ECOLOGY IN URBAN DEVELOPMENT

the potential of systems thinking to make ecology a more prominent concept in urban development

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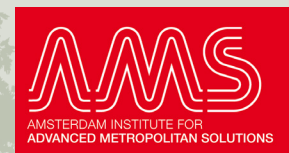t.bouma@tudelft.nl

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PREFACE

This is the last piece of my study career, my master thesis. It all started with the search for a thesis subject. Throughout my MADE career, I have always tried to focus on subjects like climate adaptation, water systems and greening the city. My interests have grown, especially for the last subject during my Living Lab, one of the final courses of the MSc MADE, for Urgenda's Meer Bomen Nu. Together with two fellow students, we have tried to create a method that helps find new planting sites for trees that contribute to climate adaptation in cities. Gaining the knowledge about this being not as easy as it sounds and being very relevant in today's heating up world, I knew I wanted to continue with my thesis on greening the city. While searching for a more specific topic, I stumbled upon a vacancy of Arcadis, Sustainability in the Built Environment, which screamed MADE. I applied, explained my field of interest and together with one of my supervisors, who was interested in the role of systems thinking in urban development, we came to the final topic of *the potential of systems thinking to make ecology more important in urban development*.

Writing this thesis has been a process with many ups and downs, loving and hating the research subject alternately but also moments simultaneously. I would like to thank Clemens Driessen and Teake Bouma, my supervisors from Wageningen University and the Technical University of Delft, for their guidance throughout this research process. Your knowledge and enthusiasm have been a great source of inspiration, feedback, and advice. Although sometimes you have turned my highs into lows, I am very happy with the collaboration we had and the help you have given me for turning this research in something with impact and eventually also turning my lows into highs.

Second, I would like to thank my Arcadis supervisors, Marjolijn Versteegden and Eva Gaaff, for the weekly check-in moments and guidance throughout the process. You have helped me with brainstorm moments, feedback, and support in also a process of personal development.

I am grateful to my friends and family, who had to deal with me throughout the process and were the listening ear when I had to complain again. Last but not least, I want to thank my fellow Arcadis interns who made life as an intern easier and more fun and who I could always go to if I needed help or a quick brainstorm session.

Henriette

ABSTRACT

Changes to ecosystems due to human activity have occurred more quickly in the previous 65 years than at any other period in history, this has resulted in an irreversible loss in biodiversity worldwide. A direct consequence is a decrease in ecosystem services - the benefits for humans that are provided by ecology - which are needed to keep especially cities liveable places. It is therefore crucial that cities are going to be developed more sustainably. Several theories acknowledge that for sustainable urban development, a shift is needed from a fragmented approach to a systematic approach to development. Therefore, this thesis has studied the potential of systems thinking to make ecology more important in the process of urban development. This has been done through document analysis and semi-structured interviews, which clarified how ecology is approached in the current process. It emphasized the current socio-technical landscape we are in, where ecology is still something that is controlled by humans and where urban ecology is not acknowledged as a distinct urban system. The interviews have been used to indicate the challenges and opportunities for systems thinking to change this landscape. This has formed the foundation of preliminary recommendations that have been validated through a workshop. Challenges like other interests, soft concept and no value can be overcome by various niche developments, tools that help in quantifying or monetising ecology so a value can be created that is interesting for developers, or help can be given to municipalities to set requirements on ecology. Using these tools, the context and its systems should always be considered for ecology not to be reduced to technical features, and no optimal ecological change can be created. Tools should also be used in a pre-initiative phase, where core challenges in an area, main drivers of developers and common goals of stakeholders can be established. Involving a wide range of stakeholders influences people to think more broadly and deeply about themes. Especially involving ecologists and maintenance departments in the design phase can create flexible designs that are future-proof and implemented successfully. Besides, ecologists, who know how to use language and create more chances in ecology instead of burdens and relate ecology to other themes, should be involved throughout the different phases of urban development as they often can make it more interesting for other disciplines. This eventually benefits the desired transition towards a landscape where the paradigm around urban ecology is entirely accepted, which results in the perception of ecology as something that is equal to humans and is therefore always on an equal level or even more important as the social and economic system ultimately benefitting the loss of biodiversity.

KEYWORDS: systems thinking, urban ecology, sustainable urban development, cities, ecological system

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."

- R. Buckminster Fuller

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ABBREVIATIONS AND GLOSSARY

BaRT   Bankable resilience tool

DSM   Decision support model

DSS   Decision support systems

Fig.   Figure

Int.   Interviewee

MLP   Multi-level perspective

Part.   Participant

Rli   Raad voor de leefomgeving en infrastructuur

SDGs   Sustainable Development Goals

SMP   Species management plan

SPvE   Stedenbouwkundig Programma van Eisen (urban planning schedule of requirements)

TEEB   The Economics of Ecosystems and Biodiversity

UN   United Nations

WBCSD World Business Council for Sustainable Development

Wnb   Wet natuurbescherming (nature preservation law)

Biodiversity - the variety of life in a particular area. It includes all types of plants, animals, and microorganisms, as well as the genetic variation within species and the variety of ecosystems they are part of.

Ecology - the study of the relationship between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them.

Urban ecology - the study of nature in cities, including humans, and the associated relationships between nature and people.

Urban development - the improvement of the living conditions of an urbanised area.

Green - living vegetation.

Green spaces - areas with a certain amount of living vegetation.

Green structures - Cohesive networks consisting of planned and realized nature reserves and connections between them.

Nature - all living organisms, their habitat, the ecosystem of which they are part and the associated self-functioning ecological processes, whether or not they occur under the influence of human action.

Sustainable development - the processes and pathways that are needed to achieve a future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life.

Sustainable urban development - the improvement of the living conditions of urban areas where environmental, societal, and economic systems are balanced.

Systems thinking - the ability to see the world as a complex system and to understand how everything is connected to everything else, which means for cities that it is acknowledged how the ecological, economic, and social systems interact.

INTRODUCTION

The introduction gives the context of the research and literature review. A description of the problem is given, whereafter the problem statement is formulated, and the main and sub-research questions are given. Also, it states the aim and the societal and scientific dilemmas of the thesis.

