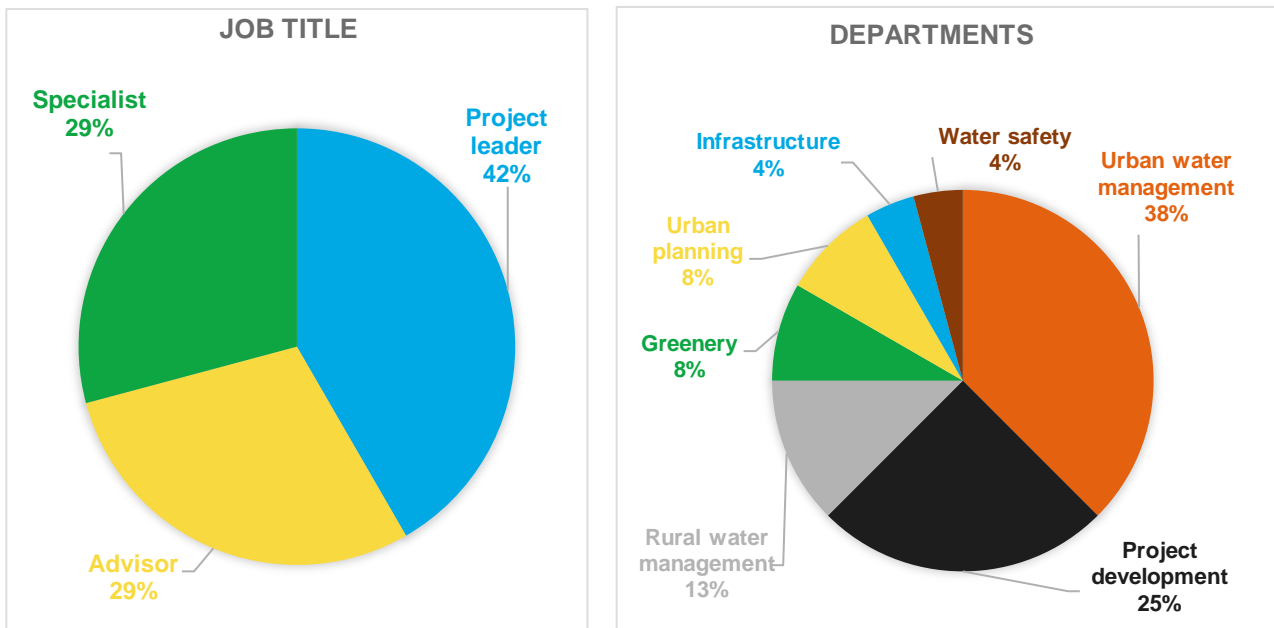
DEPARTMENTS

Figure 6 Division of interviewees on job title and departments

The main functions of project employees within Arcadis are project leader, advisors and specialists. Table 5 displays a few distinctions between these functions.

Table 5 Distinction between roles within Arcadis

	Project leader	**Advisor**	**Specialist**
Client contact	Yes	Yes	No
Focus on content	No	Not into detail	Into detail
Focus on process	Yes	Partly	Limited
Focus on finances	Yes	No	No

3.3   Data analysis

The interviews provided an overview of the current approach of climate adaptation and long-term transitions and the barriers that are encountered during these approaches. The interview guide is presented in Appendix B.

The interview transcripts were collected in Excel and organized per question. For each question the main themes were filtered from the interview results. Afterwards, these themes were used to code each answer. The steps taken for coding are elaborated in Appendix C. The essence of each answer is captured and linked to the code. In the last step relevant quotes and key points per code were organized in a data overview (Appendix C).

The results are elaborated per question (Appendix D). During the elaboration of the results, the barriers found at each interview topic were linked to the PRIMO framework (chapter 4). In the discussion and conclusion chapters the barriers found within Arcadis will be compared with the barriers found in literature for governmental organizations. In the recommendation section improvements to overcome these barriers are recommended.

3.4　　　Verification of interview results

To check whether the barriers found at Arcadis are representative for other design and consultancy companies in the Netherlands, the results were verified with four design and consultancy companies that execute similar activities in the PRIMO chain as Arcadis. The external expert-group consists of a network of experts that focusses on the development and approach of climate-proof cities within a community of practice.

In total a number of 5 external experts (Table 6) were asked if they agree or disagree with the barriers, posed as statements, found in this study. On contrary to the interviewees, these external experts lack context about the topics and background of the statements. A complete overview of the external experts and the result of the verification is added in Appendix E.

Table 6 Members of external expert-group for verification

#	Domain	Company	Role
1	Urban water management	Aveco de Bondt	Domain leader urban water and sewer
2	Urban water management	Aveco de Bondt	Senior advisor urban water
3	Urban water management	Witteveen+Bos	Team leader urban water
4	Urban water management	Sweco	Senior consultant urban water
5	Urban water management	Tauw	Consultant climate adaptation

4 INTERVIEW RESULTS

Based on the theoretical framework an interview guide is produced to semi-structure the interview. Literature study combined with the PRIMO chain reveals six themes (Figure 7) that may help identify the barriers in the approach of climate-proof cities with respect to transitions. These six themes are used to define the interview structure and questions. The interview guide is available in Appendix B. The interview results are analysed and presented per theme. In the following sequence: Climate-proof cities (P, I), ownership (O), approach (O), goals (P), norms and standards (R, I, M) and transitions (P, I, O). The capitals between brackets indicate relevance to the PRIMO chain. Maintenance is found less interesting, since the core business of Arcadis is focused on the policy, regulation and implementation phases. Apart from these topic interviewees are free to add or respond to the interview questions. This could be identified as a seventh theme "open".
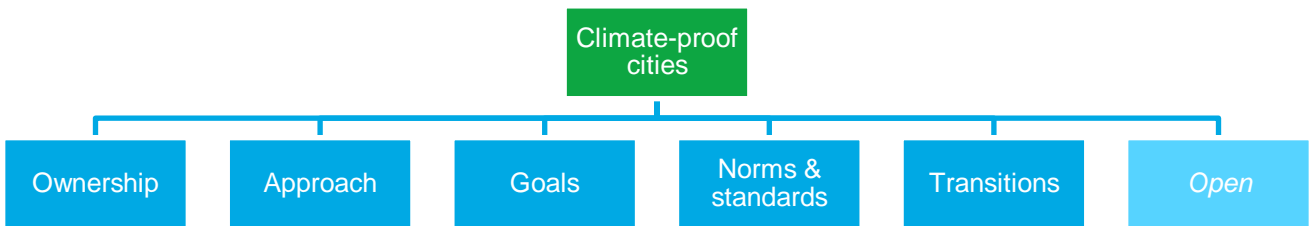
Figure 7 Themes dealt with during interviews

<u>In every paragraph an interpretation of the result is given. Although the results are represented in this interpretation, there is also a part of overall interpretation of the topic and opinion on the results.</u>

4.1 Climate-proof cities

Six questions are formulated to cover this theme. These questions aim at finding out if colleagues within other business lines are familiar with the definition of climate-proof cities and what challenges they recognize in the approach of climate-proof cities. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.1.1 Highlights of results

A large part of the interviewees referred to climate-proof cities as future-proof cities. A few used 'future-proof' to express the uncertainty of climate change projections and the need for long-term goals and continuous monitoring, while others used future-proof as replacement for climate-proof to capture the full range of transitions. In coherence with these transitions, interviewees mentioned the need for an assessment framework in order to make well-considered choices in designing future-proof cities.

Another commonly used term is liveability. Liveability is further elaborated by the interviewees as a nice, social, vital, decent place to live and work. Liveability is related to future- and climate-proof. Although liveability is highly subjective, the approach and execution of a climate-proof and future-proof city will define the liveability of a city.
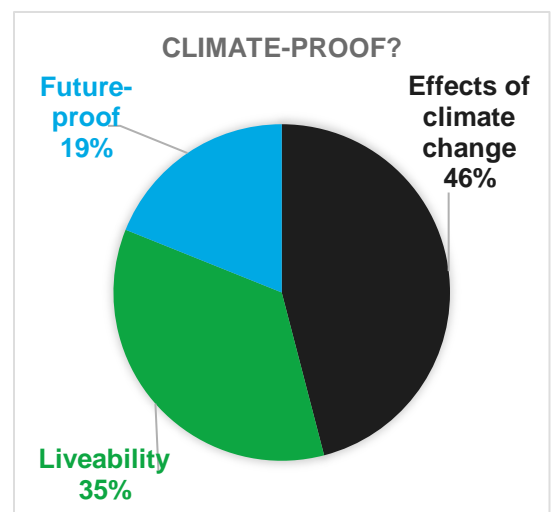
Figure 8 Description of a climate-proof city

Most interviewees refer to the climate-proof aspects to describe climate-proof cities. The Deltaplan [11] acknowledges four main aspects identified with climate change, namely pluvial, fluvial or coastal flooding, heatstress and drought. The respondents that mention these four aspects is limited. Pluvial flooding and heatstress are quoted most,

respectively 71% and 62% and only 24% of the interviewees mentioned fluvial/ coastal flooding as a climate aspect (Appendix D). Both Urban water management and Project development departments were aware of four different climate aspects, while the other departments seem to be unaware of fluvial/ coastal flooding and drought situations.

Comparing the climate-proof cities aspects on expertise and urgency indicated by each domain, an interesting overview is generated (Table 7). While you might expect an overlap on those results, the opposite is found. Except for the Rural water management department, the aspect identified by a domain as most urgent is not the aspect they consider part of their field of expertise. The shared responsibility towards these issues seems to be lacking.

Table 7 Aspect of climate change relevant to field of expertise vs. urgency

Expertise vs. Urgency		Pluvial flooding		Fluvial/ coastal flooding		Heatstress		Drought	
	Total	Expertise	Urgency	Expertise	Urgency	Expertise	Urgency	Expertise	Urgency
Urban water management	9	100%	78%	0%	22%	29%	89%	14%	67%
Project Development	6	0%	50%	33%	50%	67%	100%	0%	50%
Rural water management	3	33%	67%	67%	67%	33%	33%	100%	100%
Infrastructure	1	100%	0%	0%	0%	0%	100%	0%	0%
Greenery	2	100%	50%	0%	0%	100%	50%	0%	0%
Water safety	1	0%	0%	100%	0%	0%	100%	0%	100%
Urban planning	2	100%	100%	100%	0%	0%	100%	0%	0%

Climate-proof cities is acknowledged to be a challenge that needs input from and cooperation with different sectoral domains and themes regarding the public space. A vast part of the interviewees appointed the use of an integral approach as main challenge to achieve climate-proof cities. This challenge is mentioned for both the design and the execution phase of projects. The sectoral approach is limiting the achievement of climate-proof cities. As one interviewee (22) stated: "We all say, 'it is not possible', but it is possible you only should want it". "Technically everything is known, but the implementation depends on collaboration amongst domains and companies" [interviewee 24].

In the design phase a challenge that's often referred to is the lack of possibilities in shared financing. The current tax system and cost-benefit structure doesn't seem to be in line with the apparent need for shared finances *"Collaborate and finance and finance together".* In the execution phase this integral approach is challenging for already existing build environment. *"How can you align various existing structures with a desired future city perspective in an area with limited space?"* [interviewee 18].

Policy for achieving climate-proof cities exists on abstract levels (GRP, Deltaplan), but the translation towards implementable measures lacks. Overall the general opinion (by more than half of the respondents) is that the definition of climate-proof cities and the measures are not defined well enough to create an increase in action perspective. This is partly caused by the lack of norms and regulation. *"Project developers don't invest more than minimum. If there is no climate-proof policy, they won't implement it"* [interviewee 3]. In addition to the lack of norms, interviewees indicate that the uncertainty of climate prognoses hinders the implementation and execution with clients. A solution for this uncertainty is the use of long-term goals: *"We need to work with growth scenarios. An end goal for the long-term but results for short-terms and the possibility to deviate within the scenarios"* [interviewee 15].

4.1.2　　Interpretation of results

A large part of the interviewee group recognizes the climate aspects (pluvial flooding, fluvial/coastal flooding, heatstress and drought) as the challenges to deal with to achieve a climate proof city. While urban water and project development consider almost all aspects as part of the challenge, this is not the case for most other domains. Although all domains should play a part in the achievement of climate-proof cities, drought and fluvial/coastal flooding are not acknowledged as climate-proof city aspects. This result is also found at the expertise vs. urgency question. Even though the four climate change aspects were explained to the interviewees a similar result is noticeable. A majority acknowledges pluvial flooding as its expertise, however almost all domains identified heatstress as most urgent aspect. If no other domains recognize those aspects as part of their activities or expertise, how can there be a shared responsibility in achieving climate-proof cities?

The interviewees mention the difficulties in implementation of climate-proof cities. Despite the present technical knowledge on possible solutions, process wise there are still a few barriers that lack implementation. For example, the limited space in existing urban structures. Currently every square meter is occupied by different functions. Mobility is often a dominant function/ user of the public space and water management or greenery is, depending on the urban area, often subordinate. For me, as author of this study, this is also part of the traditional approach of designing urban areas. What if we think about the bigger picture? The ambitions of the energy transition inevitably result in opportunities for other transitions as well. If we need to intensify our energy networks, then we have to open the routes where these cables lie. Offering opportunities to redesign the public space. Same is valid for smart mobility and electric vehicles. If our mobility solutions change, do we still need this much area available for transport and parking lots?

During the interviews at some point regulation was almost always a topic. Especially the lack of regulation and norms for these 'new' situations (e.g. heatstress). Commercial companies are mentioned as actors that only deliver the minimum needed, since they are more focused on their profit than long-term goals. The lack of regulation is named as a cause for this behaviour. The downside of regulation is setting the minimum. There are also other possibilities to stimulate these companies to take their part in the achievement of climate-proof cities. Making them aware of the possibilities, subsidies and benefits of designing climate-proof.

4.1.3　　Summary of barriers

The barriers found by the respondents' input with the questions about climate-proof cities are presented below (Table 8).

Table 8 Summary barriers Climate-proof cities

Climate-proof cities	
Policy	• Unclear definition of climate-proof results in differentiated interpretation of goals, roles and responsibility • Domains are unaware of challenges
Regulation	• Lack of norms 　• results in subjective approach instead of absolute 　• impedes translation of policy into measures 　• causes uncertainty in feasibility and effect of measures
Implementation & finance	• Implementation of measures in existing urban area is difficult • Current financial system is not in line with need for: 　• shared financing 　• adequate cost-benefit division
Maintenance	

Organisation	• Sectoral approach instead of integral approach • Role and responsibility are unclear • Knowledge about climate-proof cities is insufficient

4.2 Ownership

Three questions are formulated to cover this theme. These questions aim at finding out how colleagues view upon ownership and responsibilities. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.2.1 Highlights of results

Most interviewees state that there should be a problem owner to appoint responsibility (Figure 9). One interviewee mentions that *"there is no cohesion. Lack of working integral is caused by complexity and lack of vision on the whole objective. No one is held responsible for the whole. One person is responsible for climate but another one is responsible for energy transition"* [interviewee 16]. Another respondent recalls the difficulty in responsibility versus possibilities *"the department responsible for the execution of policy and urban water management measures own the budgets but are not the ones responsible for climate adaptation"* [interviewee 20].

Figure 9 Interview result problem ownership for climate-proof cities

While some indicate the municipal organisation as responsible party for the design of public spaces and therefore also climate adaptation, at the same time interviewees mention that climate-proof cities are a shared problem, and therefore it's difficult to assign one problem owner. Furthermore, the difficulty of ownership caused by the numerous layers and interests of other organizations and stakeholders.

A lack of ownership could also be the result of unawareness towards the climate-proof cities challenges. A vast majority of 86% thinks that not every domain is aware of the challenges associated with climate-proof cities against 14% who believe all domains know what climate-proof cities is aiming for (Figure 10). Of that 14% 2 out of 3 respondents are identified as junior colleagues. This could have to do with recent education about integral topics. As one relatively recent graduated interviewee noticed at the topic 'integral approach' "For me integral working makes sense and it is logical, but I recently found out at a tender that the department head indicated the tender as a specialty because of the integral character" [interviewee 3].

Figure 10 Awareness at domains of challenges associated with climate-proof cities

A specialist mentioned specifically that "on general terms everyone is aware of the challenges" [interviewee 5]. In addition to that another interviewee remarked the following: "People are aware of the fact that climate is changing and the primary impacts, but we are still uncertain about the second and third-order effects of climate change and measures" [interviewee 11].
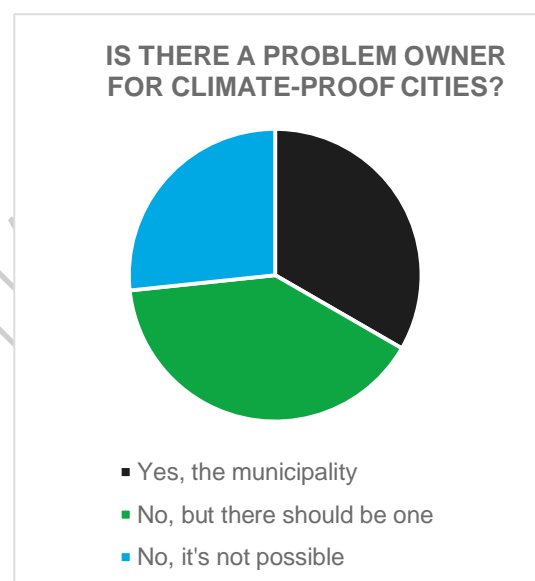
4.2.2 Interpretation of results

Ownership in climate-proof cities is found necessary to successfully approach the challenges of climate-proof cities. Within Arcadis interviewees mention projects where project leaders take initiative to look beyond their own domain and boundaries. Although interviewees spoke positive about these initiatives, this is not business as usual. It depends on the persons involved in the project whether this approach is taken. So, if project leaders decide to work sectoral and deal with the issues themselves with the knowledge they have, that is also accepted. Another issue regarding ownership is the unclarity in roles and responsibilities. Many interviewees suggested that there should be an independent programme director or chief climate officer to oversee the goal and combine the domains. A way to stimulate these possible solutions is to introduce policy or methods to work across domains and assign leadership. There is no common policy yet on how to deal with these kinds of projects. And the question arises on which level ownership should be stimulated. Is that specifically on the process steps of the PRIMO chain, or on department level or business line level?

In the role of Arcadis it is sometimes difficult to show ownership in the approach of climate proof cities, due to clients' assignment and available budgets. For example, Arcadis could suggest a certain approach. It is up to the client whether this approach fits the question or the organisation of the client. If the client wishes to focus on one of the aspects of climate-proof cities, it limits the position of Arcadis to act as problem owner (unless it's voluntary extra effort).

Besides sectoral approaches en personal preferences, knowledge could also be a possible barrier in showing ownership. As interview results reveal a minority believes that every domain is aware of the challenges associated with climate-proof cities. Most of the times this could be solved by educating colleagues and sharing the developments in this field. But there is small group, often no colleagues, that is deliberately unknowing, in the news often referred to climate sceptics. While some people believe that climate change is really something made up by environmental activists, a small part thinks that by denying they don't have to take show ownership or initiative in the approach.

Ownership further means acknowledging the domains and stakeholders that should play a role in the projects. The opinion on balancing the interests of stakeholders differs amongst the interviewees. Some find it important to include all relevant stakeholders in the approach and the PRIMO chain steps, while other try to minimize including stakeholders to avoid to many compromises and ineffective solutions. The assumptions are made that stakeholders all have diverging stakes that could never fit within a solution, while this is not necessarily true. It seems that working integral within the organisation is seen as a necessary but difficult exercise, but when it comes naturally from people themselves it is also found difficult? When stakeholders and domains want to be involved this is often viewed upon as difficult and stagnating, while this could also mean that they show ownership for the challenges themselves and want to contribute. Balancing the stakes is of course a difficult exercise and could benefit from and objective independent programme director.

4.2.3 Summary of barriers

The barriers found by the respondents' input with the questions about ownership are presented below (Table 9).

Table 9 Summary barriers Ownership

Ownership	

Policy	• Lack of vision
	• Decision making is not objective but depends on:
	  • Politics
	  • People
	  • Finances

Regulation	
Implementation & finance	• Complexity of integral projects hinder implementation • 2nd & 3rd order effects of measures are unknown

Maintenance

Organisation	• Financial system is not applicable for integral projects: responsibilities are not in line with possibilities
	• Consciously uninformed persons impede implementation
	• Sectoral approach
	• Problem owner is unclear and results in unclear:
	   • Roles
	   • Responsibilities

4.3 Approach

Four questions are formulated to cover this theme. These questions aim at finding out how climate-proof cities is approached and whether this changed over time. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.3.1 Highlights of results

Almost all interviewees from the different domains responded YES unanimously to the question whether the approach of the current challenges has changed compared to when they started working.

A total percentage of 55% of the interviewees indicated that the approach changed organisational wise, being focused on an integral approach instead of a sectoral one (Table 10). These respondents all mention a need for or an already executed integral approach. As one interviewee said: *"We think beyond borders of our own discipline"*, *"In practice we – at Arcadis – sometimes miss the overview due to project-based assignments"* [interviewee 15].