The Millennium Ecosystem Assessment reported in 2005 already that changes to ecosystems because of human activity had occurred more quickly in the previous 50 years than at any other period in the history of humanity. This has resulted in a drastic and irreversible loss in biodiversity worldwide. Still, in 2022, alarming reports are emerging warning of a biodiversity crisis. Also, in the Netherlands, the Council for the Environment and Infrastructure (*Raad voor de leefomgeving en infrastructuur* (Rli)) brought out an advisory report stating that nature in the Netherlands is deteriorating rapidly. According to the Rli, the biodiversity crisis is just as big as the climate crisis, which is alarming as vital nature is not only an essential condition for human existence (Rli, 2022), but the world is also reaching its planetary boundaries (fig. 1) (Rockström et al., 2009). Humanity must live and work within these boundaries to keep using earth's resources sustainably. These boundaries have been identified as

- the loss of biodiversity;

- global warming, e.g. carbon dioxide in the atmosphere;

- the number of nitrogen humans take from the atmosphere and the amount of phosphorus in the oceans;

- chemical pollution;

- amounts of aerosols in the atmosphere;

- ocean acidification;

- land usage by agriculture;
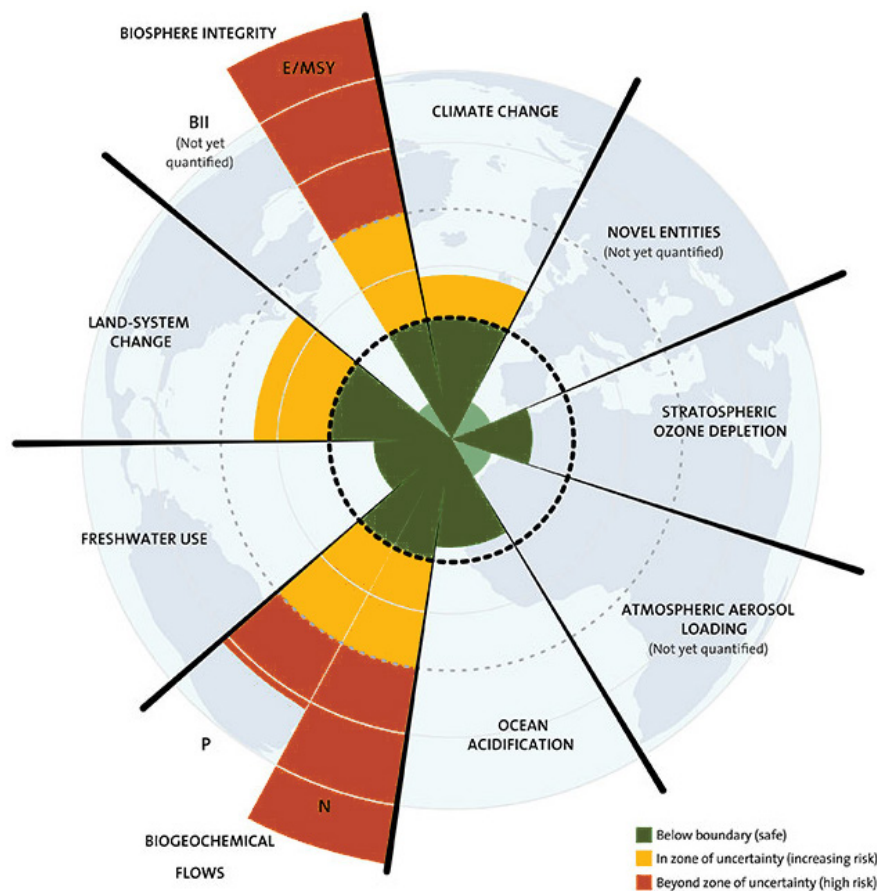
- freshwater use;

- and ozone depletion.

Fig. 1 - The nine planetary boundaries
(Stockholm Resilience Centre, n.d.)

As is shown in fig. 1, some of these boundaries have already been exceeded, of which one is the loss of biodiversity (Röckstrom et al., 2009). The direct consequence of biodiversity loss is a decrease in ecosystem services. These services can be defined as the benefits for humans that are provided by ecology or biodiversity (Mace et al., 2012). Examples are the cooling effects of green, the ability to remove pollution and improve citizens' health and well-being (Elmqvist et al., 2015). These ecosystem services are needed to keep especially cities liveable places. Cities more often need to cope with problems like the urban heat island effect, which means that cities are on average hotter than the surrounding rural areas, and pluvial floodings - floodings due to extreme rainfall. This while cities are becoming bigger and more crowded. It is estimated that in 2050 almost 70% of the world population will live in cities (United Nations, 2018), making it inevitable that cities must become more sustainable places. The United Nations (UN) describe in their eleventh Sustainable Development Goal (SDG) that urban planning should, amongst others, create resilient cities with green living conditions (UN, n.d.). The World Business Council for Sustainable Development (WBCSD) strives for the goal that people will live well and within planetary boundaries, which they define as that nature is used sustainably (WBCSD, 2021). And the UN-Habitat describes in its manifesto on achieving sustainable urban development (2014) that the city we need is a healthy city where parks and gardens harbour biodiversity and native flora and fauna. This shows that many organisations affirm the importance of nature and biodiversity in cities, which can be summarised in the concept of urban ecology. Urban ecology studies nature in cities, including humans, and the associated relationships between nature and people (Marzluff, 2008). This is an important discipline because the earth is becoming more urbanised, which impacts not only the natural systems that sustain clean air and drink water within cities but also has an effect outside urban areas on fertile soils for agriculture and wildlife habitats, for example. Maintaining and improving the ecological systems in cities through large green spaces like parks and lawns and connecting the systems inside cities to surrounding areas can help filter polluted air and water, make oxygen, mitigate urban heat islands, and offer habitat for birds and other animals. In the past years, scientists have come to realise that recognising and understanding how the living and non-living elements of urban ecosystems interact is crucial for the future of all life on this planet and for helping in not exceeding the planetary boundaries and maybe even coming back from the boundaries already exceeded (McDonnell, 2011).

The UN-Habitat (2014) and Bai et al. (2016) state that if we want to transition to sustainable urban development, we need to shift from a fragmented approach to a systematic approach toward development. Currently, cities or areas are often (re)developed through themes that are related to each other but are not approached as such. For example, buildings, infrastructure, and green structures are often all developed separately, while they do have an impact on each other. Challenges and problems are analysed and solved with small interventions and thematically, creating minimal positive environmental and social impact. So instead of understanding cities by reducing them to individual elements and solving challenges within those elements, we should start by focussing on the relationships between them. The result of this thinking in systems is that a tiny change can create more significant changes throughout the entire system (Sterman, 2000). Besides, side-effects do not exist from a systems thinking perspective; instead, just the logical results of how the system behaves occur. Climate change, the Great Pacific Garbage Patch and ozone depletion are not the side-effects of economic growth, but the predictable results of a system focused on maximising growth (Orr, 2016).

1.1 PROBLEM STATEMENT

Much research has been done on the need for integrating ecology in urban development (Colding, 2011), and the Netherlands have formulated ambitious visions and policies about greening cities, reducing their ecological footprint and negative impact on nature, wildlife and biodiversity, and creating healthy living environments (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (MBZK), n.d.-a; MBZK, n.d.-b; MBZK, n.d.-c). Principles have been drawn up on how ecosystem services can be used to enhance urban climates (de Groot et al., 2010) and theories already exist on how sustainable transitions through systems thinking work and happen. Although these principles and theories exist, the translation to actual usable information for practitioners and, therefore, the use of them in the process of urban development is still missing (Pataki, 2015). This shows that there are still many challenges in integrating ecology in urban planning and that ecosystem services are hardly ever used in urban development (de Groot et al., 2010; Song et al., 2020).

1.2 RESEARCH QUESTION

Based on the problem described in the previous section, the main research question of this research has been formulated as

What is the potential of systems thinking for making ecology more important in the process of sustainable urban development in the Netherlands?

To answer this question, it is divided into two, which both have their own sub-questions that have helped with focussing during the research process and ultimately finding an answer to the main research question.

RQ1: How can ecology become more important in the process of sustainable urban development?

1. What does the current urban development process look like?

2. How is ecology approached in this current process?

   a. What are the characteristics of ecology in cities that contribute to sustainable urban development?

3. What can be improved about incorporating ecology into urban development?

   a. What are the main challenges?

   b. And what are opportunities?

RQ2: And how can systems thinking help in this transition?

1. How can systems thinking be used in the process of sustainable urban development?

2. How can this be linked to overcoming the main challenges of including ecology in urban development?

1.3 RESEARCH AIM AND SCOPE

The focus of this research has been the lack of ecological-focused development in urban areas, which is identified in the problem statement. This research has studied a challenge, after which recommendations have been made. It also has tried to increase awareness of systems thinking and the importance of including ecology in urban development. Therefore, the main research aim has been defined as

Contributing to a better understanding of how and if we can transition to a more ecologically inclusive, sustainable urban development process through systems thinking.

The company Arcadis has been used as a case study to achieve this outcome. Arcadis is a leading international organisation for consultancy, design, and engineering services in the built and natural environment. They aim to help municipalities and cities to create healthier living environments, flourishing nature, and a resilient future. This research has aimed to provide recommendations that can help Arcadis improve its sustainable position towards competing companies. With their great number of ecologists and focus on sustainability, they are uniquely positioned to adapt to this new approach. Three steps have been taken from the perspective of Arcadis to give these recommendations. First, it was made clear what the current urban development process looks like and how ecology is approached in this process. Missing linkages have been found between the current and desired processes and challenges in including ecology in urban development. These missing linkages helped formulate recommendations towards Arcadis and relevant urban development stakeholders like project managers.

1.4 RELEVANCE

A consequence of biodiversity loss is the reduction of ecosystem services, which seriously affects human health and well-being. As having access to a healthy environment is a human right, this research is relevant to society (United Nations, 2021). Cities face multiple environmental challenges, like urban heat islands and resource scarcity. Although nature can be seen as the basis of all life, it is often not approached as such in urban development. With the recommendations proposed in this thesis, ecology can become more important, and cities can become more green, biodiverse, and thus healthier environments to live in. Besides, urban ecology can be a matter of environmental justice in many cities. Low-income neighbourhoods and communities of colour are often areas with poor access to well-maintained and safe parks, while these areas are also places where public health issues are most important (Wolch et al., 2014). Developing ecology-inclusive urban areas becomes, therefore, even more critical.

This thesis contributes to the academic field by giving more concrete actions to take on how ecology can become more important in urban development. The importance of the urban ecological system and the relevance of systems thinking in urban development have been studied in academia. However, concrete steps that must be taken to transition towards sustainable urban development are still missing. Principles have been drawn up for integrating ecology in cities, but these are not related to the actual process of urban development, which makes it difficult for practitioners actually to integrate them. Therefore, this research adds to the existing literature a deeper view of the potential of systems thinking and the importance of urban ecology and also relates these views to the urban development process through which concrete steps or recommendations could be formulated.

1.5 READING GUIDE

A theoretical framework (Chapter 2) has been drawn up in the following chapter to define the concepts introduced in the research question, and a conceptual framework has been presented. This has formulated the point of view from which the research has been done. Chapter 3 describes the methods used during the research to answer the research question. In Chapters 4 and 5, the results of the research methods used are given and analysed. Chapter 4 describes what the current urban development process looks like and how ecology is approached in this process, whereafter challenges and opportunities have been sought in making ecology more important and linkages between them have been made. Chapter 5 validates the opportunities and analyses how these can be related to the current process of urban development. The main findings and methods used are discussed in Chapter 6, after which conclusions have been made, which give the final recommendations on how systems thinking can be used to make ecology more important.

Chapter 2

THEORETICAL FRAMEWORK

The theoretical framework is written to go deeper into the concepts around systems thinking, ecology and sustainable urban development and to explore the literature concerning the research questions. First, definitions of the concepts are given together with elaborations on related concepts. And secondly, relations between the various concepts are sought. As this thesis addresses the need for a transition, a framework has been created on how the introduced concepts and theories can make transitions possible.

2.1 SUSTAINABLE DEVELOPMENT

Since the concept of sustainable development was first introduced, many definitions have been formulated. The most accurate definition is formulated by UNESCO (2015):

> Sustainable developments are the processes and pathways needed to achieve a *"future in which environmental, societal and economic considerations are balanced in the pursuit of an improved quality of life"*.

With this definition, the concepts of economic growth, social equity and environmental protection come together (fig. 2) (WCED, 1987). It implies that these concepts should be balanced, but this often seems untrue, and the economy is prioritised (Giddings et al., 2002). As Kate Raworth argues in her book about doughnut economics (2018), we have focused on economic growth in the past centuries. Leading to a disbalance between the three concepts of sustainability. In a more desired world, the concepts are not only in balance, but the importance of the environment is recognised as the economy cannot exist without the society and the living environment (fig. 3) (Raworth, 2022).
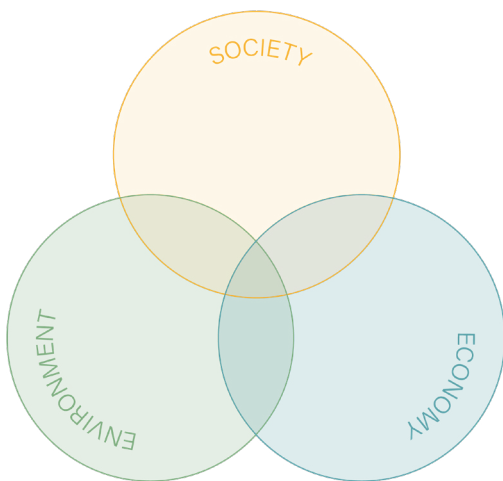
Fig. 2 - Contested way of defining sustainability
(based on Samaie et al., 2019)
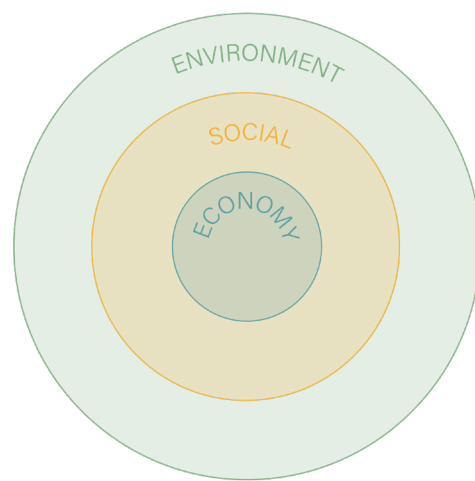
Fig. 3 - Desired way of defining sustainability
(based on Samaie et al., 2019)