Table 10 Difference in past vs. current approach of work activities

Past vs. current approach of work activities								
Out of 23	**Total**	**responses**	**%**	**Yes**	**No**	**Role**	**Organisation**	**Content**
Urban water management	9	9	100%	89%	11%	11%	44%	56%
Project Development	6	5	83%	100%	0%	0%	40%	60%
Rural water management	3	3	100%	100%	0%	0%	100%	0%
Infrastructure	1	1	100%	100%	0%	100%	0%	0%
Greenery	2	2	100%	100%	0%	0%	50%	50%
Water safety	1	1	100%	100%	0%	0%	100%	0%
Urban planning	2	2	100%	0%	100%	0%	100%	0%

45% of the respondents mentioned content related aspects as the reason for the altered approach. The projects are not limited to the discipline itself, but also include relevant social themes and transitions as well. An interviewee from urban water management stated *"our work is no longer limited to underground infrastructures but also infrastructure aboveground"* [interviewee 5]. A project developer pointed at the importance of the internal Arcadis strategy *"the specific focus points on energy transition and climate adaptation brings more perspective to the approach"* [interviewee 18].

4.3.2   Interpretation of results

Interviewees acknowledge that the approach of projects has changed over time by either change in content (e.g. from sectoral water towards climate-proof cities), role or organisational changes. Less than 10% of the interviewees found that nowadays Arcadis has more influence in initiating an integral approach. This is easier for assignments that concern policy. Designing climate-proof cities policy for a municipality is relatively easy compared to the implementation of this policy.

However, the majority still struggles with the limited and sectoral assignments of clients. Governmental tasks are often subjected to procurement regulations resulting in a competitive environment between design and consultancy firms that wish to win the task. When a governmental organisation specifies their assignment from a sectoral point of view, there is no need for design and consultancy firms to offer an integral approach. Simply because working integral involves more domains, so more persons and more effort resulting in more a costly approach. Offering an integral solution will undermine the chance to win the project compared to the sectoral approach competitors will offer. Investing in this approach could result in win-win situations and more efficient solutions, but this somehow seems to be often forgotten.

Same is valid for the highly fragmented projects. While governments might strive towards an ambition or programme, the assignments are procured in bits and pieces. On this regard, the overall vision and cohesion between different projects is missing for design and consultancy firms. In the role and position of design and consultancy firms as Arcadis this is viewed upon as a missed opportunity. Since Arcadis works for all sorts of clients and projects, the experience with certain projects and approaches is abundant. Governments could gain from these insights, but this is often forgotten in the procurement of assignments. Partly because governments fear the disruption of a levelled playing-field for competitors and party due to the costs that are associated with procurement.

Interviewees indicate that the election terms impede the approach for climate-proof cities. Since Arcadis is often involved in the execution of policy, the election term is mainly identified as a barrier instead of a chance. On the one hand this might be valid for implementation of measures, but on the other hand politicians use climate-proof cities to increase their number of votes. The statements of the politicians often remain unchanged, but the practical implementation is often hindered by budgets.

4.3.3   Summary of barriers

The barriers found by the respondents' input with the questions about approaches are presented below (Table 11).

Table 11 Summary barriers approach

Approach	
Policy	• Definition of integral approach is unclear resulting in differentiated approach • Lack of policy on transitions limit further implementation • Policy is often formulated sectoral • Election terms of governments
Regulation	
Implementation & finance	
Maintenance	
Organisation	• Financial systems are organized sectoral • Arcadis projects are often focused on one domain, because overview from client's assignment lacks • Sectoral approach as a result of:

- Competition
- Personal preferences
- Limited time

4.4 Goals

Two questions are formulated to cover this theme. These questions aim at finding out if policy goals are used in projects. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.4.1 Highlights of results

To analyse the results, the PRIMO framework was applied on the answers. All the answers were either policy, implementation & finance or organisation related (Figure 11). Regulation nor maintenance related barriers were identified by the interviewees. For all three categories, the respondents mentioned the sectoral approach as a barrier in the integral approach this is elaborated at the bullets below:

- Policy is developed sectoral. As a result, the execution of policy is also sectoral or doesn't stimulate an integral approach.
- Financial systems are organized sectoral. Investments that must be made should benefit the investor for most part, while benefits could also be gained at other domains.
- Organisation are sectoral (or vertical) which makes working together not a usual way of working.

Respondents reasoned either from Arcadis' of clients' perspective. Barriers specifically addressed to the design and consultancy company are:

Figure 11 Barriers identified in the integral approach

- Questions/ assignments of clients are often formulated for one domain, so there is no need for Arcadis to form integral teams.
- The Arcadis business model (payed per hour) and competitive tenders limit the opportunities to work integrally. Here the assumptions are made that working integrally costs money.
- It highly depends on the project leader whether other domains are involved in a project. Every department is responsible for its own workload and profit, so project leaders rather work with their colleagues within the department.
- Time is limited in projects, which makes involving other domains more difficult. If involving other domains cost money.

Besides the barriers, interviewees indicated some opportunities to work integral. Amongst the respondents 60% replied that the opportunities can be found in 'connecting the dots'. They stress the importance of using long-term trajectories and trends to give direction to the integral approach. Furthermore, they mention the need for plans that exceed election terms and the usefulness of combining different themes.

The other 40% of the respondents indicate that leadership and taking initiative can embed the integral approach more. This group calls for personal action and a clear role for leaders. One person or department should have the overview and be responsible in the integral approach.

Whether clients are focusing on long-term goals depends on the size and type of organisation (Figure 12). Commercial companies want to gain the highest profit as possible which often impedes the execution of long-term goals. When it comes to municipalities one respondents elaborated the difference in goals depending on the size: *"a small municipality does not make a climate-proof plan for 2060. They think about it but do what they always do. They also do not have a lot of problems. Larger municipalities (with large urban areas) are much more aware of these climate-proof challenges"* [interviewee 1]. In addition to this difference a division can made in the project steps. *"It is easy to design policy for long-term projections, actually implementing measures in an existing urban area is something else* [interviewee 18]*"*. Therefore, in projects the way goals are considered is often *"working what we know now and adjust gradually to new knowledge"* [interviewees 8, 10 & 16].

Figure 12 Focus of objectives in projects to achieve goals

4.4.2   Interpretation of results

Interviewees agree on the fact that building projects require long-term goals, since streets, flood defence works, and sewers and buildings are built to sustain for fifteen to one-hundred years. But according to them projects are often focused on short-term goals. The nature of the projects that Arcadis execute are partly influencing these results. Strategic plans and programs are, although the firm has enough capabilities to support clients in these questions, not part of our core business.

As stated before, the assignments are often fragmented and dealing with a small part of the strategic plan or programme. On the one hand projects executed should be fit for climate change challenges, but on the other hand election terms force the execution of fast projects so that results are delivered within these terms. Authors opinion is that these two goals should not be conflicting. Long term goals and ambitions can be translated into projects with shorter terms. Of course, a prerequisite for this approach is that the organizations should have long-term goals and ambitions towards they want to develop. In many cases this is where the barrier is found. Without long-term policy projects are executed with "traditional" regulation, norms and approaches.

Another difficulty is found in the justification of measures to finally achieve the long-term goals. For example, if a municipality decides to alter the complete water management plan to avoid water nuisance for events that might occur once every one-hundred years compared to current situations where this protection level is often set for events that occur once every two years. Everyone could imagine that changing the system to fit this new requirement will cost a lot of money. A step in the execution of the Delta Programme Spatial Adaptation is the risk dialogue. This step should initiate the dialogue between organizations and stakeholders to decide the protection level. Maybe a protection level of 1/100 years is reasonable for main transport routes and hospitals, but could 1/2 years still be enough for housing areas. A lot of organizations haven't started this risk dialogue, impeding the implementation of long-term measures.

4.4.3   Summary of barriers

The barriers found by the respondents' input with the questions about goals are presented below (Table 12).

Table 12 Summary barriers goals

Goals	
Policy	• Election terms of governments hinder long-term approach
Regulation	

Implementation & finance	• Possible long-term situations clash with investment for measures: justification
Maintenance	

Organisation	• Policy depends on organizations:
	  • Commercial: goal is profit
	  • Size of government

4.5 Norms & standards

Two questions are formulated to cover this theme. These questions aim at finding out if colleagues use norms and standards in their projects and if they are aware of climate related norms. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.5.1 Highlights of results

The use of norms for different roles is divided in use for current work activities (Figure 13) and climate related norm activities (Figure 14) A difference in usage is noticeable for the functions of the interviewees. On the one hand project leaders and advisors, who are less often doing the actual engineering work, indicate that the use of norms and standards is limited or (almost) nihil. On the other hand, most specialists acknowledge the use of norms and standards in their current work activities, which is also expected. The use of norms per domain is visualized for in Appendix C.
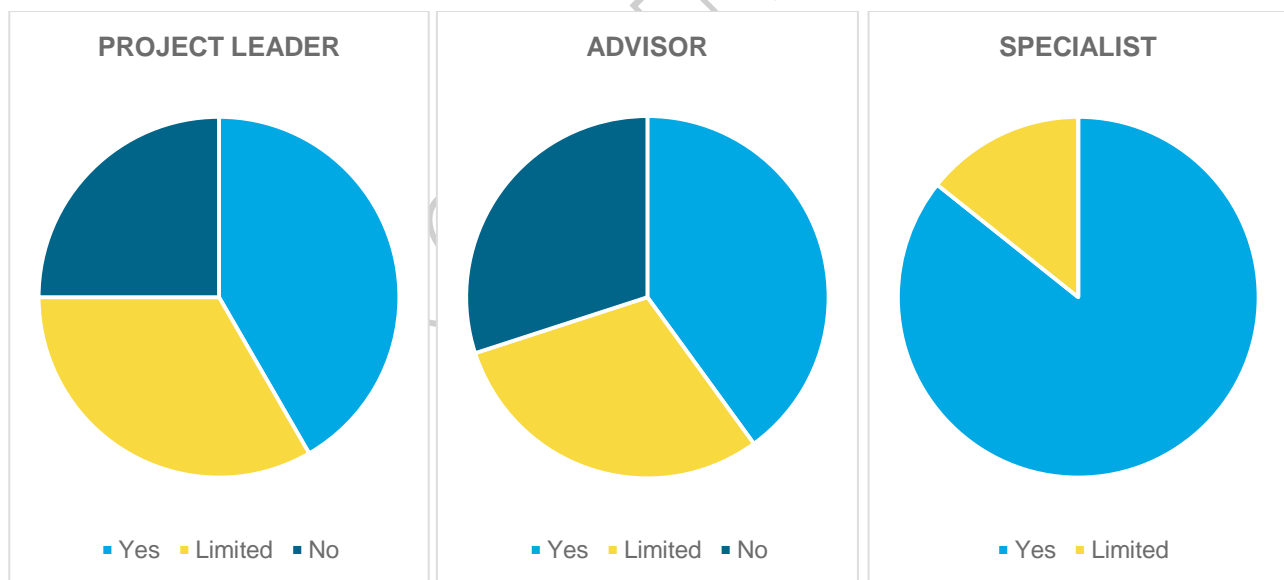
Figure 13 Difference in use of norms and standards between functions (current activities)

The usage of norms and standards in current work activities compared to climate related activities is significantly higher (Figure 13). Here the respondents mention the lack of useful norms as a reason for not being able to use norms and activities: *"they don't or barely exist"* [interviewee 10]. Clients seem the struggle with this lack of norms. An advice from an interviewee to these clients: *"When there's no standard yet: do not wait until there is one. You can do a lot without standards. The standard will only provide more grip"* [interviewee 16].
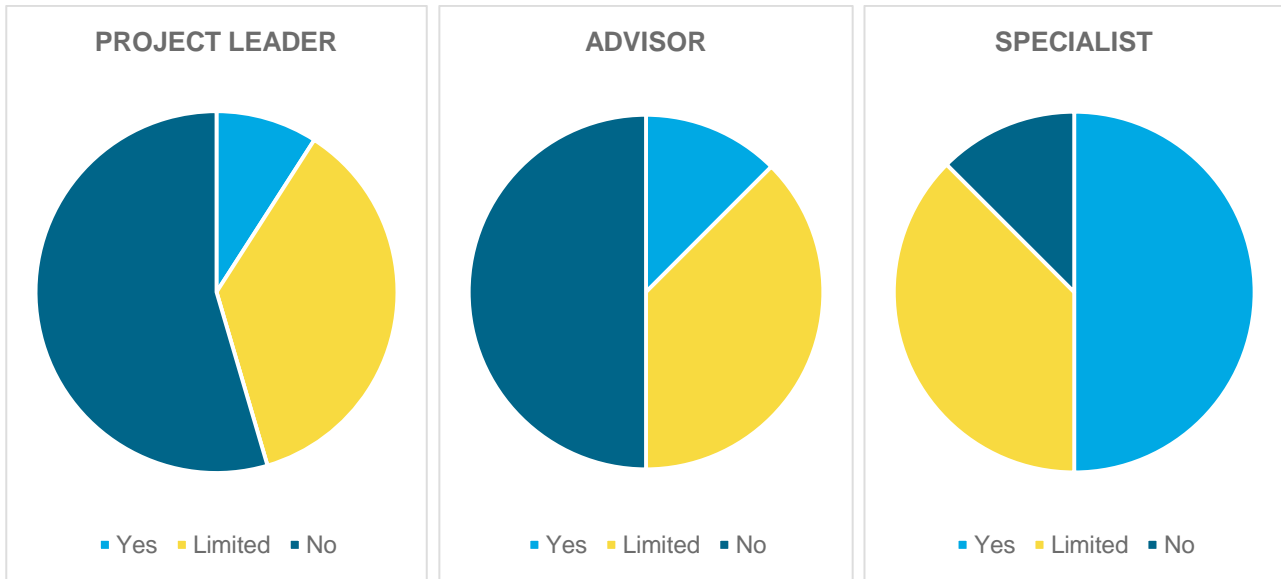
Figure 14 Difference in use of norms and standards between functions (climate-related activities)

Most interviewees agree that future developments require new norms. Norms change with new insights, since *"we cannot predict what the future will bring"* [interviewee 4]. New norms can be created by adjusting existing norms, for example increasing the volume of a rain event for capacity modelling discharge solutions in the public space. Another opportunity is to develop completely new norms. A gap that interviewees indicated is a not yet existing norm for heatstress [interviewees 10, 12 & 16].

4.5.2 Interpretation of results

As expected, specialist use norms and standards more often than project leaders and advisors. This is the case for both current and climate related work activities. The difference in these two situations is the limited availability of norms for future situations. Although it has not become clear for which types of norms and standards this finding applies, the gap for norms related to heatstress is mentioned a few times specifically.

While it became clear during the interviews that mostly project leaders and advisors believe that norms should change over time and that this will happen along the way. Specialist however need norms and standards to verify the feasibility of their designs and models. For this group the lack of norms is more likely to be a problem.

Furthermore, it became clear that specialists are often not the persons that define the project scope and approaches, while these specialists should know from experiences and specialism what could be feasible and how systems should change to deal with climate change. The current approach for specialists is usually top down. They do what is asked. Maybe the role of specialist should be extended or valued to act more bottom-up. They know the possibilities and ranges, let's profit from that in our future proof designs.

4.5.3 Summary of barriers

The barriers found by the respondents' input with the questions about norms & standards are presented below (Table 13).

Table 13 Summary barriers norms & standards

Norms & standards	
Policy	
Regulation	• Availability of climate related norms is limited • New situations require new of adjusted norms

Implementation & finance	
Maintenance	
Organisation	• Use of norms depends on role / function

4.6   Transitions

Four questions are formulated to cover this theme. These questions aim at finding out which transitions are identified for each domain and whether these transitions are considered in projects. This paragraph presents the highlights of the results (complete overview per question is collected in Appendix D. Furthermore, an interpretation of the results and the barriers found on this topic categorised by the PRIMO chain are presented. A complete overview of the data and key points is compiled in Appendix C.

4.6.1   Highlights of results

Arcadis' strategy and vision are focused on sustainability: 'Designing a world for the next generation'. However, sustainability isn't indicated as a main challenge and even less interviewees recognize this challenge as a transition within their field of expertise (Figure 15).

The most frequently mentioned future challenges are:
5. Climate & Energy
6. Social & mobility

Both climate & energy and social & mobility were equally mentioned. Looking at the future challenges identified as part of interviewees' field of expertise, the ranking is as follows:
7. Climate
8. Energy
9. Circularity

While social and mobility are mentioned as main challenges, these are not frequently recognized as transitions within the field of expertise. For mobility this is expected, since only one respondent is related to the infrastructure department. However, social challenges such as awareness, vitality, behaviour, etc. can be found within all domains. As one interviewee mentioned: *"Instead of a solely climate-proof city, it should become a vital city. Where you are challenged to exercise, feel happy and be healthy"* [interviewee 20]. In addition to social aspects, liveability is referred to as a future challenge surprisingly by only a few respondents. While interviewees referred to the importance of liveability at the topic of climate-proof cities.

MAIN CHALLENGES CITY AND SOCIETY
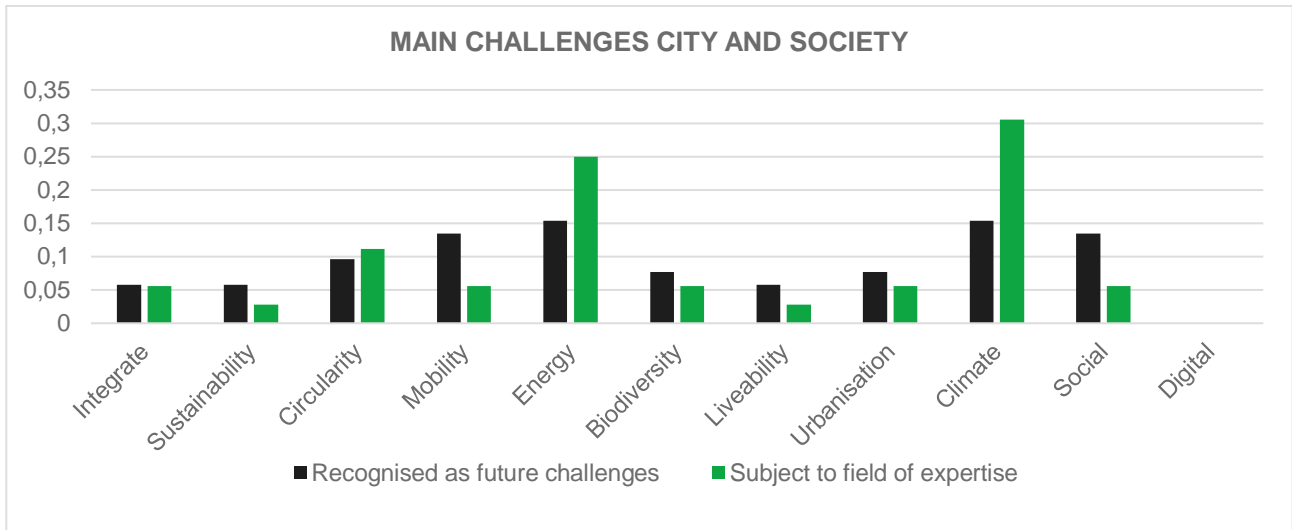
Figure 15 Main challenges city and society

Urban water management recognizes climate as part of their field of expertise (Figure 16). Within Arcadis challenges regarding climate-proof cities were explored by urban water management years ago. For pluvial flooding and drought in urban areas projects are often initiated at urban water management. Other domains that acknowledge climate as their field of expertise are also important players in the domain of public spaces. Rural water management has specific knowledge about drought and fluvial flooding. Greenery can add their expertise of cooling systems by vegetation to deal with heatstress and secure the biodiversity. Project development can connect the dots with other transitions. A domain that was expected in the pie chart is urban planning. Since they have the overview of developments in the public space and are responsible for the overall design concept.

All interviewees agreed that the extent to which transitions are subject of projects is limited. Transitions within the domain of the interviewee are considered. "Persons involved in the energy transition are not involved in smart mobility. These are separate approaches" [interviewee 22]. While one respondent mentioned that the benefits of combining transitions are not included sufficiently, another respondent recalled the approach of a municipality where the advice was to *"deal with transitions separately, because it will become too complex and extensive if you do otherwise"* [interviewee 10]. The projects where transitions were considered remain *"the good project examples, but these are rare"* [interviewee 24].

Figure 16 Transitions energy and climate as subject of field of expertise

4.6.2   Interpretation of results

Especially the energy transition and climate-proof cities are known transitions for interviewees. Of course, depending on domain a few more specific transitions are mentioned. Climate change has been in the news for years. Although a few years ago the focus to be more at climate instead of energy, this seems to have shifted. However, this is a huge assignment both for the public space and financially, clear targets are set for the energy transition. Some layman even seem to believe that by achieving these targets, climate change won't develop and there won't be a need to achieve climate-proof cities. Money can only be spent once and in general attention is given to the energy measures.

Still, focusing on the energy transition could also benefit the approach of climate proof cities. Intensifying the energy network creates also opportunities to implement climate-proof measures for public spaces.

4.6.3   Summary of barriers

The barriers found by the respondents' input with the questions about transitions are presented below (Table 14).

Table 14 Summary barriers transitions

Transitions	
Policy	
Regulation	
Implementation & finance	• Implementation is difficult due to complexity and extensivity • Social challenges are often subjective and not absolute. Hard to capture in measures.
Maintenance	
Organisation	• Urban planning doesn't acknowledge climate-proof cities as their expertise • Role & responsibilities towards sustainability are unclear • Sectoral approach of transitions

4.7 Summary interview results

The barriers found per theme are summarized according to the PRIMO framework (Table 15). These results will be compared with the barriers found by literature in chapter 5: Comparison literature and results.

Table 15 summary barriers indicated by Arcadis interviewees

Policy	• Unclear definition of climate-proof results in differentiated interpretation of goals, roles and responsibility • Domains are unaware of challenges • Lack of vision and ambition in policy documents • Decision making is not objective but depends on politics, people, finances • Definition of integral approach is unclear resulting in differentiated approach • Lack of policy on transitions limit further implementation • Policy is often formulated sectoral • Election terms of governments limit long-term approach (Politics) • Policy depends on organisation (commercial = profit) and size of government

Regulation	• Lack of norms
	   • results in subjective approach instead of absolute
	   • impedes translation of policy into measures
	   • causes uncertainty in feasibility and effect of measures
	• Availability of climate related norms is limited
	• New situations require new of adjusted norms

Implementation & finance	• Implementation of measures in existing urban area is difficult
	• Current financial system is not in line with need for:
	   • shared financing
	   • adequate cost-benefit division
	• Complexity of integral projects hinder implementation
	• 2nd & 3rd order effects of measures are unknown
	• Possible long-term situations clash with investment for measures: justification
	• Implementation is difficult due to complexity and extensivity
	• Social challenges are often subjective and not absolute. Hard to capture in measures.

Maintenance	

Organisation	• Sectoral approach instead of integral approach
	   • Competition
	   • Personal preferences
	   • Limited time
	   • Lack of leadership and initiative
	• Financial system is not applicable for integral projects (sectoral): responsibilities are not in line with possibilities
	• Problem owner, role and responsibility are unclear
	• Knowledge about climate-proof cities is insufficient
	• Consciously uninformed persons impede implementation
	• Projects are often focused on one domain, because overview from client's assignment lacks
	• Use of norms depends on role / function
	• Role & responsibilities towards transitions are unclear

5 COMPARISON GOVERNMENTAL AND ARCADIS BARRIERS

5.1 Introduction

The barriers found by interviews were categorized using the PRIMO framework [40] and compared to the barriers encountered within governmental organizations. Although both organizations seem to have difficulties with similar barriers, differences exist in the barriers identified within Arcadis and the barriers found for governmental organizations by literature study. In the following paragraphs the barriers found for both organizations are addressed and presented following the PRIMO chain sequence.

5.2 Conclusion barriers according PRIMO framework

This paragraph presents an analysis on the barriers identified in the results chapter (4). The barriers are presented following the PRIMO chain steps.

Although more barriers seem to be identified for the design and consultancy firm compared to the governmental organizations, there is an overlap in common barriers. The barriers found trough literature are more abstract than the barriers found by the interviews. Most Arcadis' specific barriers are due to the internal organisation.

The literature study demonstrated that the PRIMO chain model was the most applicable theoretical model to address climate-adaptation in the urban environment. Each step in the PRIMO chain model is discussed separately starting with an overview of the barriers found for both Arcadis and governments. The barriers presented in orange are identified as typical barriers encountered by the design and consultancy firm.

5.2.1 Policy

The barriers found for the Policy step for both Arcadis and governmental organizations are presented in this paragraph (Table 16). The Policy step consists of activities ranging from problem statement to defining policy.

Table 16 Comparison barriers PRIMO – policy (Italic highlight Arcadis barriers)

PRIMO	Barrier Arcadis	Barrier governments
Policy	• Unclear definition of climate-proof results in differentiated interpretation of goals, roles and responsibility • Domains are unaware of challenges • Lack of vision and ambition • Decision making is not objective but depends on politics, people, finances • Definition of integral approach is unclear resulting in differentiated approach • Lack of policy on transitions limit further implementation • Policy is often formulated sectoral • *Election terms of governments limit long-term approach* • *Policy depends on organisation (commercial) and size government*	• Lack of long-term vision and goals • Uncertain development paths

Common barriers found for both organizations are the lack of vision and ambition and the uncertainty of the challenges. These two barriers are related. Uncertainty and an unclear definition of climate-proof can impede the development of vision and goals. It is difficult to set goals for outcomes if organizations have to deal with a high level of uncertainty.

Apart from uncertainty there is also a group of people unaware of the challenges. Within Arcadis most interviewees were aware of climate change but were still unaware of the four aspects (pluvial flooding, fluvial/coastal flooding, heatstress, drought) related to climate change for climate-proof cities. If people are not aware, they cannot identify with climate-proof city challenges.

The unfamiliarity with future climate developments results in a wait-and-see attitude of implementation at government organizations. In addition to the unfamiliarity, the lack of long-term objectives impedes the

required approach. These long-term objectives are not only lacking because of uncertainty, but often also because of election terms that governments have to deal with. Consequently, politics influence the policy of the organizations. This is clearly experienced by the interviewees. It could be the case that long-term objectives for climate-proof cities are embedded in the organisation at one point, but that the outcome of elections force organizations towards other directions resulting in changed objectives. Interviewees mention that the short-term goals of aldermen highly influence the climate-proof cities projects

Arcadis also executes projects for commercial clients. These companies mainly aim for high levels of profit and the implementation of climate-proof policy and measures must contribute directly to the benefits for business operations or limit the risks to business operations before the benefit is recognized. For these companies, projects on climate-proof cities are often executed to fulfil short-term objectives.

5.2.2   Regulation

Several barriers were found for the Regulation step for both Arcadis and governmental organizations (Table 17). The Regulation step consists of activities such as embedment of policy within regulation and developing regulation.

Table 17 Comparison barriers PRIMO – Regulation

PRIMO	Barrier Arcadis	Barrier governments

Regulation	• Lack of norms
	  • results in subjective approach instead of absolute
	  • impedes translation of policy into measures
	  • causes uncertainty in feasibility and effect of measures
	• Availability of climate related norms is limited
	• New situations require new or adjusted norms
		• Lack of norms and guidelines

Norms and standards are part of regulation. The difference is that deviating for norms and standards is allowed (motivated) and for regulation this is not allowed. The barriers for implementation of climate-proof cities between Arcadis and governments on regulations are similar and all concern norms and standards. While this study does not give insights in the way governments deal with these barriers, it does for Arcadis.

As expected, specialist use norms and standards more often than project leaders and advisors. This is the case for both current and climate related work activities. The difference in these two situations is the limited availability of norms for future situations. Although it has not become clear for which types of norms and standards this finding applies, the gap for norms related to heatstress is addressed a few times specifically.

While it became clear during the interviews that mostly project leaders and advisors believe that norms should change over time and that this will happen along the way. Specialist address that they need norms and standards to verify the feasibility of their designs and models. It is likely the specialist will address this issue earlier, however the lack of norms also indirectly influences the work of the advisor/project leader.

5.2.3   Implementation & finance

The barriers found for the Implementation & finance step for both Arcadis and governmental organizations are presented below (Table 18). The Implementation & finance step consists of activities ranging from posing solutions and implementing measures to arranging budgets for implementation.

Table 18 Comparison barriers PRIMO – Implementation & finance (Italic highlight Arcadis barriers)

PRIMO	Barrier Arcadis	Barrier governments

Implementation & finance	• Implementation of measures in existing urban area is difficult
	• Current financial system is not in line with need for:
	  • shared financing
	  • adequate cost-benefit division
	• *Financial system is not applicable for integral projects*
		• Lack of action perspective
		• Uncertainty in effectivity measures
		• Lack of participation

(sectoral): responsibilities are not in line with possibilities
- Complexity of integral projects hinder implementation
- 2nd & 3rd order effects of measures are unknown
- Possible long-term situations clash with investment for measures: justification
- Implementation is difficult due to complexity and extensivity
- Social challenges are often subjective and not absolute. Hard to capture in measures.

An aspect of finance is the demand for joint financing and balanced cost-benefit distribution. Although this study is limited to the public area, the challenge of a climate-proof city extends beyond the public spaces. In addition, climate-proof city is a task for the entire urban area, with an impact on the regional environment. Measures implemented by the municipality at city level can positively influence multiple parties and both public and private areas. Although the municipality often only bears the costs, it would be more balanced if the parties who benefit from the measures contribute to the costs and those who are disadvantaged not.

In addition, in recent years, partnerships have emerged at the regional level (e.g., associations from the water management agreement (Bestuursakkoord water), Seven square endeavour [54]) in which several (semi-) government institutions and private parties join forces. Although it is now often: "who pays determines", the cost distribution also shifts to a more balanced situation in terms of financing. In addition to the current financial systems, it is stated that those who currently have the financial resources do not have the opportunity to contribute to climate resilience, and vice versa this is also the case.

Another barrier in the approach to climate-proof cities is the limited space in the city, this is more common knowledge than a barrier specifically valid for climate-proof cities. Several transitions and different domains compete for their share for every square meter in public space. Determining a vision and strategy at policy level does not require actual spatial integration. As soon as the measures have to be implemented, this is the case and concrete objectives, as the energy transition, will prevail above a relatively uncertain problem like climate change. As several interviewees indicate, we all work towards a future-proof city and these transitions and domains should be united, but in practice this does not yet take place sufficiently.

Even though a climate-proof city is a long-term objective and construction projects also require long-term objectives, measures are often applied for the short-term objectives. The cause of this is threefold:

1. Boards of governmental organizations often have to deal with a term of office of four to six years. Within this period, they want to achieve concrete results for their voters in accordance with their political agenda.
2. The uncertainty of the climate scenarios makes it difficult to justify measures for long-term objectives, especially if they involve large investments. This uncertainty also results in a lack of urgency towards the challenges.
3. Standardization is missing on several aspects of climate-proof city. The measures that are applied are therefore more likely to be based on subjectivity than that it is absolutely measurable that the measures are adequate.

5.2.4   Maintenance

Maintenance barriers include all barriers found for the activities in the field of evaluation and maintenance. Only for the governmental organisation's barriers were identified in the Maintenance step of the PRIMO chain (Table 19).

Table 19 Comparison barriers PRIMO – Maintenance

PRIMO	Barrier Arcadis	Barrier governments
Maintenance		• Lack of norms and guidelines

Governmental organizations are responsible for the execution of maintenance of public spaces. This is often performed by internal operational departments. Assignments on policy or implementation of measures often stems from maintenance issues, but the assignments of Arcadis in the field of maintenance on climate-proof city projects is highly limited.

5.2.5 Organisation

The barriers found for the Organisation for both Arcadis and governmental organizations are presented below (Table 20). The Organisation 'step' withholds all the activities related to the organisation of the previous policy steps, such as cooperation, communication and project organisation.

Table 20 Comparison barriers PRIMO – Organisation (Italic highlight Arcadis barriers)

PRIMO	Barrier Arcadis	Barrier governments

Organisation	• Sectoral approach instead of integral approach
	   • *Competition*
	   • Personal preferences
	   • *Limited time*
	   • Lack of leadership and initiative
	• Problem owner, role and responsibility are unclear
	• Knowledge about climate-proof cities is insufficient
	• Consciously uninformed persons impede implementation
	• *Overview from client's assignment lacks, therefore projects seem to be focused on one domain*
	• Use of norms depends on role / function
	• *Role & responsibilities towards transitions are unclear*
		• Limited knowledge production
		• Sectoral approach
		• Different perspectives "water"-issue and transitions / unclear ownership

In case of a climate-proof city, interviewees are confronted with the unfamiliarity of the challenges involved. Without a clear definition it is unclear for domains what role and responsibilities they (can) have in the approach. This is a barrier encountered by both government institutions and the design and consultancy firm. For Arcadis specifically, there is a further limitation that the extent to which the design and consultancy firm influences the approach is limited to the client's assignment. Often the customer question is limited to a small part / divided per sector of the total problem and the overview of the client's vision among the market parties is lacking. This fragmentation of the assignments and the often sectoral approach to the problems on the client's side limit the execution of the assignments. The market forces between tendering parties and the limited scope of the assignment ensure that offers made by the market that are not aimed at working integral or the objectives of climate-proof cities. While market parties do have a vision of the approach and knowledge has been greatly expanded due to previous experiences, the companies struggle with financial constraints. If a client demands a specific sectoral solution, while design and consultancy companies would advise an integral future proof solution a clash arises. If this client addresses the issue as sectoral and wishes to continue working sectoral, design and consultancy companies are 'forced' to offer a sectoral approach because offering an integral solution will frustrate their competitive position. The space (and finances) in the requests therefore determines the approach by the design and consultancy firms.

In the case of integral assignments by clients, the internal organisation of Arcadis determines the effect of execution. If a competitive price is offered during the tender, this has a restrictive effect on the composition of an integral team. A quick project execution is simply easier with two people than with a team of six or eight people. This applies to both Arcadis' and client's internal organizations. In addition, it depends on the project leader whether he/ her shows initiative to work integral. Internally, working integral and making connections between departments should be the standard rather than the exception to the challenges associated with transitions. However, personal preference and the internal organisation by domain-specific departments in combination with the financial objectives of these departments complicate the integral approach.

5.3 Concluding remarks

After analysing the barriers, it became clear that the majority of the barriers identified by interviewees at Arcadis were also identified in the literature on climate proof cities from the perspective of governmental organizations.

This research shows the internal barriers at Arcadis in the approach of climate-proof cities and furthermore the general barriers design and consultancy companies encounter in this effort. The majority still struggles with the limited and sectoral assignments of clients. Governmental tasks are often subjected to procurement regulations resulting in a competitive environment between design and consultancy firms that wish to win the task. When a governmental organisation specifies their assignment from a sectoral point of view, there is no need for design and consultancy firms to offer an integral approach. Despite that this barrier resulted from this study, it has never been presented as a barrier in literature.

6 VERIFICATION BY EXTERNAL EXPERT-GROUP

The barriers found by interviewing the employees of Arcadis were verified by an external expert-group. The experts within this group are employed at other Dutch design and consultancy companies and work in the field of climate adaptation (mainly with a background in urban water management). An overview of the barriers verified by the external expert-group is included in appendix E. The most remarkable responses are elaborated in this chapter.

6.1 Policy

Considering the barriers found at the Policy step, the overall opinion of the expert group resembles the barriers found at Arcadis (Figure 17). Especially on the sectoral formulation of policy and the presence of policy dependent on type and size of organizations all experts acknowledged these barriers. As one expert responded, "the largest municipalities clearly have more administrative capacity to shape the climate approach".
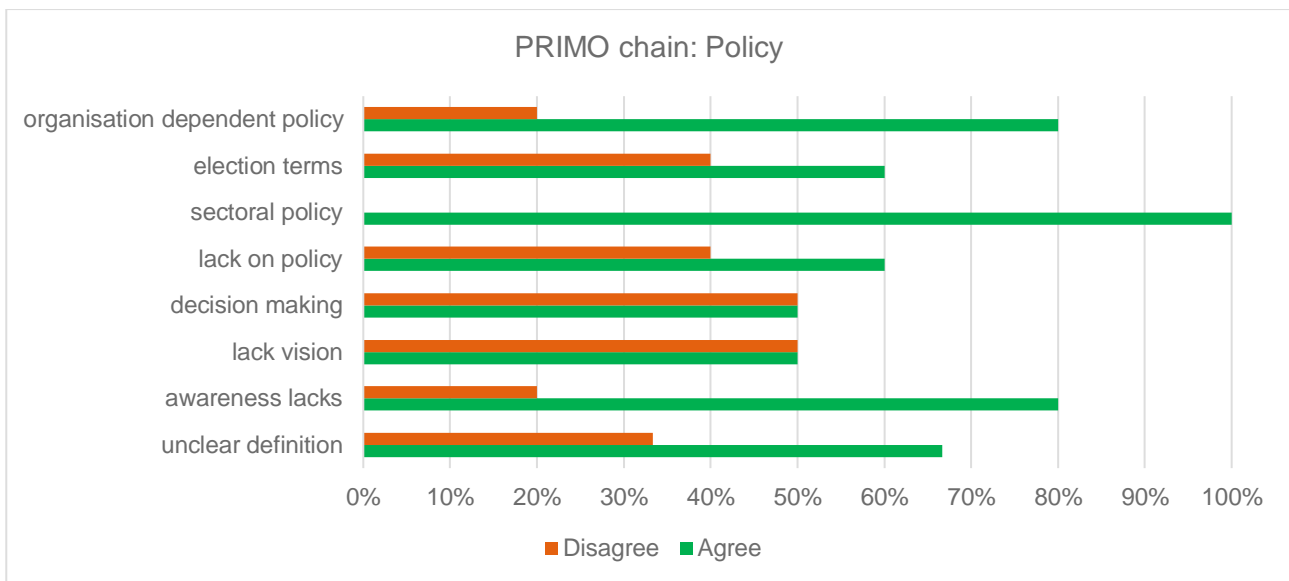
Figure 17 Verification external expert-group Policy

The experts were not equally minded on two barriers identified at Arcadis. The statement that current policy lacks vision on climate-proof cities is partly shared by the experts. External experts mention that vision is part of the thinking process, but not always translated to written policy documents. So, policy documents might lack a vision, but this does not mean that a governmental organisation lacks vision on climate-proof cities. According to the experts, lack of policy on climate-proof cities is not necessarily impeding the implementation of climate-proof cities. "the implementation is impeded by the way of working sectoral and not by the lack of embedment in policy". Furthermore, the experts believe that decision making is determined by personal, political of financial drivers, but they also state that "the current involvement of many stakeholders in projects rule out the subjectivity in decision-making".

More than half of the experts agree with the statement that election terms hinder a long-term approach. An opposing expert responded that the difference in political orientation (conservative or progressive) barely influences the approach. Interviewees didn't mention the difference in political orientation but stressed the preference of short-term goals above long-term ambitions to satisfy their voters.

6.2 Regulation

The responses on norms and standards barriers are mixed amongst the experts (Figure 18). These responses are consistent with the responses of the interviewees. The experts also mention the lack of norms and standards for climate-proof cities, but in their opinion current knowledge is enough to work towards climate-proof cities. "Some governmental organizations need clear norms and standards, while others wish to decide the guidelines for themselves'.
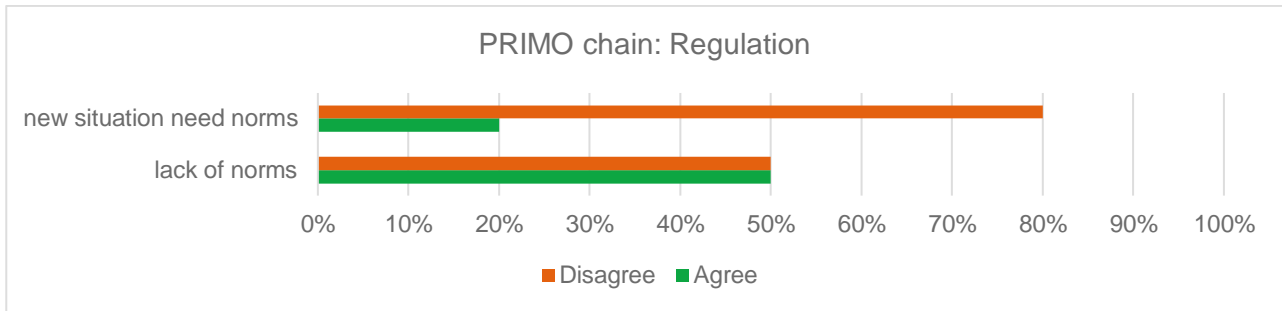
Figure 18 Verification external expert-group Regulation

6.3   Implementation & finance

According to the experts (Figure 19), implementation is staying behind due to complexity of the challenges in coherence with the other transitions, due to budget restraints and the justification of long-term measures with respect to uncertainty of climate prognoses. One expert stated that "predominantly existing projects, with a history before the economic crisis, suffer from budget restraints." Furthermore, experts indicate that budgets are sufficient to make a start with climate-proof measures but are insufficient to deal with all challenges concerning climate-proof cities.

The external experts were not equally minded on the limitations of existing urban area with the implementation of climate-proof city measures. Experts provide the sequence in renovation works as an argument for this disagreement.
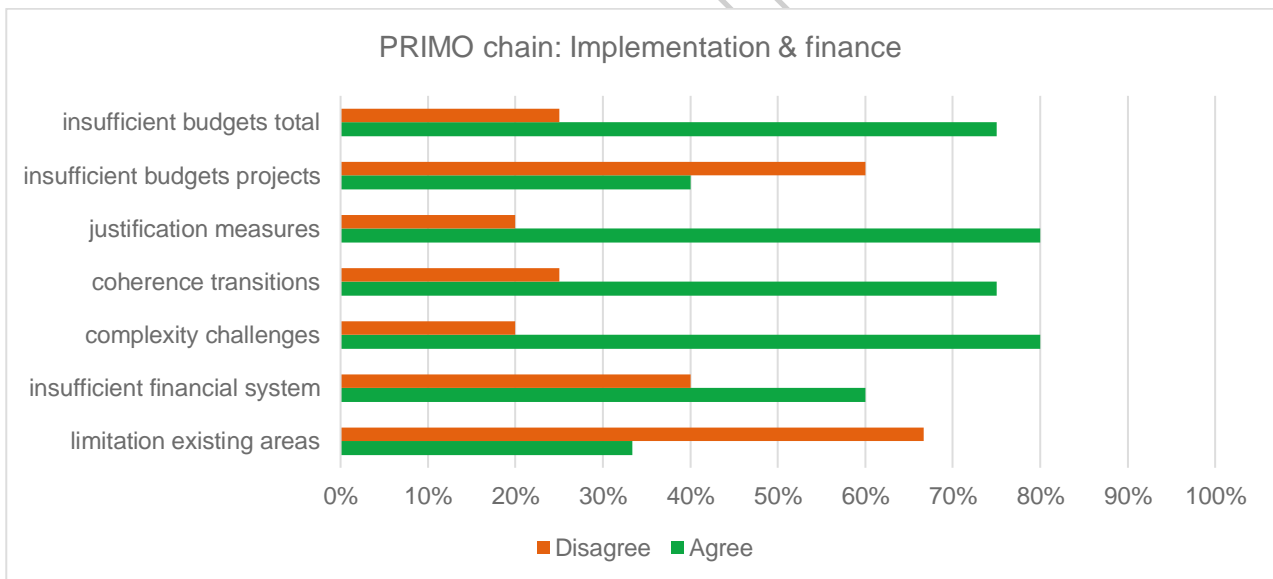
Figure 19 Verification external expert-group Implementation & finance

6.4   Organisation

When it comes to the organisational part experts acknowledge the barriers found in sectoral formulations, ownership and roles and responsibilities. For governmental organisations, the roles are formulated more clearly than previously. But as one expert stated: "for pluvial flooding, the roles are clear, but for the rest it becomes difficult".