This is summarised in the principle of doughnut economics, which is based on the doughnut model of Raworth, shown in fig. 4. In this doughnut, Raworth links the nine planetary boundaries to a social foundation based on the social aims of the SDGs, like having enough food, water and energy and access to education. Between these boundaries and foundations, an environmentally safe and socially just space can be created (Raworth, 2013). Linking this model to the desire to move away from the focus on economic growth, we get doughnut economics: an economic model that is not based on growth but the ecological boundaries and social foundation.
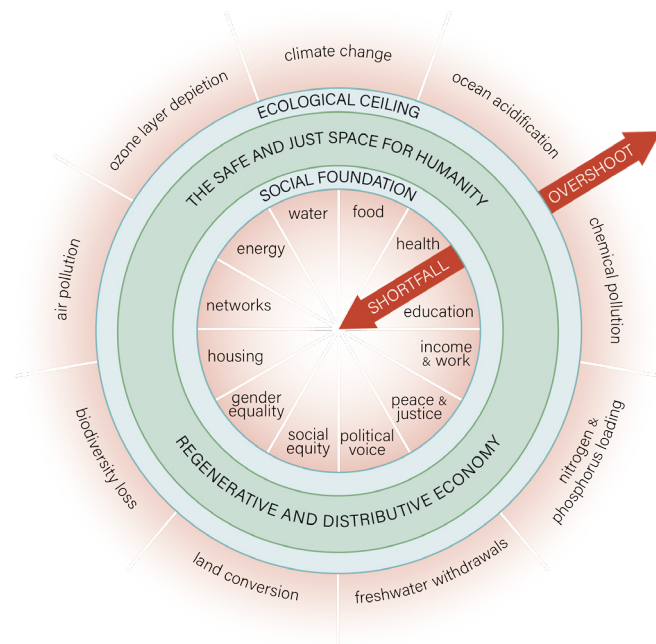
Fig. 4 - Doughnut model
(Raworth, 2013)

2.2 SYSTEMS THINKING

One of the seven ways Raworth (2018) describes how to transition to this new economy is through systems thinking. Recognising that the economy, society, and the rest of the living world are all complex, interrelated systems (Raworth, 2022) is essential. Systems thinking can be defined as acknowledging that the world is a complex system and understanding how everything is connected to everything else (fig. 5) (Sterman, 2000). It is the opposite of linear or fragmented thinking, where something is segregated into individual elements that also consist of different elements (fig. 6) (Newman & Jennings, 2008).
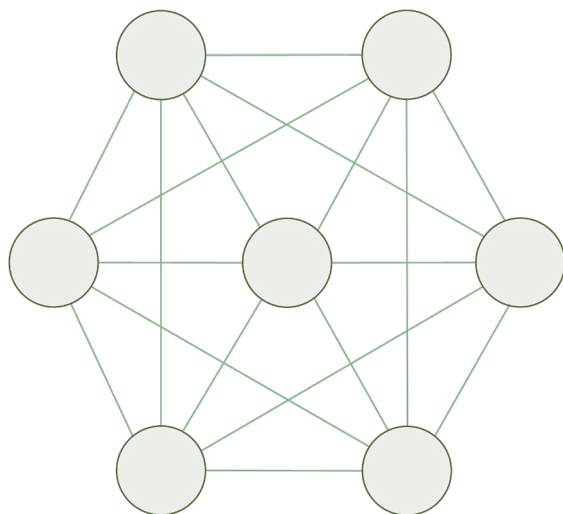
Fig. 5 - Conceptual visualisation of systems thinking
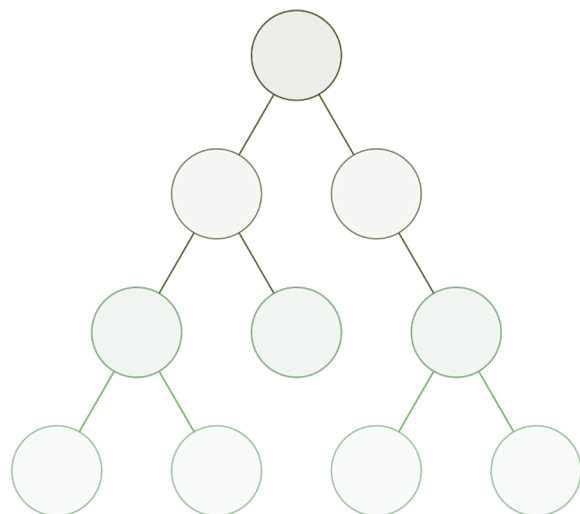
Fig. 6 - Conceptual visualisation of linear thinking

9.

Cities and the world can be seen as living systems where living and non-living environments are interconnected systems, subsystems and even sub-sub systems (van Bohemen, 2012). Cities are built from three subsystems, the physical and built, the ecological, and the social and economic system (fig. 7). These interact across governance, institutional and geographical scales. An example of how these subsystems interact is given by Bai et al. (2016):

> *"... urban planning influences the amount of green space in a city, altering urban heat island effects and consequently energy demands from buildings. ... these factors are also affected by building design and energy efficiency and, inevitably, building codes."* (p. 70)
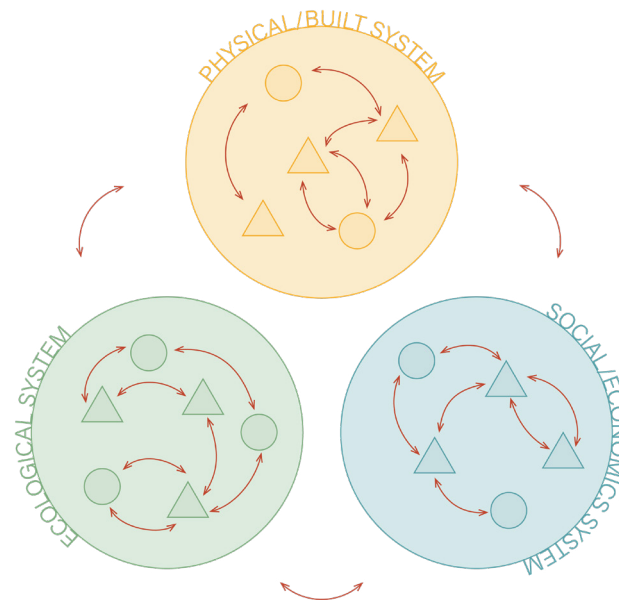
Fig. 7 - Systems of cities
(based on Bai et al., 2016)

These interactions must be accounted for in decision-making. A systems thinking approach toward urban development is necessary because the economic, ecological, and socio-cultural infrastructures are equally important when designing sustainable housing or waste and transportation systems. Or how Raworth more extremely states, the socio-cultural and ecological infrastructures are more important when wanting to design within sustainable economic systems. Systems thinking can help analyse and know the consequences of our decisions, which are often overseen. It would therefore improve the resilience of our cities in a world coping with climate change (Orr, 2016). But although systems thinking theory has already emerged between the 1950s and 1980s and the great opportunities and benefits have already been analysed, as of today, we continue to break down problems into their component elements and address them separately (Orr, 2016; Davidson and Venning, 2011). According to Orr (2016), this is due to the Enlightenment period where politics and society have been decentralised and fragmented, making it hard to address certain issues holistically. During the era of modernism, this has been further enhanced by relying on technology and engineering infrastructures to perform urban activities, the fragmentation of knowledge, and viewing people and the environment from a perspective where they are distinct from one another (Heymans et al., 2019). The challenge is now to transform the organised urban complexity based on an industrial model designed for

economic growth and cars into healthy, durable, and civil places (Orr, 2016). But, even if urban development is in its first phases and approached systematically where different subsystems are connected, the implementation is still done by a fragmented society and government, making it even harder to transition towards sustainability.

Bai et al. (2016) describe six important principles for implementing the systems approach in urban development. First, the *context* should be considered, and the systems of the respective city should be analysed and studied. It should be noted, though, that when analysing and studying the city's systems, analysis paralysis can occur. This is the moment in the process when a situation or problem is over-analysed, which means no more decisions can be made and no solution is found. It is, therefore, very important to always keep the question or the goal in mind (Zuckerberg, 2008). What and why are you analysing, and are you still doing it for this cause. The second principle is that a *vision* must be created, indicating the desirable future of the stakeholders within the city. Apart from the vision, also clear *goals* should be identified together with what must be included and can be left out. A wide range of *stakeholders* across various sectors and decision-makers must be engaged. With a systems thinking approach, the consequences of currently existing systems and set goals should also be considered, as it may tackle the systematic drivers of injustices and inequalities. An effective systems approach may empower marginalised populations. Last, it should be acknowledged that solutions are not set in time but must be *flexible* to adapt to new challenges in the future (Bai et al., 2016).

2.2.1 EXAMPLES IN URBAN DEVELOPMENT

Many highly liveable cities exist in large geographic spaces with a low population density. The result of systems thinking in Singapore is that it has become one of the few densely populated cities that can meet high living standards (Chye, 2012). Chye identified for the Centre for Liveable Cities the use of five rules that helped with systematic development in Singapore, of which the first three are similar to the principles set out by Bai et al. (2016). The first was to think long-term, which can be compared to the vision setting principle, the second was to recognise the common goal, and the third was to acknowledge that no future is predictable and to consider flexibility. The two additional rules are successful implementation, and before principles are adapted to local contexts, the underlying causes should be understood (Chye, 2012). Other cities analysed from a systems thinking approach are Indore, Da Nang, Kathmandu, and Makassar. These Asian cities have been analysed through the Building Healthy Cities project, where they used systems thinking to distinguish strategies that were applicable to city leadership, improve the health and liveability of cities, and focus on long- and short-term goals (Bachani et al., 2022). What the specific steps were to implement the systems thinking approach in these cities is not made clear, but they are all effective examples of the use of the approach in Asia, mainly intending to improve health and liveability and not explicitly for improving ecological systems. Also, examples in Europe, especially in the Netherlands, do not exist yet, and it can be questioned to what extent Asian cities and governance can be compared to the Netherlands.

2.2.2 NATURE'S SYSTEMS

While the examples of cities mentioned in the previous part focus more on the social system, this research has tried to use the systems thinking approach to improve the ecological system

in urban development. The Ecological Society of America defines ecology as *"the study of the relationship between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them"* (n.d.). Regarding cities, ecology can be approached through the concept of urban ecology. This interdisciplinary concept aims to understand how ecological and human processes can exist together in a system dominated by humans, the city (Marzluff et al., 2008). As urban ecology is about the connections between living and non-living environments, it can be seen as a system where everything is connected, this system is called the socio-ecological system (Maes et al., 2016). In socio-ecological systems, human actions are embedded in nature, where activities such as technology, economy, politics, and culture exist in the biosphere, the part of the earth where life is possible (Berkes et al., 2000). This shows that the ecological subsystem of cities is strongly related to the other two subsystems and should therefore be considered on the same level as economic and social systems (van Bohemen, 2012).

A brief history of (urban) ecology

If we want to know how ecology is currently perceived in cities, it is important to know how this was in the past (fig. 8). Before the 18th century, nature was perceived as wild, hostile and something that had to be tamed. It was not beautiful and especially not something that improved the well-being of humans. In this sense, ecology was not something humans took part in, and the concept of ecology was not acknowledged. Only in the 19th century, when cities became polluted, grey and tenser, this view of wild nature changed, and people began to see that adding nature to cities was good for the health of citizens. But with the fear of it becoming something wild, nature became domestic and was controlled by humans. Ecology was what humans were still not a part of, but something they owned (Bourdeau-Lepage, 2014). Only in post-war cities, it became more and more something aesthetic and luxurious. This has led to ecology becoming an afterthought, something nice to add to cities and something that makes money (Bess, 1995), but has also led to the emergence of the concept of urban ecology (McDonnell, 2011). As knowledge about the value and importance of nature for humans is growing, we are slowly transitioning to a new way of perceiving ecology, something that we (must) live with and in. With this new way of perceiving nature in cities, the concept emerged more often in scientific research and established itself as a new scientific discipline. Mid-20th century it was becoming clear that most ecological systems researched in the past years have been altered by humans (McDonnell, 2011). It was found difficult to acknowledge that these human-dominated ecosystems were part of the scientific studies on ecology. Therefore, only in the late 1990s urban ecology has become its own discipline and was fully acknowledged as not just being ecology in urban areas but as ecology dominated by humans. Currently, the transition is slowly going on where a desire is reflected through new developments for new ways that bring nature and cities together (Bourdeau-Lepage, 2014). We are entering an era

Fig. 8 - History of the perception of ecology in cities

where ecology is becoming something as part of the entire system of which humans are part (McDonnell, 2011) and where the difference between human-dominated ecosystems (urban ecology) and non-human-dominated ecosystems is acknowledged. In contrast to natural ecosystems, the urban ecosystem are the interactions of natural and unnatural components, which are influenced by the natural environment and individual behaviour like human activity, economics, social activities, culture, and politics.