The experts also agree on the barrier of sectoral assignments from clients, but don't recognize the competitive market as a barrier for the integral approach of climate-proof cities. Part of the experts mention that they are not in the position to recognize this barrier. The other part has not faced this barrier. As already mentioned at the regulation part, expert believe that knowledge on climate-proof cities is enough (especially internationally) to deal with these challenges.
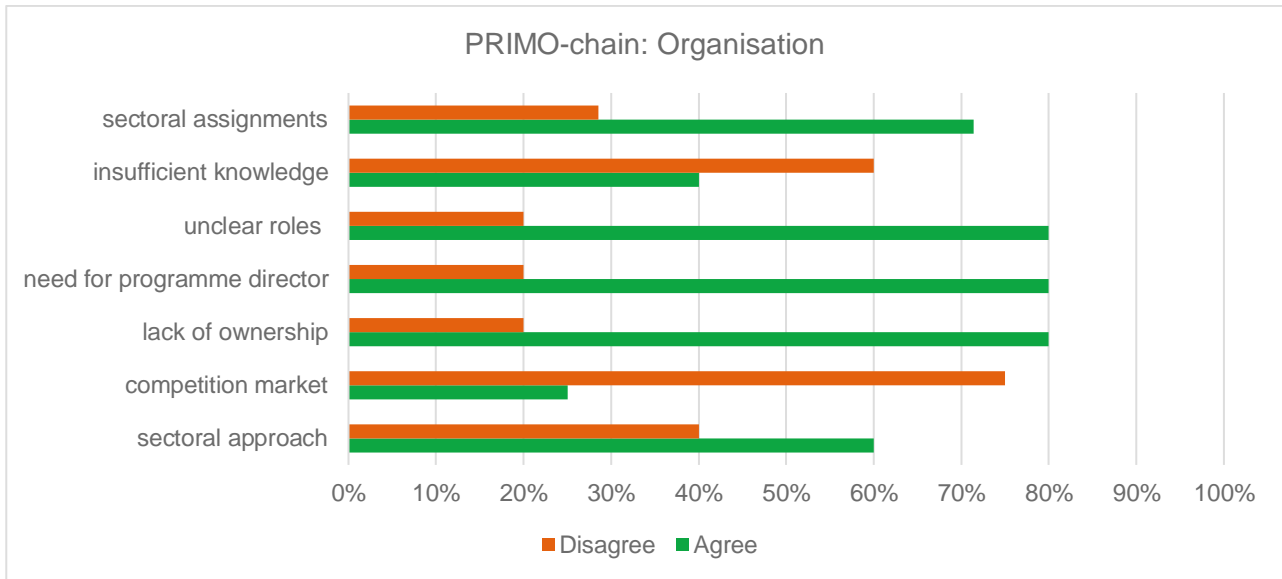
Figure 20 Verification external expert-group Organisation

6.5   Conclusion

While these experts lack the context of the interview-questions and only have been confronted with the barriers, the external expert-group, overall acknowledged the barriers found by the study conducted at Arcadis. Some disagreements on the barriers can be elaborated by the perspective of the expert. Some experts have responded to the barriers from clients' perspective, but others from their own expertise at the design and consultancy firm, this is also consistent with the interviews. On the regulation step in the PRIMO framework the results of the verification was mixed. This could be explained by the perspective and by the fact that the activities of design and consultancy companies in the field of regulation are limited.

7 DISCUSSION

In this chapter the methodology, results and analysis are reviewed critically. The aim of this chapter is to reveal the value of this study for research purposes and to identify the limitations and recommendations for future research.

7.1 Choices and assumptions made during this study

The PRIMO chain was used as framework for this study [40]. For the activities Arcadis executes for its clients, there are steps in which the firm could encounter barriers in the approach of climate proof cities. These barriers were defined using the PRIMO chain model (Policy, Regulation, Implementation and Finance, Maintenance and the Organisation). This chain model (PRIMO) provides a possibility to categorize the barriers by these five aspects. Categorization offered more focus in the data analysis, by collecting the data per aspect and drawing conclusions based on the categories. However, five choices possibly influenced this study.

First, this chain-model suggests that if one of the components of the chain is not executed successfully, the applicability of the policy or measures should be questioned by policymakers. Subsequently, the question emerged whether this also applies to the activities of Arcadis. More specifically, if one of the steps in the PRIMO chain receives less attention or no attention at all, one could wonder if the outcome of the policy process should be questioned. One might argue that this is the case only at client's side, since this chain is applicable for the policy implementation. But this does not influence the activities of Arcadis itself in the chain negatively. Although the results of this thesis are not conclusive about this issue, the results predominantly suggest that design and consultancy companies have too little insight in the complete programme or vision of the client to execute this chain properly. An example that emphasizes this issue is the fact that during this study the PRIMO chain step 'maintenance' receives less attention, since most projects of Arcadis do not include the maintenance part.

Second, the interview topics were related to the PRIMO chain when analysing the results. However, the questions were categorized in different themes in order to have proper conversations about climate-proof cities with the interviewees. The relation between the interview themes and the PRIMO chain steps could have been made more explicit in the interview-guideline. This would have especially made the analysis of results to the PRIMO chain more convenient. Overall the barriers identified in the interviews showed overlap with the organisation barriers and specific Arcadis barriers, therefore the conclusion can be drawn that the consequence of this design choice on the outcome was minimal and the main aim of this study was still achieved.

Third, the interviews were conducted at Arcadis with 24 interviewees. Almost one-third of the interviewees has a function at the urban water management department. These colleagues presume that climate-proof cities is the main transition in their field of expertise. However, to deal with the full range of challenges associated with climate-proof cities, more disciplines should be involved to have an integral overview of perspectives. To achieve an overview of opinions of multiple disciplines, interviews were conducted with interviewees from other domains. Unfortunately, the number of interviewees from other domains involved in this thesis is much lower. Respondents from other domains were suggested by the department heads or interviewees themselves. When interviewees from these other domains do not work with climate change issues or transitions in their daily work the outcome of the interviews might not represent the current view on climate-proof cities from these domains. In retrospective this might have been the case for water safety and infrastructure respondents. Although the answers were in line with the expectations, it is difficult to draw conclusions related to the differences between departments. For future research efforts it is advised to include more representatives from other departments as well and to ensure that the interviewees work on the theme of climate-proof cities daily.

Fourth, the barriers found within Arcadis are compared to the barriers found by literature for governmental organisations. While both organisations are involved in activities concerning climate-proof cities, the barriers they encounter are not necessarily related. Although this might be concluded from this interview, no research was conducted to define or proof this relationship. Therefore, future research should consider if this relationship exists.

Fifth, the verification of the results is performed by the external expert-group. This group consisted of experts in the field of urban water management, daily working on climate-proof city projects. However, the interviews conducted within Arcadis were carried out amongst all domains involved in climate-proof projects in the public space. Extremes between these domains, could be ruled out to find the common opinion. This is not the case for the external expert-group, since these experts are all employed in the field of urban water. In addition to that only one or two per design and consultancy firm contributed to the verification and furthermore the group lacked the context given to the interviewees. The verification therefore can give a misleading presentation of the situation. At the same time, a large part of the interviewees within Arcadis was working at the domain of urban water management. Altogether the verification gives insight in the situation at design and consultancy firms that confirms the barriers found at Arcadis for most part.

7.2   Analysing the dataset

Besides the choices and assumptions made during this study, some limitations were caused by the choices made in the analysis phase of this thesis. Five limitations are formulated and discussed in the upcoming paragraph.

First, the interview themes and questions were derived from the theoretical framework. Apart from an introduction to the subject, further context or framework were not shared with the interviewees. The main reason to withhold this information was the aim of the interview was to verify if the knowledge of the interviewees on climate-proof cities. A downside of this approach is that depending on the questions and the knowledge or interests of the interviewee's context might be insufficient to receive comparable answers for all interviewees. The first respondent might look at a question from a different perspective than the second respondent and interpreted differently than meant by the interviewer. This became for example apparent when integral approach was analysed. By analysing the answers of the respondents, it became clear that the definition of 'integral' differed amongst the interviewees or that some interviewees reasoned from client's perspective instead of their own Arcadis perspective. Hence, this introduced noise in the dataset and made it sometimes difficult to analyse and extract conclusions. In future studies, the interviewer could introduce the definitions of the main concepts used after the verification questions, in order to evaluate whether the context and definitions used are perceived in the same order by all interviewees.

Second, the literature study showed a barrier [44] related to maintenance. Maintenance was not included in the interview, since the activities of Arcadis are limited in this field and interviewees do not fulfil any projects in this field. Although maintenance might be not relevant for Arcadis at this moment, governmental organizations could certainly benefit from answers on this topic because implementing a solution for climate goals could have a large impact in required maintenance efforts. In practice many implementation efforts seem to be constrained by the demands and approach of maintenance departments. For example, if water management systems change from sewer transport to transport above ground this could influence the availability of roads for transportation. Another example is making the city greener by trees. More trees result in more maintenance to avoid clogging of gully pots or to avoid slippery roads in autumn and winter periods. Not part of this study, but definitely interesting to mention is the ability of Arcadis to identify and respond to the maintenance constraints in their projects. Like one interview mentioned before "*It is easy to design policy for long-term projections, actually implementing measures in an existing urban area is something else*" [interviewee 18].

Third in addition, Visschedijk [41] discussed in her study about adding politics to the PRIMO chain. This study shows that politics influence the full chain starting at policy as well. If climate-cities is not found relevant for a certain organisation than no further steps in the PRIMO chain will be taken to address this issue.

Fourth, the analyses were carried for each individual question. Interpretation of the results in paragraph two of each results chapter presents an overall result on the questions combined for each topic. While the interpretation is based on the analyses, this paragraph also consists of author's opinion based on the total amount of conducted interviews. As a result, these chapters are partly subjective. For future research this could be prevented by appointing two reviewers and checking both interpretations on similarities and differences. Nevertheless, the main findings will hold and present the outcome as it is presented by the interviewees.

Fifth, this study is limited to Arcadis Netherlands only. Arcadis NL has offices around the world with a total of 27,000 employees. Conducting this research within other countries could result in different outcomes, since these countries deal with other authorities, policies and procedures. In addition to those aspects culture could also result in other opinions and therefore other outcomes of the study.

7.3   Practical and theoretical contributions of this thesis

In the approach of climate-proof cities and other transitions there is never one organisation only responsible for success. Every organisation can and should play a role at some point. There has not been a study on the role of a design and consultancy firm in the approach of climate-proof cities. This study sheds new light on the barriers a representative design and consultancy firm encounters internally in the approach and which barriers they have to deal with when dealing with clients in the Netherlands.

This study reveals that design and consultancy firms struggle with the current process of winning projects with respect to the contribution they can deliver to the approach of climate-proof cities. Competition and the assignment specified by the client impede the integral approach that is found necessary to deal with these transitions properly. One side of the barrier is that the approach that design and consultancy firms offer fit the question of the client. The other side is that integral approach seems to be not valued by clients when it's offered.

The barriers that are identified in paragraph 5.3.1 as external influences are general barriers that other design and consultancy firms also could experience. This seems valid for political changes and the tendering process that all firms have to deal with. Although this might be the case, the scope of the study provides too little data to conclude this firmly. Three reasons why these barriers could be experienced differently or even do not exist at all at other firms are:

- Internal organizations differ between consultancy firms;
- The size of the firm can influence the applicability of the barriers. In smaller company's people tend to be in contact with each other more easily;
- The type of the firm determines whether barriers are experienced. Some companies focus especially on climate-proof city projects, these companies will offer different approaches compared to firms where the focus lies on more 'traditional' projects.

For the activities Arcadis executes for its clients, there are steps in which the firm could encounter barriers, being policy, regulation, implementation and finance, maintenance and the organisation. The chain model (PRIMO) provided a possibility to categorize the barriers by these five aspects. Categorization offered more focus in the data analysis, by collecting the data per aspect and drawing conclusions based on the categories. The PRIMO framework has not been applied on the approach of climate-proof cities before. This study shows that the PRIMO chain is suitable to identify the barriers not only for governmental organizations.

7.4   Recommendations for future research

This study is limited to the barriers that are identified with the domains concerned with design and maintenance of public spaces. Respondents mentioned the division of public space vs. private property (30/70%). To gain full impact on the goals of climate-proof cities it would be interesting to study the barriers owners of private properties encounter in the aim of climate-proof cities.

The study presented three barriers, election terms, organisation dependent policy and sector specific projects, that design and consultancy firms in general experience in the approach of climate-proof cities (and other transitions). For future research it could be valuable to research these three topics more in-depth. Such as studying solutions to and effects of overcoming these barriers to increase the action perspective of design and consultancy companies and ultimately improving the approach of climate-proof cities. Ideally this type of research is executed in the form of pilots, since these solutions will have some impact on the traditional procurement and cooperation structures.

8   CONCLUSION

The aim of this study was to identify barriers for climate-adaptation of the urban environment within a design and consultancy firm. Research up to now focused only on the barriers governmental organizations encounter, this study reveals barriers that a design and consultancy company in this field encounter. To this end, a series of 24 interviews were held at the departments concerning the design and maintenance of public spaces of urban environments within the Dutch design and consultancy firm Arcadis.

Besides the common barriers between governments and Arcadis, a few barriers were identified that exist specifically due to the relation of Arcadis with clients or because of the organisational structure of Arcadis. Most design and consultancy companies execute assignments for governments. They encounter several barriers related to the organisation at the clients' sides. In this paragraph the concluding barriers concerning the organisation structure of Arcadis are presented, together with the barriers that relate to external influences.

8.1   Barriers external influences

1. Election terms of governments limit long-term approach. Interviewees indicate that politics are focused on short-term results to satisfy voters instead of the long-term approach which is found needed to approach climate-proof cities. This short-term approach is caused by the political system, and not necessarily by the change of conservative or progressive politicians by these elections.

2. Policy depends on organisation (commercial = profit) and size of government. Large governmental organisations have more capacity to create policy on transitions. Commercial companies do not always have policy on these transitions, since their policy and goals are mainly focussed on profit gains. Lack of policy on transitions impedes the implementation of measures and reduces opportunities for design and consultancy firms to share expertise.

3. Projects from clients are often focused on one domain:
    -   Assignments are procured fragmented, so that overview on complete programme lacks for design and consultancy companies.
    -   Competition in tenders results in low priced offers.
    -   Low priced offers result in limited time to execute projects properly.

8.2   Barriers Arcadis organisation

1. Role & responsibilities towards transitions are unclear.
    According to the interviewees, the roles and responsibilities of individuals and departments in the achievement of climate-proof cities is unclear. The results show that especially expertise on pluvial flooding is present within the Arcadis departments, while heatstress is identified as urgent but lacking in clear expertise within the departments. However, this knowledge is currently being developed within the Urban water department, still responsibilities towards the challenges is unclear. The unclarity is related to ownership. Who should take initiative in the climate-proof cities projects to make decisions and to include all the relevant domains?

2. Financial system is not applicable for integral projects (sectoral organisation structure)
    Currently the internal organisation is structured by departments united in business lines. Every department, for example Urban water management, is responsible for its own workload and profit. Every departments also has its own financial targets. When expertise is needed from other departments, a share of this profit will be "claimed" by the other departments, decreasing the opportunity to gain a good profit and achieve the financial target. Interviewees acknowledge this structure as it limits in the approach of climate proof cities.

8.3   So close, yet so far?

Overall governmental organizations as well as design and consultancy companies struggle with similar barriers in knowledge gaps, uncertainty of the outcomes and the sectoral approach. Knowledge is developing on climate change aspects and feasibility of measures. Small steps are taken in the execution of the Delta Programme Spatial adaptation, currently working on the risk dialogue. Small steps to get closer to the final goal: climate proof cities.

This study shows the barriers of design and consultancy companies in its efforts to achieve climate-proof cities. Working together and sharing experience instead of end of the line advisory is identified as a major barrier for these companies. If these cooperation and financial structures don't change, we are likely to keep on doing the same as we have done for sectoral projects. So close yet so far? Maybe. We are getting closer in our separate efforts, but together, internally and externally, we get further!

9 RECOMMENDATIONS

In total five barriers are identified that Arcadis as a design and consultancy firm encounters in its approach to achieve climate proof cities. It is difficult to influence external processes that are identified as barriers, but still a few suggestions have been made in paragraph 9.1. Paragraph 9.2 gives a few suggestions to overcome the two barriers indicated as organisational barriers.

9.1 Recommendations external influences

9.1.1 Barrier election terms

Barrier
"Election terms of governments limit long-term approach".

Context
Interviewees indicate that politics are focused on short-term results to satisfy voters instead of the long-term approach which is found needed to approach climate-proof cities.

Recommendation
The political system will not change, so it is difficult to overcome this barrier with solutions at the source. However, introducing a bonus or malus system for governments separate from the political system could increase the action perspective of government officials. This implies that aiming for climate-proof cities is a mandatory assignment of governments.

An 'easier' solution could be, as some interviewees suggested, to formulate long-term goals and ambitions and translate these into steps with smaller time frames. However, in that case government officials are responsible for the execution of the small steps in line with the long-term goals themselves. This requires discipline and cooperation of all domains and organisational layers involved in the approach of climate-proof cities.

9.1.2 Barrier company dependent policy

Barrier
"Policy depends on organisation (commercial = profit) and size of government".

Context
Large governmental organisations have more capacity than smaller organizations to create policy on transitions. Commercial companies do not always have policy on these transitions, since their policy and goals are mainly focussed on profit gains.

Recommendation
While policy on climate-proof cities has been developed mostly based on intrinsic motivation, of governments or companies involved in the design and maintenance of public spaces. And more recently due to the Delta decision Spatial adaptation. Still governments and commercial companies lack policy in this field. For governmental organizations, the development of policy on climate proof cities is an ongoing process. According to the Delta decision climate-proof and water robust aims should be part of policy.

Commercial companies will give attention to the climate-proof challenges when corporate policy imposes the need on the different organisational layers or when the challenges threaten business activities of the companies. For these companies a first step could be the awareness of the challenges and possible impacts on their business continuity.

9.1.3 Barrier sectoral focus

Barrier
"Projects from clients are often focused on one domain".

Context

Design and consultancy companies do not always have the overview of client's programme due to the fragmented and sectoral procurement. For competition reasons companies offer sectoral solutions and approaches. These two actions result in a vicious process maintaining the sectoral approach.

Recommendation

On governments' side it could help if market parties have more insight in programmes to provide better solutions on the challenges. On governments' as well as Arcadis' side awareness could be increased on the benefits of an integral approach.

9.2 Recommendations for Arcadis

9.2.1 Barrier role & responsibilities

Barrier
According to the interviewees, "the roles and responsibilities of individuals and departments in the achievement of climate-proof cities is unclear".

Context
The results show that especially expertise on pluvial flooding is present within the Arcadis departments, while heatstress is identified as urgent but lacking in clear expertise within the departments. However, this knowledge is currently being developed within the Urban water department, still responsibilities towards the challenges is unclear. The unclarity is related to ownership. Who should take initiative in the climate-proof cities projects to make decisions and to include all the relevant domains?

Recommendation
Based on the results of this study, more clarity is given in the expertise of the departments involved in climate-proof cities. It is recommended to clearly communicate what the tasks concerning the climate-proof aspects withhold and who is responsible for execution of these tasks and keeping the overview. This could be realized within the current organisational structure. However, it is recommended to form teams in which expertise on the different aspects are united, so that communication and overview can be organized more easily. The Arcadis' strategy (2018-2020) includes a growth priority on climate adaptation (Appendix F). Relying on the knowledge of all domains and working integral are ambitions that are already recognised in this growth priority, but still roles and responsibilities are preconditions to achieve these ambitions. It is advisable to clarify the expectations, roles and responsibilities for the domains involved in the strategy, so that colleagues can act accordingly. Note that this can affect function descriptions as well.

Not part of the results section on the topics, but still part the interview - open questions - was a question about examples of good practice. A few times 7 Square Endeavour [54] and Wonderwoods [55] were mentioned, both innovative concepts of urban design. These projects are part of the urban design and planning domains and recognized as future proof designs in the achievement of climate-proof cities. These good examples could appeal other domains to be more involved in the challenges. Maybe urban design could fulfil a directive role in climate-proof cities, so that they can 'seduce' other domains to take their role and responsibilities.

A few years ago, first steps were taken towards embedding climate-proof cities in the Arcadis organisation by appointing a programme leader. This resulted in more exposure for the challenges internally and externally. Since the beginning of this year a new programme leader started to enrol climate-proof cities within the organisation. After a good conversation with her, it became clear that she also identified these barriers of roles and responsibilities. Currently integral teams are formed throughout the organisation focusing on the strengths of the domains involved in the four aspects of climate-proof cities.