With the concept of urban ecology being acknowledged as a separate discipline from ecology, urban planning and design professionals also started to recognise the value of an ecological approach more (Heymans et al., 2019). Concepts for a more complete socio-ecological systems approach toward urban planning emerged in the 2000s. This can be explained by the growing awareness of the negative effects of urbanisation on the environment and worldwide ecosystems, the impact on human well-being, systems thinking insights, and the emergence of research on the development of policy and sustainability (Newman and Beatley, 2011). A new ecological paradigm for urban design is emerging because of this thorough understanding of interconnected urban systems. A transition is going on where we move away from a modernistic paradigm of urban development where humans were separate from and, most importantly, superior to nature (fig. 8). According to this new paradigm, urban planners and designers should try to influence urban development in a more ecologically direction using knowledge on ecology and sustainability principles (Heymans et al., 2019). It is important here, that the focus is not only on creating new and better connections in and between the urban ecosystem and other surrounding systems. New strategies in urban development often emphasise only the opportunities for adaptive reuse of existing infrastructures for health norms to not be compromised and are often not focused on problematic forms of green spaces (like parks beneath high- or railways) (Wolch et al., 2014). The phenomena of ecological gentrification should be considered when (re)developing infrastructures, as well as improving existing green spaces. Urban greening initiatives can trigger gentrification, a phenomenon where higher-income citizens start to move to lower-income areas. This happens as older, often low-income, or industrial neighbourhoods of existing cities are made more habitable and appealing, drastically changing housing options and commercial infrastructures that sustain lower-income populations (Wolch et al., 2014). Wolch et al. (2014) propose a strategy called 'just green enough', which is about developing areas where just enough green space is created for housing and land prices do not increase enough to trigger gentrification. This strategy can be implemented through systems thinking. Ecological gentrification can be prevented by considering the ecological system for economic purposes and the social system by involving local stakeholders and citizens. When designing areas 'just green enough', it might even be more important to take a systems thinking approach if ecological systems are to be improved and strengthened with 'just enough green'.

2.3 HOW TO TRANSITION TO A SUSTAINABLE FUTURE?

As the topic of this research is about making transitions - from urban development to sustainable development and from linear thinking to systems thinking - it is important to understand the process of transitions. As defined by Loorbach et al. (2017), a transition is a structural change in how a social system works. It is a process from one stable state towards another. The transition to a sustainable city requires systematic changes in various areas, for example, technology, economy, ecology, and culture. Therefore, such a transition is intertwined with social processes and rooted in prominent institutions and infrastructures (Dirven et al.,

2002). Geels (2011) refers to them as socio-technical transitions, and a theory that helps understand these movements is the multi-level perspective (MLP) framework. This framework takes a socio-technical approach to transitions, explaining that they do not happen at once but only under specific conditions (Geels, 2005). Transitions occur because of interactions between the processes at three distinct levels. These levels are the niche and the socio-technical regime and landscape (fig. 9). The niche is the level where entrepreneurs, corporations, and policymakers build networks to develop more sustainable alternatives to the ones present in the current regime. Regulations, norms, and rules that guide the usage of specific technologies in daily practices make up the socio-technological regime which is seen as the meso-level of the framework. The macro-level in the framework is the socio-technical landscape, where transitions happen. It includes the spatial activities that make it possible to coexist and the material aspects of society. It is difficult to bring about changes because of the system's stability (Geels, 2005).
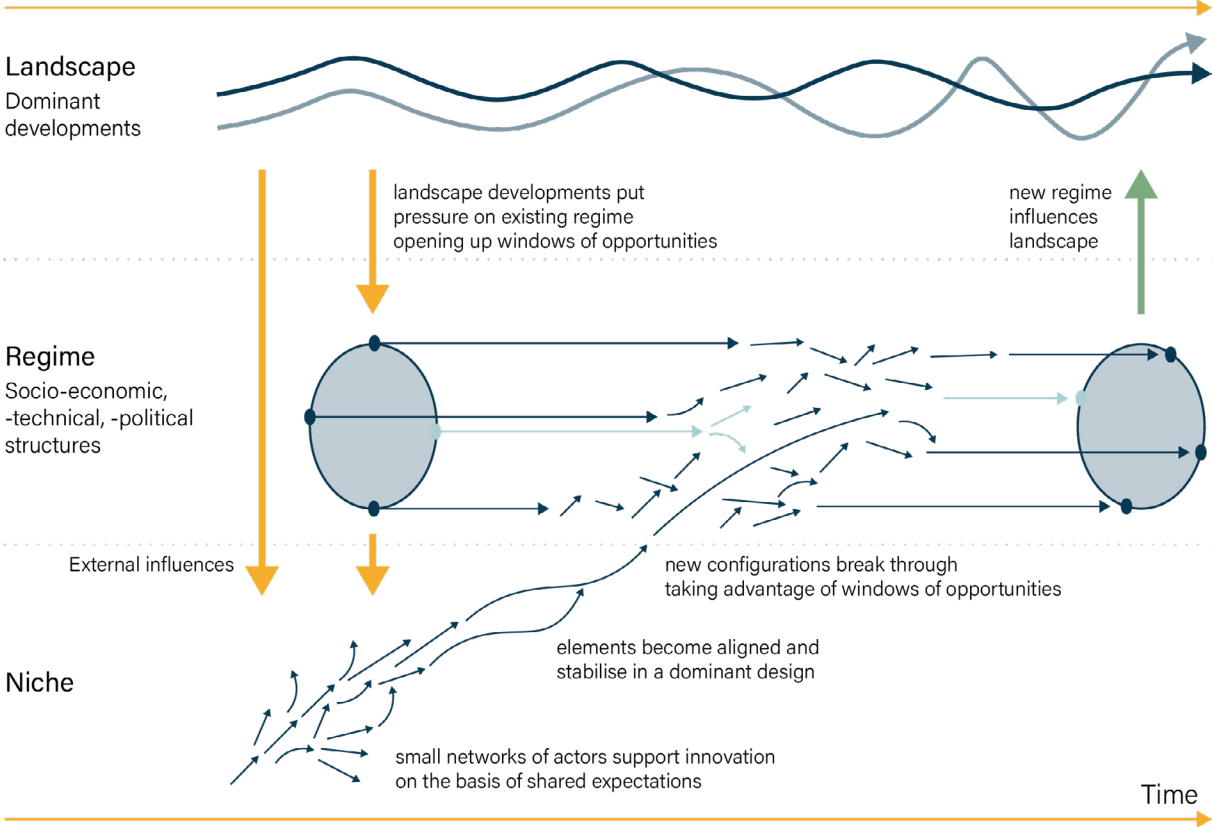
Fig. 9 - Multi-level perspective framework
(based on Geels and Schot, 2017)