9.2.2 Barrier financial structure

Barrier
"Financial system is not applicable for integral projects (sectoral organisation structure)"

Context
Currently the internal organisation is structured by departments united in business lines. Every department,

for example, Urban water management, is responsible for its own workload and profit. Every departments also has its own financial targets. When expertise is needed from other departments, a share of this profit will be "claimed" by the other departments, decreasing the opportunity to gain a good profit and achieve the financial target. Interviewees acknowledge this structure as it limits in the approach of climate proof cities.

Recommendation

Financial and organisational structures are the base of an organisation and cannot be change easily. Based on the current developments and this study, two suggestions are given to decrease this barrier.

1. The departments within the business line Infrastructure have recently changed to form departments based on workflows, where colleagues are united based on a certain field of expertise and across workflows. This new structure is implemented as a pilot and will be embedded in the other business lines when it is found successful. Forming new departments based on workflows could create a possibility to form a climate-proof cities department, where colleagues are united with their expertise on the four climate-proof aspects.

2. Interviewees indicate that the financial targets and workload division impede working integrally. When expertise outside a department is needed, this will undermine the targets of its own department. Of course, a financial overview is needed to decide whether the company is doing well, but the current strict financial structure does not stimulate working together. It might be an option to stimulate the integral approach by for example setting a department exceeding target on climate-proof cities projects. Where departments involved in the design of public spaces could contribute by working integral. In the end the shares of the departments are discounted from the department target. And departments contributing to this collective target get promoted in some sense (bonus, extra education, lower target on traditional projects). In this case it can contribute positively to the integral approach.

10   REFERENCES

[1] IPCC (2007). *Climate Change 2007: Synthesis Report*. Synthesis Report. [online] Valencia (Spain): Intergovernmental Panel on Climate Change. Available at: https://www.ipcc.ch/report/ar4/syr/ .

[2] Biesbroek, G., Swart, R., & van der Knaap, W. (2009). *The mitigation–adaptation dichotomy and the role of spatial planning*. Habitat International, 33(3), 230-237. http://dx.doi.org/10.1016/j.habitatint.2008.10.001

[3] Hoppe, T., van den Berg, M., & Coenen, F. (2014). *Reflections on the uptake of climate change policies by local governments: facing the challenges of mitigation and adaptation*. Energy, Sustainability And Society, 4(1), 8. http://dx.doi.org/10.1186/2192-0567-4-8

[4] IPCC (2014). *Climate Change 2014*. Synthesis Report Summary for Policymakers. [online] Intergovernmental Panel on Climate Change. Available at: https://www.ipcc.ch/report/ar5/syr/

[5] Epa.gov. (n.d.). *Heat Island Effect | US EPA*. [online] Available at: https://www.epa.gov/heat-islands [Accessed 21 Apr. 2017].

[6] Deltacommissie (2014). *Synthesedocument Ruimtelijke adaptatie*. Achtergronddocument B3. Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken.

[7] Albers, R., Bosch, P., Blocken, B., van den Dobbelsteen, A., van Hove, L., & Spit, T. et al. (2015). *Overview of challenges and achievements in the climate adaptation of cities and in the Climate Proof Cities programme*. Building And Environment, 83, 1-10

[8] Knowledge for Climate research programme (2014). Embarking *on spatial adaptation*. Ruimtelijke adaptatie. Retrieved 16 July 2017, from http://ruimtelijkeadaptatie.nl/

[9] Rotmans, J. (2010). *Transitieagenda voor Nederland*. Nieuwkoop: Ecodrukkers.

[10] Rotmans, J., Kemp, R. and van Asselt, M. (2001). *More evolution than revolution: transition management in public policy*. Foresight, 3(1), pp.15-31.

[11] Staff of the Delta Programme Commissioner (2017). *Delta Programme 2018*. Deltaplan on spatial adaptation. Ministry of Infrastructure & Environment.

[12] Technischweekblad.nl. (2018). *Top 50 ingenieursbureaus*. [online] Available at: https://www.technischweekblad.nl/upload/documents/tinymce/TW_13_2018_Top_50_Ingenieursbureaus.pdf [Accessed 20 Dec. 2018].

[13] United Nations Department of Economic and Social Affairs (2018). *World Urbanization Prospects*. The 2018 Revision. United Nations.

[14] CBS (2016). *PBL/CBS prognose: Groei steden zet door*. [online] Centraal Bureau voor de Statistiek. Available at: https://www.cbs.nl/nl-nl/nieuws/2016/37/pbl-cbs-prognose-groei-steden-zet-door [Accessed 26 Aug. 2018].

[15] Grimmond, S. (2007). Urbanization and global environmental change: local effects of urban warming. *The Geographical Journal*, 173(1), pp.83-88.

[16] U.S. Environmental Protection Agency. 2016. C*limate change indicators in the United States, 2016. Fourth edition*. EPA 430-R-16-004. www.epa.gov/climate-indicators.

[17] AP NEWS. (2016). *Trump's denial of climate science at odds with world leaders*. [online] Available at: https://apnews.com/9f61f5a9f8b242bc8eb12a9b36449b54 [Accessed 5 Sep. 2018].

[18] News.nationalgeographic.com. (2019). *A running list of how President Trump is changing environmental policy*. [online] Available at: https://news.nationalgeographic.com/2017/03/how-trump-is-changing-science-environment/ [Accessed 22 Jan. 2019].

[19] Barham, J. (n.d.). *The Top 15 Climate-Change Scientists: Consensus & Skeptics*. [online] TheBestSchools.org. Available at: https://thebestschools.org/features/top-climate-change-scientists/ [Accessed 5 Sep. 2018].

[20] Royal Netherlands Meteorological Institute (2015). *KNMI '14 climate scenarios for the Netherlands*. [online] KNMI. Available at: http://www.klimaatscenarios.nl/brochures/images/KNMI14_Klimaatscenarios_folder_EN_2015.pdf.

[21] de Graaf, R., van de Giesen, N. and van de Ven, F. (2007). Alternative water management options to reduce vulnerability for climate change in the Netherlands. *Natural Hazards*, 51(3), pp.407-422.

[22] NU.nl (2018a). *Droogte in Nederland houdt aan: 'De koeien gaan 's nachts de wei in' | NU - Het laatste nieuws het eerst op NU.nl*. [online] Nu.nl. Available at: https://www.nu.nl/weekend/5350484/droogte-in-nederland-houdt-aan-de-koeien-gaan-s-nachts-wei-in.html [Accessed 2 Aug. 2018].

[23] NU.nl (2018b). *'Voor boeren kan schade door droogte heel groot zijn' | NU - Het laatste nieuws het eerst op NU.nl*. [online] Nu.nl. Available at: https://www.nu.nl/dvn/5379209/voor-boeren-kan-schade-droogte-heel-groot-zijn.html?redirect=1 [Accessed 2 Aug. 2018].

[24] NU.nl (2018c). *Officieel landelijk watertekort, drinkwater niet in gevaar | NU - Het laatste nieuws het eerst op NU.nl*. [online] Nu.nl. Available at: https://www.nu.nl/binnenland/5395019/officieel-landelijk-watertekort-drinkwater-niet-in-gevaar.html [Accessed 2 Aug. 2018].

[25] NU.nl (2018d). *Tientallen huizen verzakken en scheuren door droogte | NU - Het laatste nieuws het eerst op NU.nl.* [online] Nu.nl. Available at: https://www.nu.nl/binnenland/5550932/tientallen-huizen-verzakken-en-scheuren-droogte.html [Accessed 16 Dec. 2018].

[26] NRC.nl (2018). *'Droogte dreigt ramp te worden' - de zomer van 1976 was nóg erger.* [online] NRC. Available at: https://www.nrc.nl/nieuws/2018/07/20/recordjaar-1976-zo-droog-was-het-nog-nooit-geweest-a1610689 [Accessed 2 Aug. 2018].

[27] Rijksoverheid (2018). *Droogte in Nederland vraagt om verdeling water.* [online] Rijksoverheid.nl. Available at: https://www.rijksoverheid.nl/onderwerpen/droogte-en-hitte/nieuws/2018/08/02/droogte-in-nederland-vraagt-om-verdeling-water [Accessed 2 Aug. 2018].

[28] United Nations (2015). *Paris Agreement.* Paris: United Nations. Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

[29] van Leeuwen, R., de Wit, J. and Smit, G. (2017). Review of urban energy transition in the Netherlands and the role of smart energy management. *Energy Conversion and Management*, 150, pp.941-948.

[30] de Jong, M., Joss, S., Schraven, D., Zhan, C., & Weijnen, M. (2015). Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production*, 109, 25-38. doi: 10.1016/j.jclepro.2015.02.004

[31] TNO (2014). *Trends Transities TNO.* Strategie 2015-2018. TNO.

[32] Rijksoverheid (2016). *Energieagenda: doelen voor 2050.* [online] Rijksoverheid.nl. Available at: https://www.rijksoverheid.nl/onderwerpen/duurzame-energie/uitwerking-energieagenda [Accessed 7 Oct. 2018].

[33] Rijksoverheid (2016). *Nederland Circulair in 2050.* Rijksbreed programma Circulaire Economie. Rijksoverheid.

[34] Gemeente Rotterdam (2016). *Rotterdam Vitale Stad.* Nota Publieke Gezondheid 2016-2020. Rotterdam: Gemeente Rotterdam.

[35] Suckall, N., Tompkins, E., Nicholls, R., Kebede, A., Lázár, A., Hutton, C., Vincent, K., Allan, A., Chapman, A., Rahman, R., Ghosh, T. and Mensah, A. (2018). A framework for identifying and selecting long-term adaptation policy directions for deltas. *Science of The Total Environment*, 633, pp.946-957.

[36] The UK Water Partnership (2015). *Future visions for water and cities.* A thought piece. The UK Water Partnership.

[37] Bulkeley, H., Broto, V. and Edwards, G. (2015). *An Urban Politics of Climate Change.* London: Routledge.

[38] Ven, F. and Vroege, M. (2005). *Water in drievoud.* Delft: Eburon, p.33.

[39] Van de Ven, F. (2017). *Water management in urban areas - planning, structural approach.* Page 24: Rijsberman (2002). Speelveld van thema's, actoren en gebieden.

[40] Ministry of Infrastructure and Water management – ARB (1997). *Resultaat gericht beleid.* Advies bij beleidsontwikkeling, communicatie en samenwerken. Den Haag: Drukkerij Deltadruk.

[41] Visschedijk, A. (2014). *Identifying and Overcoming Socio-Institutional Constraints.* Master of Science. Delft University of Technology.

[42] Andersson-Sköld, Y., Thorsson, S., Rayner, D., Lindberg, F., Janhäll, S., Jonsson, A., Moback, U., Bergman, R. and Granberg, M. (2015). An integrated method for assessing climate-related risks and adaptation alternatives in urban areas. *Climate Risk Management*, 7, pp.31-50.

[43] Stang, G. and Ujvari, B. (2015). Climate change as a 'wicked problem'. *Issue Alert*, [online] 2015(52). Available at: https://www.iss.europa.eu/sites/default/files/EUISSFiles/Alert_52_Climate_change.pdf [Accessed 13 Aug. 2018].

[44] Moser, S. and Ekstrom, J. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, 107(51), pp.22026-22031.

[45] Avelino, F. (2009). Empowerment and the challenge of applying transition management to ongoing projects. *Policy Sciences*, 42(4), pp.369-390.

[46] Miedziński, M. (2018). Do policy makers tell good stories? Towards a multi-layered framework for mapping and analysing policy narratives embracing futures. *Futures*, 101, pp.10-25.

[47] Loorbach, D. and Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, 42(3), pp.237-246.

[48] Rittel, H. and Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), pp.155-169.

[49] Lazarus, R. J. (2009) "Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future", Georgetown Law Faculty Publications and Other Works. 159. https://scholarship.law.georgetown.edu/facpub/159

[50] Bassett, E. and Shandas, V. (2010). Innovation and Climate Action Planning. *Journal of the American Planning Association*, 76(4), pp.435-450.

[51] Sciencedirect.com. (2018). *ScienceDirect.com | Science, health and medical journals, full text articles and books.* [online] Available at: https://www.sciencedirect.com/.

[52] Maguier, M., Delahunt, B. (2017). Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars. *AISHE-J*, [online] 9(3). Available at: http://ojs.aishe.org/index.php/aishe-j/article/view/335 [Accessed 12 Aug. 2018].

[53] Bree, R., Gallagher, G. (2016) Using Microsoft Excel to code and thematically analyse qualitative data: a simple, cost-effective approach. *AISHE-J*, [online] 8(2). Available at: http://ojs.aishe.org/index.php/aishe-j/article/view/281/467 [Accessed 10 Aug. 2018].

[54] 7square-endeavour.nl. (2019). *7 Square Endeavour*. [online] Available at: http://www.7square-endeavour.nl/ [Accessed 13 Mar. 2019].

[55] MVSA Architects. (2019). *Wonderwoods - MVSA Architects*. [online] Available at: https://mvsa-architects.com/project/wonderwoods/ [Accessed 5 Apr. 2019].

APPENDIX A LIST OF INTERVIEWEES

#	Domain	chain-model activities	Role	First order	Second order
1	Urban water management	policy, implementation & finance	Specialist	x	
2	Project development	implementation & finance	Specialist	x	
3	Rural water management	policy, implementation & finance	Project leader	x	
4	Urban water management	implementation & finance	Specialist	x	
5	Urban water management	policy, implementation & finance	Specialist	x	
6	Project development	policy, implementation & finance	Project leader	x	
7	Greenery	policy, regulation, implementation & finance	Advisor	x	
8	Urban water management	implementation & finance	Project leader	x	
9	Rural water management	policy, regulation, implementation & finance	Project leader	x	
10	Urban water management	policy, regulation, implementation & finance	Advisor	x	
11	Project development	policy, implementation & finance	Advisor	x	
12	Urban water management	policy, regulation, implementation & finance	Advisor	x	
13	Project development	policy, implementation & finance	Project leader	x	
14	Urban planning	policy, regulation, implementation & finance	Project leader	x	
15	Urban water management	policy, regulation, implementation & finance	Specialist	x	
16	Urban water management	policy, regulation, implementation & finance	Advisor	x	
17	Rural water management	implementation & finance	Specialist		x
18	Project development	policy, regulation, implementation & finance	Advisor		x
19	Urban water management	policy, regulation, implementation & finance	Project leader	x	
20	Greenery	policy, implementation & finance	Specialist	x	
21	Infrastructure	policy, regulation	Project leader	x	
22	Urban Planning	policy, regulation, implementation & finance	Project leader		x
23	Water safety	policy, implementation & finance	Advisor		x
24	Project development	policy, regulation	Project leader		x

APPENDIX B INTERVIEW GUIDE

Interview ##
Interviewee:
Date:
Time:

General questions for interviewee
- A. What is your background?
- B. Which function do you have within Arcadis?
- C. What do your work activities mainly consist of?

Climate-proof cities
1. What characterizes a climate proof city in your opinion?
2. What challenges do you see for achieving climate-proof cities?
3. Which aspect of climate change is most relevant in your field of expertise and which aspect do you see as urgent?
4. How do you deal with uncertainties regarding the climate prognoses in your work-activities?
5. Does your current knowledge and expertise provide sufficient action perspective with respect to a climate-proof city?

Ownership
6. is there a problem owner / initiator for climate-proof cities?
7. How are interests from other domains dealt with?
8. Is every domain aware of the challenges concerning climate-proof cities?

Approach
9. Is the approach for these (future) challenges different from when you started working?
10. Can you identify barriers for an integral approach?
11. Can you identify opportunities for an integral approach?
12. Are there topics in your domain that are being tackled integrally?

Goals
13. Are objectives of projects focused on short (about 5 years) or long-term (about 15-25 years) goals?
14. When are goals relevant to you as a person?

Norms & standards
15. Do you make use of norms and standards in your work activities?
16. Are current standards and norms applicable to the (future) challenges?

Transitions
17. What are the main future challenges for cities and our society?
18. Which transitions can be identified in your field of expertise?
19. Are transitions considered in projects?
20. Do you expect changes in your work activities as a result of these transitions?

Open

APPENDIX C DATA OVERVIEW AND KEY POINTS INTERVIEW

Qualitative coding & analysis

Identify codes

The first step in coding the interview transcripts the highlights of each question were used to identify the main concepts and categories. For example, if interviewees talked about liveability consistently or something related to this concept than liveability was identified as a concept. At the end of this exercise the full transcript per question contained two to five highlighted concepts (themes).

Confirm codes

The second step existed of reading the answers to the questions using the concepts and categories. This step was performed to confirm that the concepts and categories represented the interview responses.

Identify second-level categories

After confirming the codes second level categories were distinguished within the main concepts and categories. Resulting in the key elements that interviewees mentioned at each main concept and category.

Data overview

The final steps in coding was the summarization of concepts, key elements and relevant quotes per question and concept in tables. Those tables are found below for each question. The tables provided the starting point for collecting and describing the interview results.

Question 1: What characterizes a climate-proof city?

	Data overview and key points
Theme	Future-proof
Data overview/ quotes	Future-proof covers the entire range of transitions / On the climate aspects, the city must be future-proof, for the situations we will face in 30 to 50 years. / A city where well-considered choices have been made about the design of the public space / climate adaptation interwoven with other functions / all developments (transitions) in the city are integrated. / protection levels
1	Recognition of transitions and other functions
2	Long-term goals
3	Dealing with uncertainty of events
4	Well-considered choices and protection levels determine design of public space

	Data overview and key points
Theme	Liveability
Data overview/ quotes	A city should remain to be liveable at all times / In 100 years the liveability should be equal or preferably better than it is now / A city has to cope with extremes in a way that residents suffer as little as possible, without affecting the experience of people, to ensure that the negative effects do not occur or do not cause harm. / A healthy city is a city in balance (ecosystems)/ a city where you can live decently and work pleasantly (decent = healthy, vital, without nuisance). / The development of cities (hard) is induced by social development (soft). / Daily life must be able to continue with all weather conditions that we will encounter.

1	Subjective definition, being social, healthy, vital, without hinder/ nuisance, decent, nice, experience of people
2	Level of liveability must be equal or preferably better on the long-term than it is in 2018
3	Dealing with events due to transitions should not affect daily life

	Data overview and key points
Theme	Dealing with Climate-proof aspects
Data overview/ quotes	A city that can deal with the consequences of climate change on the four climate aspects: drought, heat stress, pluvial flooding and fluvial / coastal flooding.
1	Four climate aspects: drought, heat stress, pluvial flooding and fluvial / coastal flooding
2	City design can deal with consequences of climate change

Question 2: What challenges do you see for achieving climate-proof cities?

	Data overview and key points
Theme	Integral approach
Data overview/ quotes	Integral linking of different sectoral themes and domains in the public space during all process steps. / Aligning various existing urban structures with the desired future city in an area with limited space. / Dealing with already build environment.
1	Recognition of integral approach
2	Available area in existing urban context is limited
3	Implementing climate-proof measures on existing build environment compared to newly build areas is challenging

	Data overview and key points
Theme	Cost & benefits
Data overview/ quotes	the current tax system must change allocating the right budgets & create a fair cost-benefit structure (people do not the benefits but bear the costs) / persuading or encouraging private parties to invest in climate-proof measures / working together and financing together.
1	Current tax system doesn't match the necessary allocation of budgets
2	Current tax system doesn't provide a fair cost-benefit structure
3	Increase action perspective of private parties to invest in climate-proof measures
4	working and financing together

	Data overview and key points
Theme	Policy & Legislation
Data overview/ quotes	Knowing the risks and the control measures to provide more guidance: Uncertainty in development trajectory climate impacts stagnates implementation. / Lack of intrinsic motivation in the absence of legislation and policy - legislation is necessary for implementation. / Influence on the private parties. / Defining the preconditions or a leading role of municipalities. / Transforming decision-making in politics and among users.
1	Mobilize responsible parties despite uncertainty of climate change effects
2	Means to influence or increase action perspective of all involved parties

	Data overview and key points
Theme	Awareness & knowledge
Data overview/ quotes	Awareness and lack of urgency. / Liveability is subjective and therefore difficult to express in facts and figures. / Knowledge gap for heatstress and drought. / *"We have a green office but is that such a nice place to work?"*/ It is mainly about social challenges. Behaviour change in lifestyle habits is necessary. / *"We all say, 'it is not possible', but it is possible, but you must want it"*.
1	Lack of awareness and urgency
2	Subjectivity in design values
3	Behaviour and lifestyle habits
4	Knowledge gap for heatstress and drought

	Data overview and key points
Theme	Stakeholder engagement
Data overview/ quotes	the involvement (how) of private parties, because the municipality cannot solve these challenges by themselves. Define the protection levels with all relevant stakeholders and engage stakeholders in the consequences and execution of measures within public and private domains. / Acceptance: Which damages can we accept.
1	Definition of protection levels
2	Stakeholder engagement on multiple levels
3	Extent of challenges, not only responsibility municipality

Question 3: Which aspect of climate change if most relevant in your field of expertise and which aspect do you see as urgent?

3a: Expertise							
Out of 16	**Total**	**Responds**	**%**	**Pluvial flooding**	**Fluvial/ coastal flooding**	**Heatstress**	**Drought**
Urban water management	9	7	78%	100%	0%	29%	14%

	Total	Responds	%	Pluvial flooding	Fluvial/ coastal flooding	Heatstress	Drought
Project Development	6	3	50%	0%	33%	67%	0%
Rural water management	3	3	100%	33%	67%	33%	100%
Infrastructure	1	1	100%	100%	0%	0%	0%
Greenery	2	1	50%	100%	0%	100%	0%
Water safety	1	1	100%	0%	100%	0%	0%
Urban planning	2	1	50%	100%	100%	0%	0%

3: urgency							
Out of 20	**Total**	**Responds**	**%**	**Pluvial flooding**	**Fluvial/ coastal flooding**	**Heatstress**	**Drought**
Urban water management	9	9	100%	78%	22%	89%	67%
Project Development	6	2	33%	50%	50%	100%	50%
Rural water management	3	3	100%	67%	67%	33%	100%
Infrastructure	1	1	100%	0%	0%	100%	0%
Greenery	2	2	100%	50%	0%	50%	0%
Water safety	1	1	100%	0%	0%	100%	100%
Urban planning	2	2	100%	100%	0%	100%	0%

Question 4: How do you deal with uncertainties regarding the climate prognoses in your work-activities?