Lawhon and Murphy (2012) add four ways to integrate political-ecological views to this socio-technical approach. Political ecology focuses on studying the relations between economic, social, and political factors and environmental challenges and changes (Sheppard, 2008). The first way of integrating this is to recognise interconnected challenges and conflicting interventions. They state that policymakers should not restrict themselves to one cause of environmental degradation and instead consider wider and interlinked social and economic systems. Rethinking how a problem is described by addressing the larger context broadens the

types of intervention, leading to a shift toward the social explanation of a regime's regulations. Second, not only a broader context needs to be considered, but also a broader range of stakeholders. This is also effective for taking a systems thinking approach, according to Bai et al. (2016). Involving a diverse group of stakeholders forces transition theorists to think more deeply and broadly about who has knowledge about particular environmental problems. As a result, questions about the roles that are played and the types of relationships between them will arise. Third, power is an important element for convincing others to support a particular position. Language is then again important for expressing this power. Understanding the usage of language and the formation of networks will assist in explaining why specific alliances form around transition techniques, as well as how decisions are reached. Finally, it is important to not only see the outcomes of socio-technical transition but also the impacts, which is again also important for taking a systems thinking approach (Bai et al., 2016).

2.4 CONCEPTUAL FRAMEWORK

Relating the previous theories to each other and comparing them with the MLP framework of Geels (2005), the adapted framework shown in fig. 10 can be created. The landscape we are currently in is created by the paradigm in which ecology in cities is something dominated by humans. This is slowly transitioning to a state where it is acknowledged that urban ecology is a separate discipline from ecology, in which humans are not excluded. This transition can only happen when there are changes in the current regime which consists amongst others of the
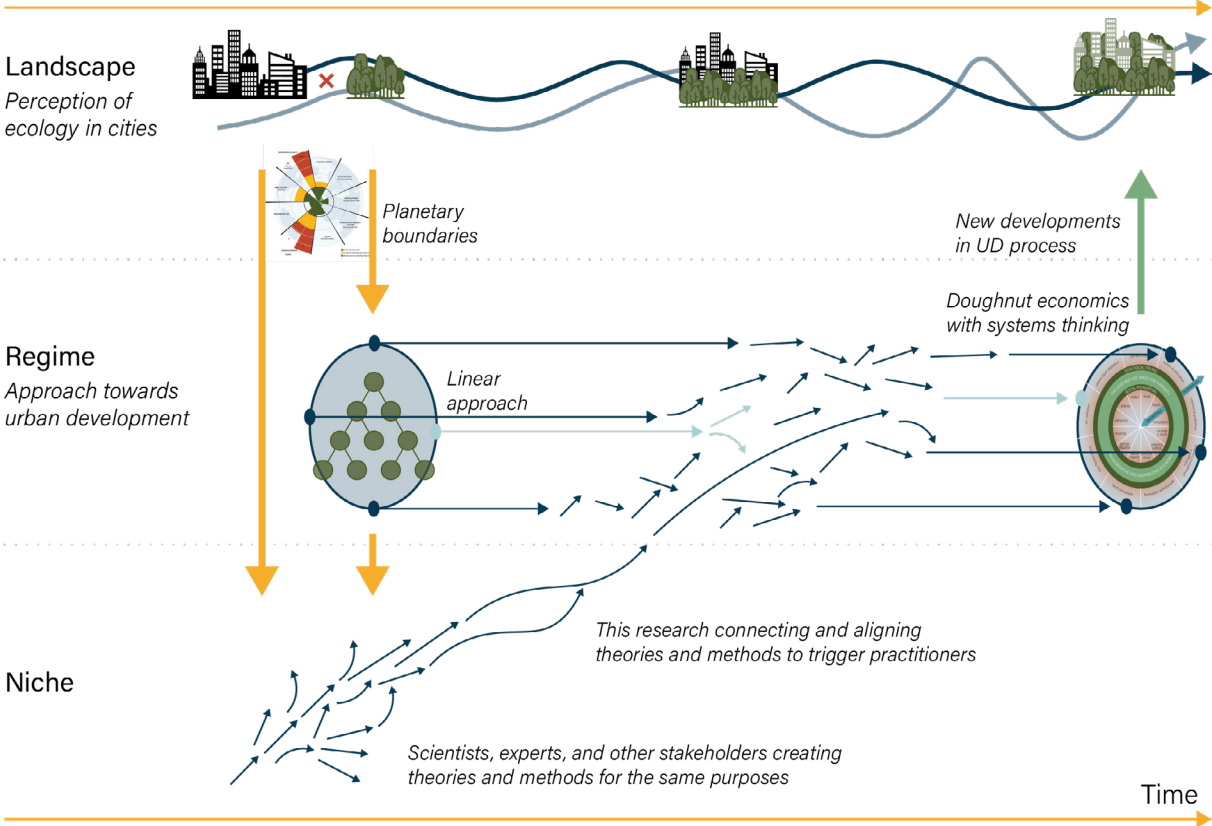
Fig. 10 - Adapted MLP framework
(based on Geels and Schot, 2017)

current linear approach towards urban development. A systematic approach which considers all three sub-systems of cities - the ecological, the social and the economic - helps change this existing regime towards one where doughnut economics is the norm. This means, for urban development, that a process where the focus lies on economic growth changes towards a process where planetary boundaries and social foundations are accounted for. This way, urban ecology can thrive in a socially just environment. From there on, the landscape can transition even further to a state where 'adding more green' is something that cannot trigger phenomena like gentrification, but where healthy cities where nature and biodiversity thrive are normal and not a tool for 'making more money'.

The niche needed for this regime change is externally influenced by developments in the landscape, like acknowledging the importance of ecosystems and us exceeding the planetary boundaries. This triggers scientists, experts and other stakeholders who form the niche to influence the existing regime through different methods and innovations. Scientists create the discipline of urban ecology and research how to implement this correct, like the theory of Bai et al. (2016), Lawhon and Murphy (2012), and Wolch et al. (2014). Experts on ecology or system thinking, like Kate Raworth, can create tools or methods that help translate the new approach towards stakeholders with lesser knowledge of systems thinking in urban development. This research contributes to the niche in a way that connects the two. By connecting theories and other methods and relating them to the process of urban development, practitioners can be triggered even more to take on a systems thinking approach and change the regime. As soon as this new regime is entirely accepted in all socio-economic, -technical and -political structures, it will influence the landscape paradigm, which can change quicker in the right direction.

Chapter 3

METHODOLOGY

This chapter describes the methods used to gather the data needed to answer the research question. The purpose of the methods is explained as well as how the data is gathered and analysed.