	Data overview and key points
Theme	Irrelevant
Data overview/ quotes	Clients are not working with scenarios. Future developments are uncertain and therefore difficult to quantify. / *You always use certain future developments to get projects executed.*
1	You always use certain future developments to get projects executed.
2	Uncertainty of future developments hinders implementation and execution for clients

	Data overview and key points
Theme	KNMI Scenarios
Data overview/ quotes	The projects must be feasible and efficient in relation to the climate prognoses. / Choose a scenario to avoid too complex outcomes. / Comparison of the effects of the four KNMI-scenarios to start dialogue with clients. / Dealing with uncertainty by designing future-proof measures (adaptable). *"We need to work with growth scenarios. An end goal for the long-term but results for short-terms and the possibility to deviate within the scenarios"*
1	Compare the results of all four scenarios to start dialogue
2	Choose one scenario to avoid too complex outcomes
3	Keep in mind feasibility and efficiency with respect to climate scenarios
4	Design future-proof measures

5	*We need to work with growth scenarios. An end goal for the long-term but results for short-terms and the possibility to deviate within the scenarios.*

Question 5: Does your current knowledge and expertise provide enough action perspective with respect to a climate-proof city?

	Data overview and key points
Theme	Action perspective
Data overview/ quotes	What is climate-proof? We don't have a clear definition yet. / Subjectively we know what we should do, but absolute we don't know how to achieve the objectives. / There is a lot of generic information, but every situation is unique. / We are not yet aware of the 2nd and 3rd order effects. If you don't know the effects of your measures on other domains, it's difficult to start a dialogue with other domains. We need more knowledge on those effects. / We can design measures, but the difficulty lies at the scale of the measures and the dependency with other domains.
1	*What is climate-proof? We don't have a clear definition yet.*
2	*Subjectively we know what we should do, but absolute we don't know how to achieve the objectives.*
3	*There is a lot of generic information, but every situation is unique.*
4	*We are not yet aware of the 2nd and 3rd order effects. If you don't know the effects of your measures on other domains, it's difficult to start a dialogue with other domains. We need more knowledge on those effects.*
5	*We can design measures, but the difficulty lies at the scale of the measures and the dependency with other domains.*

Question 6: Is there a problem owner / initiator for climate-proof cities?

	Data overview and key points
Theme	No, it's not possible
Data overview/ quotes	Climate-proof cities is a shared problem, there isn't one problem owner. Stakeholders don't take responsibility nor initiative.
1	Problem ownership is unclear
2	Stakeholders don't take initiative
3	Stakeholders don't take responsibility

	Data overview and key points
Theme	Yes, the municipality
Data overview/ quotes	The municipality has a key role as director of the public spaces and is ultimately responsible, supported by the other authorities.
1	Municipality is key player as director of public space

2 Municipality should be responsible and is supported by national and regional government

	Data overview and key points
Theme	No, but there should be
Data overview/ quotes	Authorities must give direction. / There is a need for an independent programme director who can find balance. Someone who is responsible for the cooperation between domains and parties. Someone must have affinity with management, specialists, someone with passion for its environment. A Chief Climate Officer. / To some extent, everyone picks up a piece of the problem, for the less obvious issues as heat stress this is less the case, probably because no one feels responsible for this. Everyone must be aware of his input. *"The guys of urban water management are not the guys who implement climate adaptation, but they do have the budgets to do that."*
3	There is a need for an independent director to integrate parties and domains: chief climate officer
4	Every party and domain should be aware of its role and added value
5	*"The guys of urban water management are not the guys who implement climate adaptation, but they do have the budgets to do that."*

Question 7: How are interests from other domains dealt with?

	Data overview and key points
Theme	Depends on project
Data overview/ quotes	Participation depends on the size and nature of projects. / Project leader determines involvement of stakeholders and other domains. / *The efforts for involving stakeholders with respect to the impact on the result is often not considered.* / The matter of successful implementation of different stakes in projects depends on intrinsic motivation, knowledge, scale and perspective of the problem. / Common goals and ambitions, mutual gains and policy approaches give handles for balancing interests. /
1	The nature of the project determines participation level
2	The engagement of relevant disciplines depends on project leader
3	Assessment frameworks help balance interests (Common goals and ambitions, mutual gains and policy approaches (MIRT, law))
4	Implementation of different stakes depends on persons working on the project
5	*The efforts for involving stakeholders with respect to the impact on the result is often not considered*

	Data overview and key points
Theme	Depends on policy
Data overview/ quotes	Sometimes stakeholders are involved only for policy reasons, but the effect is limited, and the solution is already known. / Political influence and whoever shout loudest determine highest stakes. / The one held responsible for the project is the one who has the final decision (board, project leader). / Weighing of stakes should be done objectively, not all stakes can be approved. / A stakeholder analysis provided insights to the importance and the stakes of the stakeholder. / Not all stakes can be heard, to avoid the solution of a project becomes a compromise instead of an effective solution.

1	if and how stakeholders and domains are involved depends on available policy and differs per organizations
2	The one held responsible for the project is the one who has the final decision:
3	Balancing of interest seems to be influenced by the party or person that is responsible for the result.
4	Not all stakes can be heard, to avoid the solution of a project becomes a compromise instead of an effective solution.

	Data overview and key points
Theme	Depends on finances
Data overview/ quotes	Financial aspects are often decisive. / Can solutions or initiatives from municipalities with shared interests for water authorities and provincial authorities also be partly reimbursed by these parties? / The importance of interests is determined by authority / client (that has the budget).
1	Financial aspects are often decisive
2	The importance of interests is determined by authority / client (that has the budget).

Question 8: Is every domain aware of the challenges associated with climate-proof cities?

	Data overview and key points
Theme	No 86%
Data overview/ quotes	"Farmers have requirements to keep their land cultivable, for example a fixed low level, which accelerates soil subsidence is. This traditional approach could lead to completely uncultivable areas within 50 years."/ "If you have not yet experienced a future problem (extreme precipitation e.g.) then you cannot identify with it." / "There is little regard for how things can be done differently and especially when the task doesn't lie within the field of expertise" / "It is crucial that you can translate the challenges into action perspective". "Some people are unconsciously uninformed; others are consciously uninformed." / "People are aware of the fact that climate is changing and the primary impacts, but we are still uncertain about the second and third-order effects of climate change and measures."
1	Difference in generation
2	Knowledge
3	Motivation
4	Action perspective

	Data overview and key points
Theme	Yes 14%
Data overview/ quotes	In general, every domain is aware of the challenges. Within a certain field of expertise everyone is aware of the challenge's 'bubble'. *"I do not meet many people that I still have to convince."*
1	Domain dependent

Question 9: Is the approach for these (future) challenges different from when you started working?

Out of 23	Total interviewees	Interviewees responded	%	Yes	No	Role	Organisation	Content
Urban water management	9	9	100%	89%	11%	11%	44%	56%
Project Development	6	5	83%	100%	0%	0%	40%	60%
Rural water management	3	3	100%	100%	0%	0%	100%	0%
Infrastructure	1	1	100%	100%	0%	100%	0%	0%
Greenery	2	2	100%	100%	0%	0%	50%	50%
Water safety	1	1	100%	100%	0%	0%	100%	0%
Urban planning	2	2	100%	0%	100%	0%	100%	0%

Question 10: Can you identify barriers for an integrated approach?

	Data overview and key points
Theme	Policy
Data overview/ quotes	Not everyone is aware of the problem and their role. / Policy is organized sectoral.
1	Not every person is aware of the challenges and his/her role in approaching these challenges
2	Current policy does not stimulate the integral/ broad approach of the challenges
3	Policy is developed sectoral

	Data overview and key points
Theme	Implementation & finance
Data overview/ quotes	Investment that need to be made to earn profits in other sectors sometimes benefits other owners. / Investments that must be made to earn profits in other sectors are not always valued. / In the revenue model of Arcadis (hours factory) there is too little time to work integrally. / Projects are gained under a competitive price, so there is insufficient budget to have the right expertise in your team.
1	The Arcadis business model makes integral approach difficult
2	Financial systems are organized sectoral
3	Competition limits the opportunities to work integrally

	Data overview and key points
Theme	Organisational

Data overview/ quotes	Assignments of clients are limiting – working integral is not requested. /Mindset at Arcadis: "To determine the question behind the question for clients"/ Assignments to specialists should be broadened in order to stimulate their own initiative. / Arcadis is organized in divisions and advisory groups; each advisory group is responsible for its own workload and profit. / The organisational structure limits the integral approach across the divisions or advisory groups. As a result, specialists from other divisions are less often involved. / Sectoral design impedes integral approach. / Integral working is person related. You must be open to collaboration to work together. "I seek for collaboration, because I think it is necessary." / Time plays an important role. / Insufficient time to build a bridge between different disciplines and specialists. / Cooperation and different diverging interests of parties.
1	Time in projects is limited and impedes integral approach
2	Whether projects are integrally approached depends on the person involved
3	The Arcadis organisation structure (sectoral) makes working integral difficult
4	Questions of clients do not require an integral approach or are limited to a domain

Question 11: Can you identify opportunities for an integrated approach?

	Data overview and key points
Theme	Connect the dots
Data overview/ quotes	Use trends to fulfil the implementation of the transition. / Team capacities play a role in the way projects are implemented. / Combining different themes. / Use sectoral methods that support the broad approach (duurzaam GWW, MIRT). / Use long-term trajectories. / Develop plans that exceed election periods.
1	use trends and make plans that exceed election terms.
2	look at organisation malfunctions.
3	combine different themes.
4	use existing methods that support broad approach.
5	use long-term trajectories

	Data overview and key points
Theme	Appoint leader
Data overview/ quotes	One person or one department should be responsible for execution and implementation. One person should have the overview.
1	one person or department must be responsible
2	one person needs to have the overview

	Data overview and key points
Theme	Take initiative

Data overview/ quotes	Start working across departments to show an example that others can follow. / Working integrally is a process that needs time to be implemented. / Internal reorganizations impede the collaboration between departments, we must put more effort in that.
1	set an example for others by starting to collaborate across departments
2	don't stress the implementation of the integral approach, this needs time

Question 12: Are there topics in your domain that are being tackled integrally?

	Data overview and key points
Theme	Not yet
Data overview/ quotes	Climate-proof cities requires an integral approach. Slowly steps are being taken in this direction, for example with the risk dialogue. / An integral team within Arcadis would be interesting to capture different perspectives on the problem. / Although the sectoral approach of clients justifies our sectoral approach, we must work more integral. / Energy and sustainability surpass departments. Collaboration depends on the departments and the role of people. / Existing structures and systems limit our integral approach.
1	Integral approach for domain surpassing themes is recognized, but not carried out.
2	Sectoral approach at client's organisation justifies sectoral approach within Arcadis.
3	Collaboration depends on departments and roles.
4	Existing structures and systems limit the integral approach.

	Data overview and key points
Theme	Yes
Data overview/ quotes	Flood defence works cannot be executed without support of all parties involved.
1	Fluvial / Coastal flooding is only executed with full support.

Question 13: Are objectives of projects focused on short (about 5 years) or long-term (about 15-25 years) goals?

	Data overview and key points
Theme	Both
Data overview/ quotes	We work with what we know now and adjust gradually to new knowledge. / Not consciously, but the projects require a long-term approach. / We need arguments and instruments to provide a long-term approach. / Policy making is relatively easy for long-term but implementing measures that are future-proof is more difficult in existing urban fabric.
1	Policy making for long-term is feasible, implementing measures is difficult
2	Build structures are realized for the long-term, but long-term adaptation policy is not considered.

3	Arguments and instruments are needed to provide a long-term approach
4	Starting point is working with what is known, and gradually adjust to new situations

	Data overview and key points
Theme	Long term
Data overview/ quotes	Design of flood defence works must be flexible to implement future adjustments or improvements. The long-term for flood defence projects is 50 to 100 years.
1	For flood defence works the objectives are focused on long-term goals.

	Data overview and key points
Theme	Depends on client
Data overview/ quotes	the objectives depend on the client and size clients organisation./ With municipalities the focus lies on the goals achievable within the four years term of office for the aldermen./ Commercial companies have goals related to gain as much profit as possible other goals are subordinate./ Project developers do the minimum of what they have to do, so the municipality or waterboard is responsible for determining the minimum.
1	Commercial companies focus on profit (short-term)
2	Objectives of projects depend on the client and size of clients' organisation
3	Companies that implement policy will only do the minimum of what is needed

	Data overview and key points
Theme	Short term
Data overview/ quotes	Election terms limit the focus on long-term goals. / Adaptation goals in projects are usually short-term. / Future proof measured are not obliged and therefore not considered. / Lack of urgency of long-term goals make it difficult to justify measures. /
1	Election terms limit the focus on long-term goals
2	Lack of urgency of long-term goals make it difficult to justify measures
3	Future proof measures are not obligated and therefore not considered

Question 14: When are goals relevant to you as a person?

	Data overview and key points
Theme	Goals must be appealing
Data overview/	Goals must connect to the perception of the person that has to be appealed by the goals. / Goals must be practical and functional to appeal other disciplines. / Goals must relevant to your discipline to be appealing

quotes

1 Relevant to your discipline to be appealing

2 Connect to the perception of the person that must be appealed by the goals

3 Practical and functional goals, not too abstract, to appeal to other disciplines

Question 15: Do you make use of norms and standards in your work activities?

Current work activities						
Total 23 responses	Total interviewees	Interviewees responded	% responses of total	Yes	Limited	No
Urban water management	9	9	100%	89%	56%	22%
Project Development	6	5	83%	40%	20%	40%
Rural water management	3	3	100%	67%	33%	33%
Infrastructure	1	1	100%	0%	0%	100%
Greenery	2	2	100%	0%	50%	0%
Water safety	1	1	100%	100%	0%	0%
Urban planning	2	2	100%	50%	0%	0%
				15	8	6

Climate related						
Total	Total interviewees	Interviewees responded	% responses of total	Yes	Limited	No
Urban water management	9	9	100%	44%	56%	33%
Project Development	6	5	83%	0%	20%	80%
Rural water management	3	3	100%	33%	33%	33%
Infrastructure	1	1	100%	0%	0%	100%
Greenery	2	2	100%	0%	50%	0%
Water safety	1	1	100%	100%	0%	0%
Urban planning	2	2	100%	0%	50%	50%
				6	8	11

Question 16: Are current standards and norms applicable to the (future) challenges?

	Data overview and key points
Theme	No
Data overview/ quotes	I do not know any standards for heat stress. / It differs per area (existing, new). / My impression is that this still needs to be looked at. / At a certain moment you can't sell the continue adjustment of standards. / There are developments that are happing now which are not future proof, because of the lack of norms.

1 Current norms and standards are insufficient for future developments

2 There are no norms for heatstress

3 Future development requires new norms

	Data overview and key points
Theme	Yes
Data overview/ quotes	For the calculation of stress tests, we look further and further ahead. / Standards and guidelines are ongoing developments. We cannot predict what the future will bring. / What is valid today may be different tomorrow, we should not dwell on that for too long./ It is not the case that those standards no longer meet the challenges, but perhaps something needs to be added to the existing norms.

1 Norms change with new insights

2 Future development requires new norms

Question 17: What are the main future challenges for cities and our society?

Out of 20	Total	Responded	%	Integrate	Sustainability	Circularity	Mobility	Energy	Biodiversity	Liveability	Urbanization	Climate	Social	Digital
Urban water management	9	9	100%	22%	11%	33%	22%	56%	22%	11%	11%	56%	11%	0%
Project Development	6	3	50%	33%	0%	33%	67%	67%	33%	0%	67%	67%	33%	0%
Rural water management	3	3	100%	0%	33%	33%	0%	0%	33%	33%	0%	0%	67%	0%
Infrastructure	1	1	100%	0%	0%	0%	100%	0%	0%	100%	100%	0%	100%	0%
Greenery	2	1	50%	0%	100%	0%	0%	0%	0%	0%	0%	100%	100%	0%
Water safety	1	1	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Urban planning	2	2	100%	0%	0%	0%	100%	50%	0%	0%	0%	0%	50%	0%

Question 18: Which transitions can be identified in your field of expertise?

Out of 23	Total	Responded	%	Integrate	Sustainability	Circularity	Mobility	Energy	Biodiversity	Liveability	Urbanization	Climate	Social	Digital
Urban water management	9	9	100%	0%	11%	22%	0%	11%	11%	11%	0%	89%	11%	0%
Project Development	6	6	100%	0%	0%	0%	0%	83%	0%	0%	0%	17%	0%	0%
Rural water management	3	3	100%	0%	0%	33%	0%	0%	0%	0%	33%	33%	0%	0%
Infrastructure	1	1	100%	0%	0%	0%	100%	100%	0%	0%	100%	0%	0%	0%
Greenery	2	2	100%	100%	0%	50%	0%	100%	50%	0%	0%	50%	50%	0%
Water safety	1	1	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Urban planning	2	1	50%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%

Question 19: Are transitions considered in projects?

	Data overview and key points
Theme	Limited
Data overview/ quotes	Only demography and housing developments are taken into account./ Transitions are different paths and belong to different domains./ The benefits of combining transitions is not insight./ There are a few good project examples where transitions are implemented in projects, but these are rare./ Sustainability and circularity is taken into account, but social transitions aren't./ Circularity is taken into account, but food security should be taken into account./ Liveability is taken into account.
1	Only transitions within the domain of the interviewee are considered
2	The benefits and projections of combined transitions are not considered sufficiently
3	Transitions are not considered structurally.
4	Transitions are viewed from perspective of discipline, but implementation is limited
5	The dynamics (transitions) should be investigated at the beginning of the project
6	Transitions are used to function as charger for policy goals

Question 20: Do you expect changes in your work activities as a result of these transitions?

	Data overview and key points
Theme	Yes
Data overview/ quotes	I think that modelling will become more globally and integrally. / New technologies will be used in our work. / I expect social factors or climate resilience to play a more prominent role. / The way of working and communication is changing. / More application of intelligent information systems, more focus on cooperation with the environment.
1	Social aspects will influence our project scope
2	Models will be more abstract and integral
3	New technologies will influence our work activities
4	Communication and efficacy will change
5	collaboration will influence our work activities

APPENDIX D INTERVIEW RESULTS PER QUESTION

1. What characterizes a climate-proof city?

The answers to this question revealed an overlap that could be summarized by three main labels (Figure A), which are:

- Future-proof
- Liveability
- Dealing with climate aspects

A large part of the interviewees referred to climate-proof cities as future-proof cities. A few used 'future proof' to express the uncertainty of climate change projections and the need for long-term goals and continuous monitoring, while others used future-proof as replacement for climate-proof to capture the full range of transitions. In coherence with these transitions, interviewees mentioned the need for an assessment framework in order to make well-considered choices in designing future-proof cities.
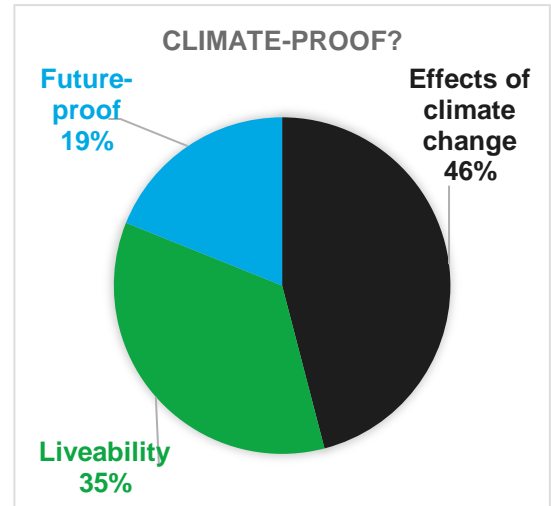
Another commonly used term is liveability. Liveability is further described by the interviewees as a nice, social, vital, decent place to live and work. Liveability is related to future- and climate-proof. Although liveability is highly subjective, the approach and execution of a climate-proof and future-proof city will define the liveability of a city. An experienced project leader mentioned that 'in 100 years the level of liveability should be equal or preferably better than it is now'.

CLIMATE-PROOF?

Future-proof 19%
Effects of climate change 46%
Liveability 35%

Figure A Description of a climate-proof city

Most interviewees refer to the climate-proof aspects to describe climate-proof cities. The Deltaplan [11] acknowledges four main aspects identified with climate change, namely pluvial, fluvial or coastal flooding, heatstress and drought. The respondents that mention these four aspects is limited (Table A). Pluvial flooding and heatstress are quoted most, respectively 71% and 62% and only 24% of the interviewees mentioned fluvial/ coastal flooding as a climate aspect. Both Urban water management and Project development departments were aware of four different climate aspects, on the contrary the other departments seem to be unaware of fluvial/ coastal flooding and drought situations. The shared responsibility towards these issues seems to be lacking. The interviewees are also questioned on climate aspects in question 2 and 3 of this topic.

Table A Percentage of respondents that mentioned climate aspects to explain climate-proof cities.

Question #1: **Climate aspects**							
Out of 21	**Total**	**Responses**	**%**	**Pluvial flooding**	**Fluvial/ coastal flooding**	**Heatstress**	**Drought**
Urban water management	9	9	100%	56%	44%	56%	56%
Project Development	6	4	67%	75%	25%	50%	25%
Rural water management	3	2	67%	50%	0%	50%	0%
Infrastructure	1	1	100%	100%	0%	100%	0%
Water safety	1	1	100%	100%	0%	0%	0%
Urban planning (including greenery)	4	4	100%	75%	0%	75%	25%

2. What challenges do you see for achieving climate-proof cities?

Climate-proof cities is acknowledged to be a challenge that needs input from and cooperation with different sectoral domains and themes regarding the public space. A vast part of the interviewees appointed the use of an integral approach as main challenge to achieve climate-proof cities. This challenge is mentioned for both the design and the execution phase of projects. In the design phase a challenge that's often referred to is the lack of possibilities in shared financing. The current tax system and cost-benefit structure doesn't seem to be in line with the apparent need for shared finances *"Collaborate and finance and finance together".* In the execution phase this integral approach is challenging for already existing build environment. *"How can you align various existing structures with a desired future city perspective in an area with limited space?"* [interviewee 18].

Policy for achieving climate-proof cities exists on abstract levels (GRP, Deltaplan), but the translation towards implementable measures lacks. This is partly caused by the lack of norms and regulation. *"Project developers don't invest more than minimum. If there is no climate-proof policy, they won't implement it"* [interviewee 3].

The sectoral approach is limiting the achievement of climate-proof cities. As one interviewee (22) stated: "We all say, 'it is not possible', but it is possible you only should want it". "Technically everything is known, but the implementation depends on collaboration amongst domains and companies" [interviewee 24].

3. Which aspect of climate change is most relevant in your field of expertise and which aspect do you see as urgent?

You might expect an overlap in these two results. Since people tend to think about their own topic as being most urgent. The opposite is found in the results (Table B). The aspect identified by a domain as most urgent is not the aspect they consider part of their field of expertise.

Table B Aspect of climate change relevant to field of expertise vs. urgency

Question #3: Expertise vs. Urgency		Pluvial flooding		Fluvial/ coastal flooding		Heatstress		Drought	
	Total	Expertise	Urgency	Expertise	Urgency	Expertise	Urgency	Expertise	Urgency
Urban water management	9	100%	78%	0%	22%	29%	89%	14%	67%
Project Development	6	0%	50%	33%	50%	67%	100%	0%	50%
Rural water management	3	33%	67%	67%	67%	33%	33%	100%	100%
Infrastructure	1	100%	0%	0%	0%	0%	100%	0%	0%
Greenery	2	100%	50%	0%	0%	100%	50%	0%	0%
Water safety	1	0%	0%	100%	0%	0%	100%	0%	100%
Urban planning	2	100%	100%	100%	0%	0%	100%	0%	0%

Comparing both answers a few differences and similarities can be noticed:

- Interviewees of urban water management, rural water management, greenery and urban planning identify pluvial flooding as their field of expertise, but they all point another aspect of climate-proof cities as being the most urgent.
- Fluvial/ coastal flooding is the field of expertise of the department water safety. This department identifies heatstress and drought as most urgent.
- Rural and Urban water management indicate their own fields of expertise as urgent.

4. How do you deal with uncertainties regarding the climate prognoses in your work-activities?

The majority of the interviewees used the KNMI scenarios to present and compare the impacts of different climate change scenarios and at the same time, a few interviewees mentioned two contradictory reasons regarding the effect of uncertain climate prognoses:

1. The future is always uncertain, but this uncertainty is used to get projects executed (pressure)
2. Projects aren't executed because the uncertainty hinders the implementation and execution with clients.

A possible solution to the second effect is given by one of the interviewees that do use KNMI-scenarios: '*"We need to work with growth scenarios. An end goal for the long-term but results for short-terms and the possibility to deviate within the scenarios"* [interviewee 15]. The use of the KNMI-scenarios differs amongst the respondents. Sometimes only the worst-case scenario is chosen to reveal the possible impacts, mainly to avoid too complex decision making. In other projects the four scenarios are compared in order to start a dialogue on risks and prevention levels.

5. Does your current knowledge and expertise provide enough action perspective with respect to a climate-proof city?

Overall the general opinion (by more than half of the respondents) is that the definition of climate-proof cities and the measures are not defined well enough to create an increase in action perspective. The quotes below capture some of the barriers in the action perspective.

"What is climate-proof? We don't have a clear definition yet" [interviewee 5]

*"Subjectively we know what we should do,
but absolute we don't know how to achieve the objectives"* [interviewee 9]

*"We are not yet aware of the 2nd and 3rd order effects. If you don't know
the effects of your measures on other domains, it's difficult to start a dialogue with other domains.
We need more knowledge on those effects"* [interviewee 12]

*"We can design measures, but the difficulty lies
at the scale of the measures and the dependency with other domains"* [interviewee 19]

6. Is there a problem owner / initiator for climate-proof cities?

In the current situation, there is no clear problem owner for climate-proof cities (Figure B), but the interviewees recognize the need for a problem owner and initiator for these challenges, a "Chief Climate Officer" of a "programme director" [interviewees 15 & 21]. "You need an independent programme director who can balance everything equally" [interviewee 15]. Even if a part of the challenges such as pluvial flooding is being picked up by multiple organizations, the different organisational layers and integral character make implementation complex. No ownership is recognized by the different interviewees for the less visible issue heatstress, since "no one feels responsible for this" [interviewee 3].

Most interviewees state that there should be a problem owner to appoint responsibility. One interviewee mentions that *"there is no cohesion. Lack of working integral is caused by complexity and lack of vision on the whole objective. No one is held responsible for the whole. One person is responsible for climate but another one is responsible for energy transition"* [interviewee 16]. Another respondent recalls the difficulty in responsibility versus possibilities *"the department responsible for the execution of policy and urban water management measures own the budgets but are not the ones responsible for climate adaptation"* [interviewee 20].

While some indicate the municipal organisation as responsible party for the design of public spaces and therefore also climate adaptation, at the same time interviewees mention that climate-proof cities are a shared problem, and therefore it's difficult to assign one problem owner. Furthermore, the difficulty of ownership caused by the numerous layers and interests of other organizations and stakeholders.
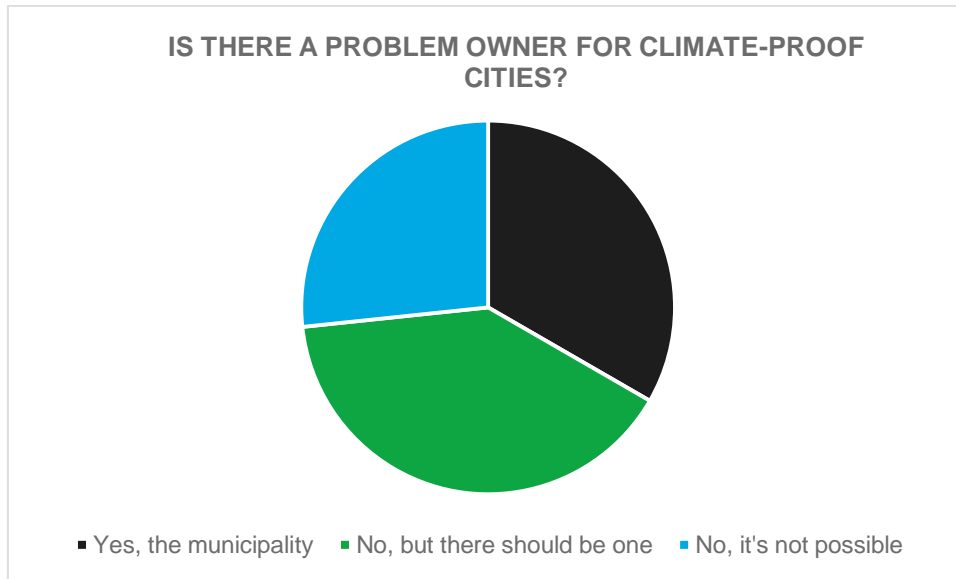
IS THERE A PROBLEM OWNER FOR CLIMATE-PROOF CITIES?

■ Yes, the municipality   ■ No, but there should be one   ■ No, it's not possible

Figure B Interview result problem ownership for climate-proof cities

7. How are interests from other domains dealt with?

Interests are dealt with in different ways. On the one hand, senior colleagues believe it depends on leading policy or the nature and size of a project, on the other hand, medior colleagues refer to finances being the main driver for dealing with interests. For all themes (project, policy and finances) can be concluded that the one held responsible, whether that means responsible for project, budget or politics, is the one making the final decision. Therefore, the way and extent to which other domains are invited to share their interests or knowledge highly depends on the person in charge.

The way interests are dealt with differs amongst colleagues. One interviewee indicated that all interests are heard and collected but mentions a difficulty in the approval of the stakes: "not all stakes can be approved" [interviewee 3]. Assessment frameworks help balance those interests, for example mutual gains or policy approaches (MIRT, law) [interviewees 11, 14 & 23].

Whereas another colleague remarks that not all interests can be heard to avoid the solution of a project becoming a compromise instead of an effective solution [interviewee 5]. Assuming that most domains have diverging stakes. Another colleague expressed his concerns towards the involvement of other domains: "the efforts for involving stakeholders with respect to the impact on the result is often not considered" [interviewee 19]. He strongly suggested to consider which domains to involve and the period of involvement.

8. Is every domain aware of the challenges associated with climate-proof cities?

The pie-chart (Figure C) provides the quick answer to this question. A vast majority of 86% thinks that not every domain is aware of the challenges associated with climate-proof cities against 14% who believe all domains know what climate-proof cities is aiming for. Of that 14% 2 out of 3 respondents are identified as junior colleagues. This could have to do with recent education about integral topics. As one relatively recent graduated interviewee noticed at the topic 'integral approach' "For me integral working makes sense and is logical, but I recently found out at a tender that the department head indicated the tender as a specialty because of the integral character" [interviewee 3].

A specialist mentioned specifically that "on general terms everyone is aware of the challenges" [interviewee 5]. In addition to that another interviewee remarked the following: "People are aware of the fact that climate is changing and the primary impacts, but we are still uncertain about the second and third-order effects of climate change and measures" [interviewee 11]. A colleague working at project

AWARENESS OF CHALLENGES CLIMATE-PROOF CITIES
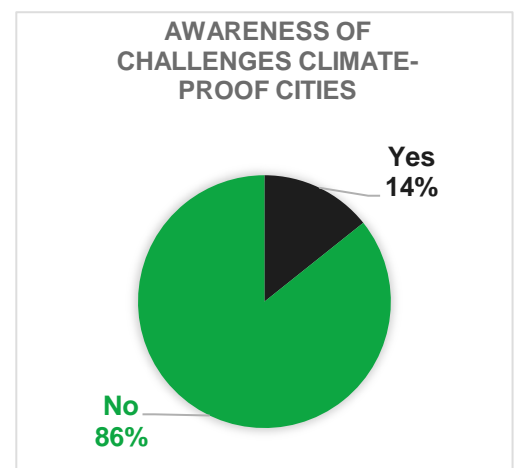
Yes 14%

No 86%

Figure C Awareness at domains of challenges associated with climate-proof cities

development found it hard to believe that not everyone is aware since it's highlighted in the news almost every day. However, he added that he works at a department that must deal with transitions (energy), so he often talks with equally minded colleagues. In contrast with this opinion some respondents believe that persons are consciously uninformed, with the result that they don't (have to/ want to) take responsibility or measures.

9. Is the approach for these (future) challenges different from when you started working?

Almost all interviewees from the different domains responded YES unanimously to the question whether the approach of the current challenges has changed compared to when they started working (Figure D). All domains confirmed, except urban planning. Both interviewees answered negative to the question. Although a negative response would be expected from the interviewees identified as junior (0-3 years working experience), since the approach would not have changed over time so fast, the opposite of this hypothesis is found in the results.
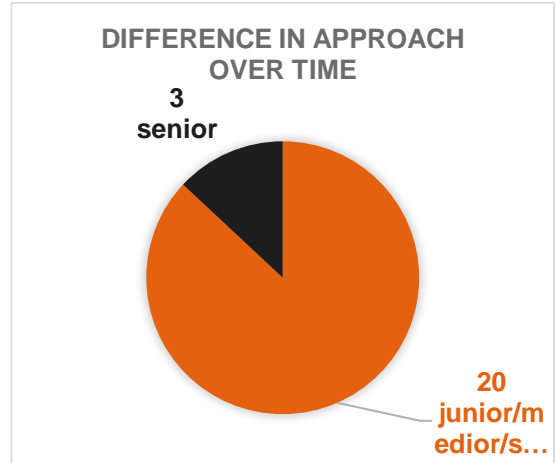
A total percentage of 55% of the interviewees indicated that the approach changed organisational wise, being focused on an integral approach instead of a sectoral one. These respondents all mention a need for or an already executed integral approach. As one interviewee said: *"We think beyond borders of our own discipline"*, *"In practice we – at Arcadis – sometimes miss the overview due to project-based assignments"* [interviewee 15]. A project leader from Rural water management mentioned the increasing participation of stakeholders within projects over time. An ecologist stated a possible downside of this increasing participation, namely "blending in of all stakes instead of differentiating to optimize".

Figure D Difference in approach of (future) challenges over time

Table C Difference in past vs. current approach of work activities

Question #9: Past vs. current approach of work activities								
Out of 23	Total	responses	%	Yes	No	Role	Organisation	Content
Urban water management	9	9	100%	89%	11%	11%	44%	56%
Project Development	6	5	83%	100%	0%	0%	40%	60%
Rural water management	3	3	100%	100%	0%	0%	100%	0%
Infrastructure	1	1	100%	100%	0%	100%	0%	0%
Greenery	2	2	100%	100%	0%	0%	50%	50%
Water safety	1	1	100%	100%	0%	0%	100%	0%
Urban planning	2	2	100%	0%	100%	0%	100%	0%

45% of the respondents mentioned content related aspects as the reason for the altered approach (Table C). The projects are not limited to the discipline itself, but also include relevant social themes and transitions as well. An interviewee from urban water management stated *"our work is no longer limited to underground infrastructures but also infrastructure aboveground"* [interviewee 5]. A project developer pointed at the importance of the internal Arcadis strategy *"the specific focus points on energy transition and climate adaptation brings more perspective to the approach"* [interviewee 18].

While most respondents thought about differences in project organisation and content, two interviewees mentioned a change in role of Arcadis as a design and consultancy company. For many years, the expertise of a design and consultancy company was limited to the assignment given by the clients. A senior project leader [interviewee 12] pointed out that the role of Arcadis nowadays consists more and more of participation to shape ideas and visions at the side of the client. However, respondents form Urban planning mention the limitations of clients who don't have policy to approach certain problems [interviewee 14 & 22]. These clients lack means to approach issues therefore Arcadis' role to advise on those issues is limited. Another respondent mentioned the need to work together with other companies to cover the full range of themes (transitions) [interviewee 16].

10. Can you identify barriers for an integral approach?

To analyse the results, the PRIMO framework was applied on the answers. All the answers were either policy, implementation & finance or organisation related (Figure E). Regulation nor maintenance related barriers were identified by the interviewees. For all three categories, the respondents mentioned the sectoral approach as a barrier in the integral approach this is elaborated at the bullets below:

- Policy is developed sectoral. As a result, the execution of policy is also sectoral or doesn't stimulate an integral approach.
- Financial systems are organized sectoral. Investments that must be made should benefit the investor for most part, while benefits could also be gained at other domains.
- Organisation are sectoral (or vertical) which makes working together not a usual way of working.
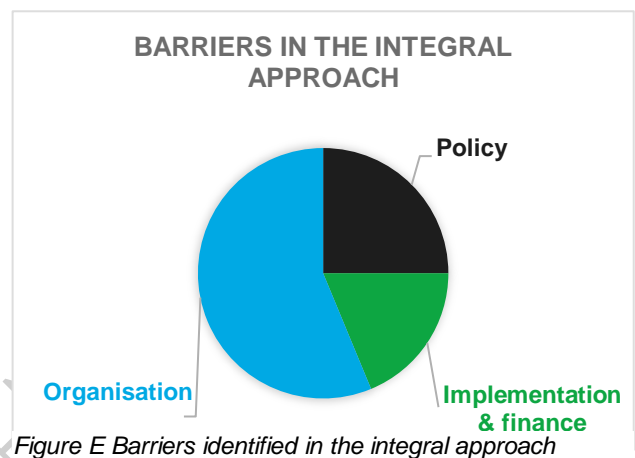

Figure E Barriers identified in the integral approach

Respondents reasoned either from Arcadis' of clients' perspective. Barriers specifically addressed to the design and consultancy company are:

- Questions/ assignments of clients are often formulated for one domain, so there is no need for Arcadis to form integral teams.
- The Arcadis business model (payed per hour) and competitive tenders limit the opportunities to work integrally. Here the assumptions are made that working integrally costs money.
- It highly depends on the project leader whether other domains are involved in a project. Every department is responsible for its own workload and profit, so project leaders rather work with their colleagues within the department.
- Time is limited in projects, which makes involving other domains more difficult. If involving other domains cost money.

11. Can you identify opportunities for an integral approach?

Besides the barriers, interviewees indicated some opportunities to work integral. Amongst the respondents 60% replied that the opportunities can be found in 'connecting the dots'. They stress the importance of using long-term trajectories and trends to give direction to the integral approach. Furthermore, they mention the need for plans that exceed election terms and the usefulness of combining different themes.

The other 40% of the respondents indicate that leadership and taking initiative can embed the integral approach more. This group calls for personal action and a clear role for leaders. One person or department should have the overview and be responsible in the integral approach. Additionally, one interviewee said "set an example for others by starting to collaborate across departments" [interviewee 3].

12. Are there topics in your domain that are being tackled integrally?

This question shows an overlap with the question about transitions, since transitions require an integral approach. The overall answer for all domains was "not yet", except for the flood defence projects. According to two interviewees who answered positive to this question [interviewees 10 & 23], flood defence works cannot be executed without full support of all parties involved. The other respondents who answered not yet referred to the barriers they encounter in the integral approach as presented at question 10. In addition to

question 11, one respondent mentioned: "An integral team within Arcadis would be interesting to capture different perspectives on the problem".

13. Are objectives of projects focused on short (about 5 years) or long-term (about 15-25 years) goals?

Objectives in flood defence projects are solely focused on long-term goals. For other domains the answer was differentiated (Figure F).

Short term goals in projects are often related to the election terms for governmental organizations. An alderman wants to make an impact and realize something tangible. In addition to these objectives a respondent acknowledged the difficulty in the justification of measures – and investment of money – with respect to possible long-term situations.

Whether clients are focusing on long-term goals depends on the size and type of organisation. Commercial companies want to gain the highest profit as possible which often impedes the execution of long-term goals. When it comes to municipalities one respondents elaborated the difference in goals depending on the size: *"a small municipality does not make a climate-proof plan for 2060. They think about it but do what they always do. They also do not have a lot of problems. Larger municipalities (with large urban areas) are much more aware of these climate-proof challenges"* [interviewee 1]. In addition to this difference a division can made in the project steps. *"It is easy to design policy for long-term projections, actually implementing measures in an existing urban area is something else* [interviewee 18]*"*. Therefore, in projects the way goals are considered is often *"working what we know now and adjust gradually to new knowledge"* [interviewees 8, 10 & 16].
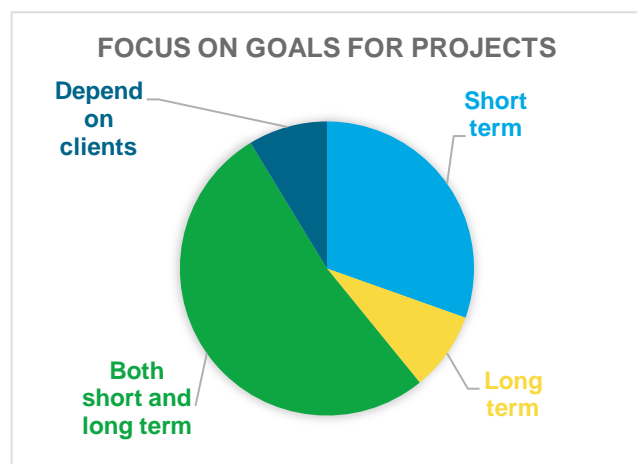

Figure F Focus of objectives in projects to achieve goals

14. When are goals relevant to you as a person?

During analysis of the interview result this question was found not relevant for the aim of this research. Nevertheless, the data overview and key-points are included in Appendix C.

15. Do you make use of norms and standards in your work activities?

The answer to this question is divided in two parts. First the use of norms and standards for current work activities is presented. Secondly the use of norms and standards for climate related work activities is displayed.

A difference in usage is noticeable for the functions of the interviewees (Figure G). On the one hand project leaders and advisors, who are less often doing the actual engineering work, indicate that the use of norms and standards is limited or (almost) nihil. On the other hand, most specialists acknowledge the use of norms and standards in their current work activities, which is also expected. The use of norms per domain is visualized for in Appendix C.
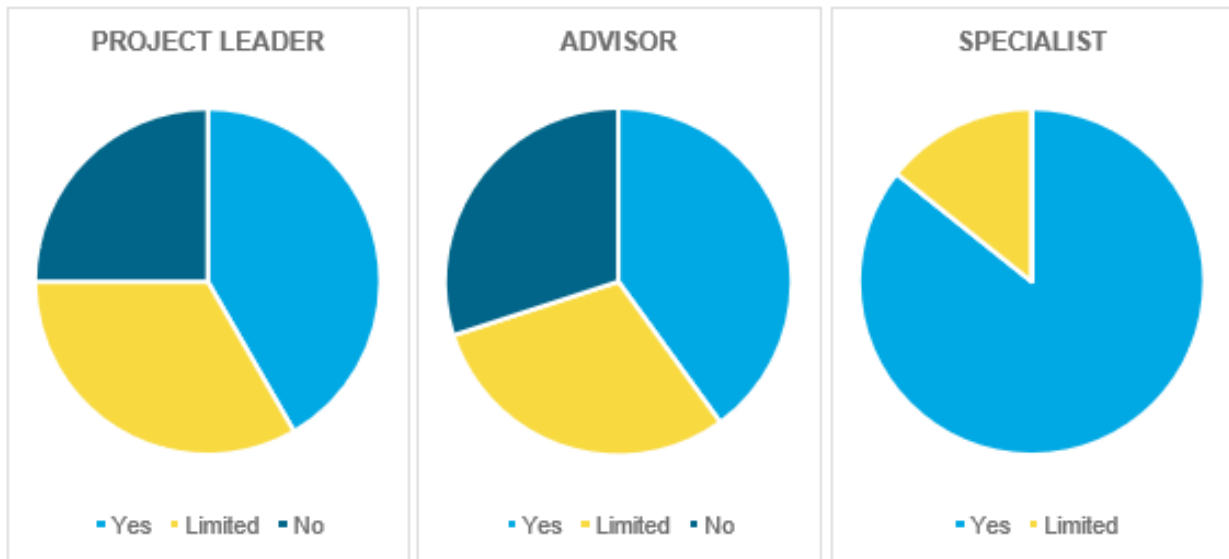
Figure G Difference in use of norms and standards between functions of interviewees (current work activities)

The usage of norms and standards in current work activities compared to climate related activities is significantly higher (Figure H). Here the respondents mention the lack of useful norms as a reason for not being able to use norms and activities: *"they don't or barely exist"* [interviewee 10]. Clients seem the struggle with this lack of norms. An advice from an interviewee to these clients: *"When there's no standard yet: do not wait until there is one. You can do a lot without standards. The standard will only provide more grip"* [interviewee 16]*.*
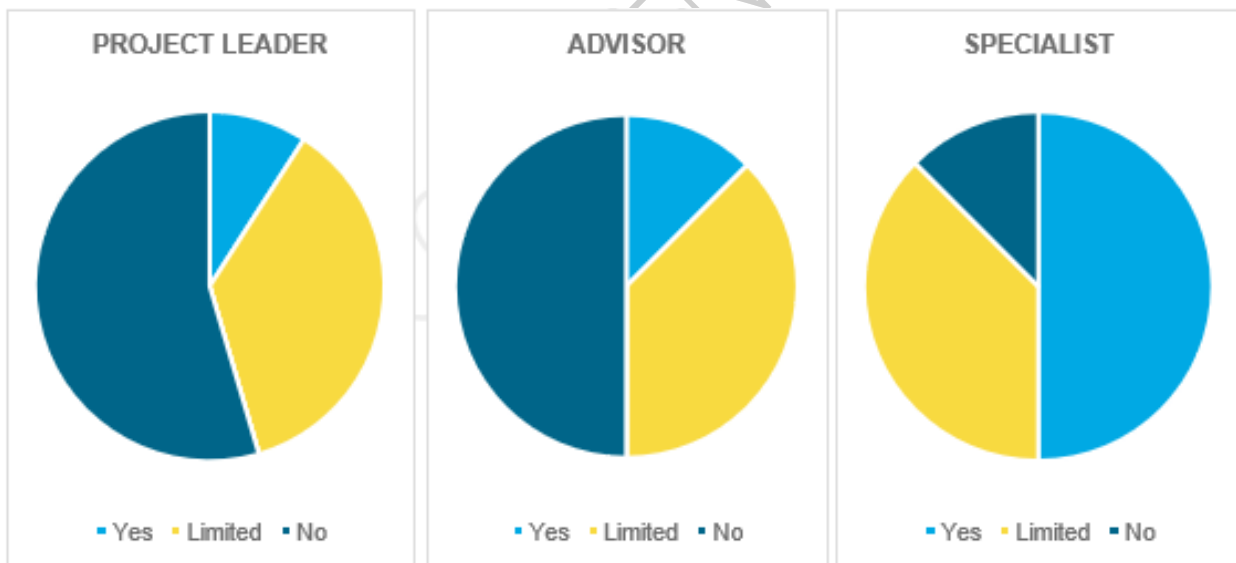

Figure H Difference in use of norms and standards between functions of interviewees (climate-related work activities)

The answers to this question show opposite results for the use of norms and standards with current work activities compared to climate related work activities. This result is visualized best by grouping all domains together for the same answer (Figure I).
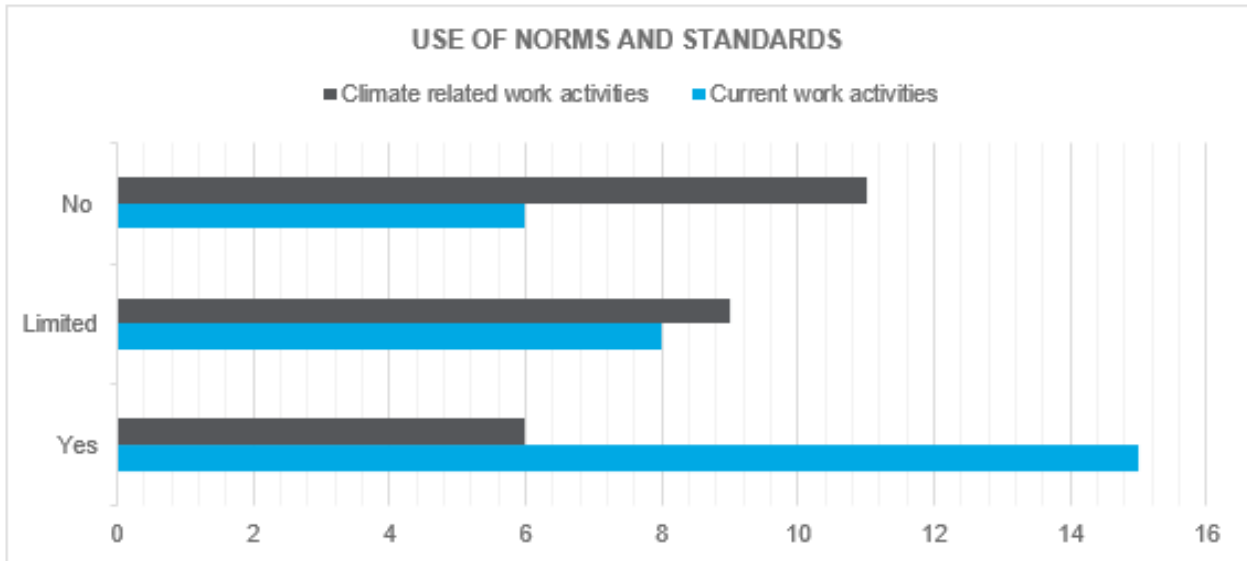
Figure I Use of norms and standards current work activities vs. climate related work activities

16. Are current standards and norms applicable to the (future) challenges?

Whereas the answers are categorized in 'yes' and 'no', most of both groups agree that future developments require new norms. Norm changes with new insights, since *"we cannot predict what the future will bring"* [interviewee 4]. New norms can be created by adjusting existing norms, for example increasing the volume of a rain event for capacity modelling discharge solutions in the public space. Another opportunity is to develop completely new norms. A gap that interviewees indicated is a not yet existing norm for heatstress [interviewees 10, 12 & 16].

17. What are the main future challenges for cities and our society, and which can be identified in your field of expertise?[3]

Despite that this question was initially split in two questions, combining the results gives an overview of the identified challenges and the field of expertise to which these challenges according to the interviewees belong. Figure J shows these results. Arcadis' strategy and vision are focused on sustainability: 'Designing a world for the next generation'. However, sustainability isn't indicated as a main challenge and even less interviewees recognize this challenge as a transition within their field of expertise.

The most frequently mentioned future challenges are:
1. Climate & Energy
2. Social & mobility

Both climate & energy and social & mobility were equally mentioned. Looking at the future challenges identified as part of interviewees' field of expertise, the ranking is as follows:
1. Climate
2. Energy
3. Circularity

While social and mobility are mentioned as main challenges, these are not frequently recognized as transitions within the field of expertise. For mobility this is expected, since only one respondent is related to the infrastructure department. However, social challenges such as awareness, vitality, behaviour, etc. can be found within all domains. As one interviewee mentioned: *"Instead of a solely climate-proof city, it should become a vital city. Where you are challenged to exercise, feel happy and be healthy"* [interviewee 20,]. In addition to social aspects, liveability is referred to as a future challenge surprisingly by only a few respondents. While interviewees referred to the importance of liveability at question 1.

---

[3] *Interview results of question 17 and 18 combined.*

Last remark at Figure J is the absence of 'digital' as being a main challenge for cities and society. Digital is a focus point in the current Arcadis strategy (2018-2020) and is viewed by experts as the main challenge we are facing for cities and society.
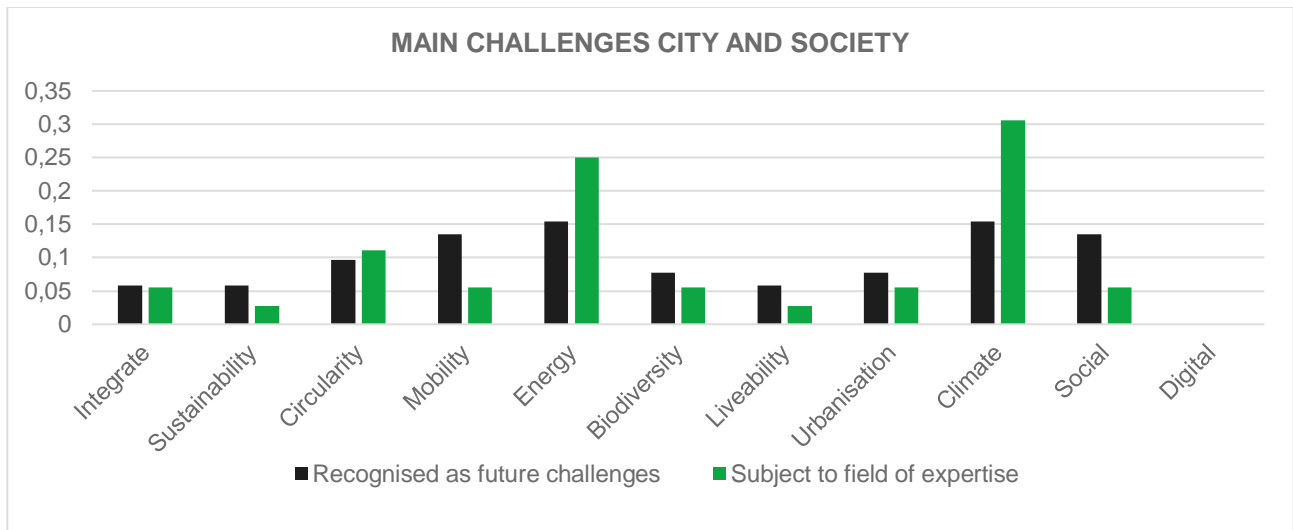

MAIN CHALLENGES CITY AND SOCIETY

■ Recognised as future challenges   ■ Subject to field of expertise

Figure J Main challenges city and society

Zooming in on the most referred to transitions energy and climate a difference in field of expertise is noticeable (Figure K). Energy is indicated as subject in the field of expertise of the department of project development. In this department also the colleagues of energy and sustainability are united, so this is result was expected. Remarkably greenery also refers to the energy transition as their field of expertise. Analysing the answers this is due to the biodiversity gained or lost by increasing energy efficiency of buildings. As one ecologist pointed out *"the poorer a building is isolated, the higher the chance for protected species"* [interviewee 7].

Urban water management recognizes climate as part of their field of expertise. Within Arcadis challenges regarding climate-proof cities were explored by urban water management years ago. For pluvial flooding and drought in urban areas projects are often initiated at urban water management. Other domains that acknowledge climate as their field of expertise are also important players in the domain of public spaces. Rural water management has specific knowledge about drought and fluvial flooding. Greenery can add their expertise of cooling systems by vegetation to deal with heatstress and secure the biodiversity. Project development can connect the dots with other transitions. A domain that was expected in the pie chart is urban planning. Since they have the overview of developments in the public space and are responsible for the overall design concept.
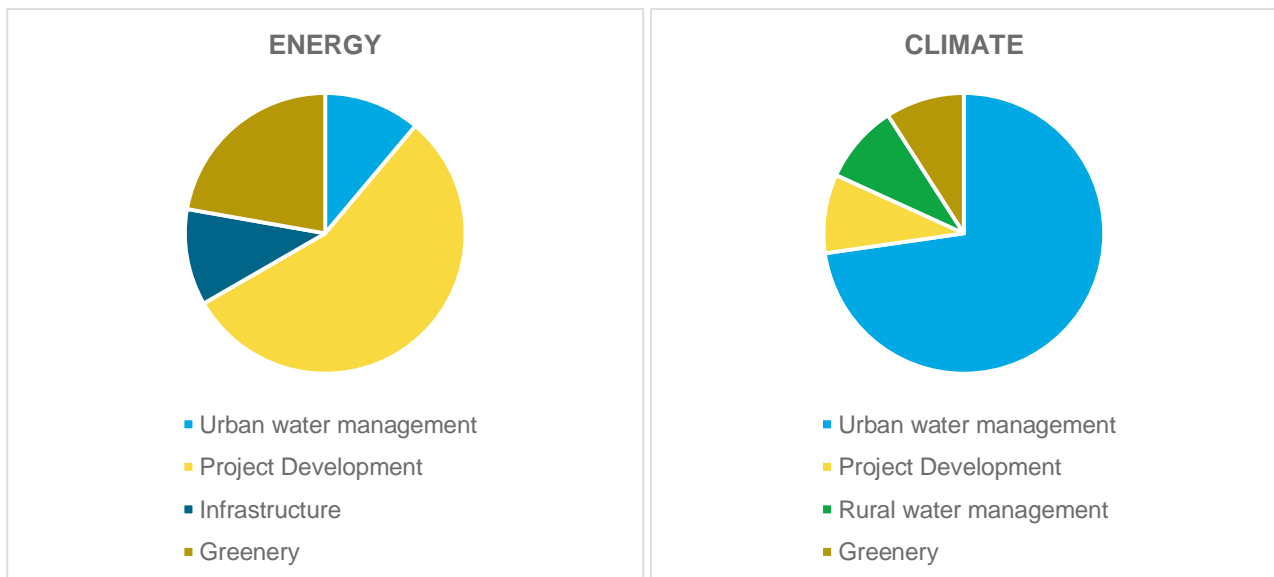

ENERGY

■ Urban water management
■ Project Development
■ Infrastructure
■ Greenery

CLIMATE

■ Urban water management
■ Project Development
■ Rural water management
■ Greenery

Figure K Transitions energy and climate as subject of field of expertise

18. Are transitions considered in projects?

All interviewees agreed that the extent to which transitions are subject of projects is limited. Transitions within the domain of the interviewee are considered. *"Persons involved in the energy transition are not involved in smart mobility. These are separate approaches"* [interviewee 22]. While one respondent mentioned that the benefits of combining transitions are not included sufficiently, another respondent recalled the approach of a municipality where the advice was to *"deal with transitions separately, because it will become too complex and extensive if you do otherwise"* [interviewee 10]. The projects where transitions were considered remain *"the good project examples, but these are rare"* [interviewee 24]*.*

19. Do you expect changes in your work activities as a result of these transitions?

During analysis of the interview result this question was found not relevant for the aim of this research. Nevertheless, the data overview and key-points are included in Appendix C.

APPENDIX E RESULTS VERIFICATION

The barriers found during this study were verified by an expert-group. The experts were employed at three different Dutch design and consultancy companies. Table D gives an overview of the respondents and their background. Table E shows the result of the verification step.

Table D Difference in past vs. current approach of work activities

#	Domain	Company	Role
1	Urban water management	Aveco de Bondt	Domain leader urban water and sewer
2	Urban water management	Aveco de Bondt	Senior advisor urban water
3	Urban water management	Witteveen+Bos	Team leader urban water
4	Urban water management	Sweco	Senior consultant urban water
5	Urban water management	Tauw	Consultant climate adaptation

Table E Difference in past vs. current approach of work activities

	Barrier	Agree	Disagree
Policy	Unclear definition of climate-proof results in differentiated interpretation of goals, roles and responsibility	67%	33%
	Domains are unaware of challenges	80%	20%
	Lack of vision and ambition in policy documents	50%	50%
	Decision making is not objective but depends on politics, people, finances	50%	50%
	Lack of policy on transitions limit further implementation	60%	40%
	Policy is often formulated sectoral	100%	0%
	Election terms of governments limit long-term approach (Politics)	60%	40%
	Policy depends on organisation (commercial = profit) and size of government	80%	20%
Regulation	Lack of norms impedes translation of policy into measures	50%	50%
	New situations require new of adjusted norms	20%	80%
Implementation & finance	Implementation of measures in existing urban area is difficult	33%	67%
	Current financial system is not in line with need for adequate cost-benefit division	60%	40%
	Complexity of integral projects hinder implementation	80%	20%
	Implementation is difficult due to extensivity	80%	20%
	Possible long-term situations clash with investment for measures: justification	80%	20%
	Current financial system (budgets) is not in line with need for climate-proof projects.	40%	60%
	Current financial system (budgets) is not in line with need for total climate-proof	75%	25%

challenges.

	Sectoral approach instead of integral approach due to competition	25%	75%
	Problem owner, role and responsibility are unclear	80%	20%
Organisation	Role & responsibilities towards transitions are unclear	80%	20%
	Knowledge about climate-proof cities is insufficient	40%	60%
	Projects from clients are often focused on one domain	71%	29%

APPENDIX F ARCADIS STRATEGY CLIMATE ADAPTATION

KLIMAATADAPTATIE

KLANTEN KLAAR VOOR DE TOEKOMST

Klimaatverandering is een actueel en urgent thema – en blijft dat de komende jaren. Het is de belangrijkste dreiging voor onze bebouwde omgeving in de komende periode. Denk bijvoorbeeld aan meer extreme buien, overstromingen, hittestress en droogte. Onze klanten zijn zich meer dan bewust van de uitdagingen: klimaatadaptatie staat op al hun agenda's. Wij zijn een strategische partner in de aanpassing van de bebouwde omgeving aan de gevolgen van het veranderende klimaat. Met onze ervaringen uit Nederland én de rest van de wereld helpen we steden, ontwikkelaars, investeerders en industrieën. Dit doen we door samen met hen adaptatiestrategieën en actieplannen op te stellen én ervoor te zorgen dat ze worden uitgevoerd.
Hiermee dragen we direct bij aan een sustainable future.

WE BEREIKEN ONZE AMBITIE OP KLIMAATADAPTATIE DOOR:

- Ons profiel te versterken door onderscheidende integrale oplossingen en voorstellen te ontwikkelen. Daarmee worden we gezien als partij met een brede, integrale aanak.
- Onze marktfocus uit te breiden naar andere publieke, private en industriële sectoren. Denk hierbij aan RWS, provincies, FI's en O&G Proposities.
- Onze proposities te verrijken met kennis van en ervaring met assetmanagement en life cycle costing.
- Digitale en datagerelateerde proposities (data mining, benchmarking) samen met onze GEC's. te ontwikkelen.
- Ecosystemen te creëren met strategische partners. Samen ontwikkelen we state-of-the-art-oplossingen, inclusief digitale concepten.
- Samen met groeiprioriteit O&M en innovatieprioriteit Duurzaamheid in de markt op te trekken met de Taskforce Stadsontwikkeling.
- Gebruik te maken van de kennis en ervaring van collega's uit Europa. We verbeteren daardoor samen onze proposities en imago als wereldspeler.
- Jaarlijks aanzienlijk te investeren in de ontwikkeling van producten, proposities en marktcampagnes.

'Klimaatadaptatie is een spannend en uitdagend onderwerp om aan te werken. Het is urgent - de kranten staan bijna elke dag weer vol met de gevolgen van het veranderd klimaat - en elk aspect van de gebouwde omgeving heeft er mee te maken. Als Arcadis hebben we natuurlijk ontzettend veel te bieden op dit onderwerp. Veel disciplines komen bij elkaar: de afgelopen anderhalf jaar werkte ik aan projecten en proposities met collega stedelijk waterexperts maar ook economen, duurzaamheidsexperts, waterbeheerders en gebiedsontwikkelaars. Die variatie maakt het onderwerp zo boeiend en dat ik bij elk project weer iets leer. '

Robert de Kort

Sabrina Helmyr
Focus: Klimaatadaptatie

Lees meer over inspiratie / Klimaatadaptatie

ARCADIS | Design & Consultancy for natural and built assets

COLOPHON

THE BARRIERS A DESIGN AND CONSULTANCY COMPANY ENCOUNTER IN ITS EFFORTS TO CREATE CLIMATE-PROOF CITIES
SO CLOSE, YET SO FAR?

CLIENT
Arcadis

AUTHOR
Nadi Luiten-Modderman

OUR REFERENCE
Version E

DATE
3 June 2019

Arcadis Nederland B.V.

P.O. Box 220
3800 AE Amersfoort
The Netherlands
+31 (0)88 4261261

www.arcadis.com