In this thesis, mixed research methods have been applied to develop recommendations to make ecology a more prominent concept in urban development. These methods include semi-structured interviews, a document review, and a workshop. Fig. 11 shows the methodological design of the thesis: semi-structured interviews together with the document review have resulted in the first conclusions structured as preliminary recommendations (Chapter 4 - Results I). These recommendations have then been evaluated and validated through a workshop (Chapter 5 - Results II) after which concluding recommendations have been made (Chapter 6 - Discussion and conclusion).

SEMI-STRUCTURED INTERVIEWS   DOCUMENT REVIEW

PRELIMINARY RECOMMENDATIONS

WORKSHOP FOR RECOMMENDATIONS ASSESSMENT

CONCLUDING RECOMMENDATIONS
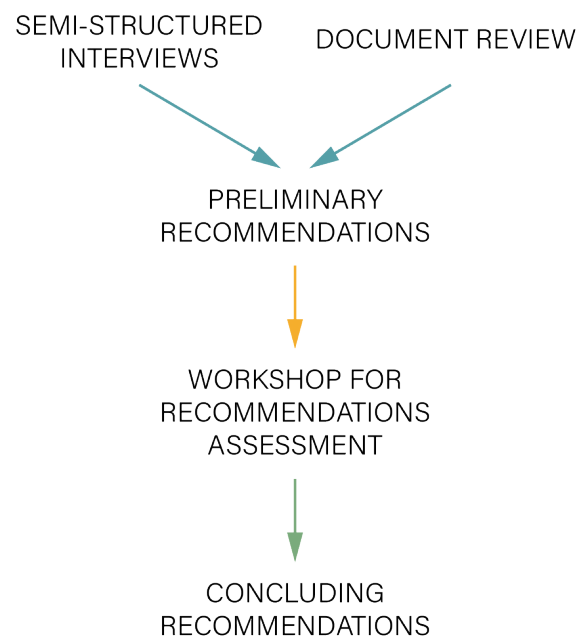
Fig. 11 - Methodological design

3.1 SEMI-STRUCTURED INTERVIEWS

Semi-structured interviewing is a method where questions are asked within a pre-established theoretical framework. But neither the order nor the wording of the questions are fixed. Answers during the interview can help in guiding questions in the future to create a more solid knowledge basis (Dearnley, 2005). In this research, the interviews have been used to gain more generic insights into how ecology is currently approached and how it should be approached within cities. The interviewees have been categorised into three groups. These categories have been constructed to gain insights from various perspectives and control possible biases during the interview sessions:

1. Stakeholders of urban development within Arcadis;

2. Stakeholders of urban development within municipalities;

3. Experts on ecology or nature in cities and systems thinking outside and inside Arcadis.

The groups include people with professions or backgrounds in, amongst others, landscape planning, project managers and leaders, (urban) ecology and system analytics. An overview of all interviewees together with their transcripts can be found in Appendix A. To select interviewees for each group, snowball sampling has been used. This is a method of selecting a sample via

networks. Firstly, a few interviewees are chosen, data is collected, and then they are asked if they know others with the same or even more knowledge on the topics they have been interviewed on (Kumar, 2014). As a result, these individuals are interviewed and asked identical questions. The first few interviewees were selected based on their expert knowledge or position at Arcadis or municipalities.

The interviews have been held over the course of two months, from March 30th to May 16th, 2022. Before interviewing, an interview guide has been drawn up, which can be found in Appendix B. The interviews have been conducted, recorded, and transcribed which has resulted in a large amount of data. This data has been coded based on the theoretical framework and sub-questions that are drawn up in Chapters 1 and 2. The coding is done through a three-step process where the steps are not necessarily consecutive but are intertwined.

1. **Open coding:** In the first step, the transcripts have been read over again, and codes have been attached to quotes. The codes indicate the theme of the quote.

2. **Axial coding:** With axial coding, the codes from step one are analysed, and codes that belong together have been merged together within umbrella codes.

3. **Selective coding:** In this step, relations and connections have been sought between codes and code networks have been made (Appendix D), after which conclusions have been drawn up.

The codes that have been analysed were chosen based on their frequency; codes that have been used only once or twice have been excluded from the study. Appendix C contains the complete code list. The program Atlas.ti has helped with conducting the analysis of the interviews. The texts and quotations used in Chapter 4 have been created using the analysed data.

3.2 LITERATURE REVIEW

The literature review includes a study of grey documents (e.g., municipal and governmental policy, ambition and vision documents). Document analysis, as defined by Bowen, is a method of evaluating or assessing documents that are both efficient and systematic (2009). In addition to other research methods, documents are helpful for giving background information, context, and extra data. Documents can also propose questions to ask and assist in the verification of findings from other sources (Bowen, 2009). Therefore, a grey literature review was used to help in finding out how ecology is approached in the process of urban development, what is needed to include ecology in the process and what steps or information are still missing.

3.2.1 DATA COLLECTION

To create a reliable overview, documents of 15 different municipalities have been reviewed. Five small, medium-sized and big municipalities have been compared. The distribution of municipalities is based on a document by the Ministry of Social Affairs and Employment (Ministerie van Sociale Zaken en Werkgelegenheid, 2019) which categorises municipalities as follows:

- Big: 100.000+ inhabitants

- Medium: 50.000 - 100.000 inhabitants

- Small: 50.000- inhabitants

The municipalities that have been compared were chosen randomly, and documents vary through green visions, green ambitions, environmental visions, future visions, green policies, sustainability visions and structural visions. The small municipalities included Huizen, Gorinchem, Vlissingen, De Bilt and Zwijndrecht. For the medium-sized municipalities Oosterhout, Amstelveen, Schiedam, Vlaardingen, and Midden-Groningen have been chosen. The big municipalities are Amsterdam, Eindhoven, 's-Hertogenbosch, Delft and Breda.

Apart from municipal documents, also provincial, governmental, and institutional documents have been revised including advisory documents, national environmental visions, or execution agendas. A complete overview of all grey literature that has been revised can be found in Appendix E. In this appendix, the data analysis can also be found. The documents have been analysed based on the theoretical framework set in the previous chapter. Municipalities have in this way been compared on what main messages they convey or requirements they set and what terminology they use in various phases of the process of urban development.

3.3 WORKSHOP

After comparing the results of the various studies and interviews, preliminary recommendations have been made on how ecology can become more prominent in urban development and what the role of systems thinking can be in this transition (Chapter 4 - Results I). To validate these recommendations and to connect them to the process of urban development, a workshop has been done, conducted as a group interview in which the researcher has led the conversation and where the interviewees have discussed the issues introduced. It allows the researcher to collect data that is created by the conversations between the participants (Finch & Lewis, 2003; Morgan, 1996).

The workshop has been held with interviewees from groups 1 and 3, Stakeholders of urban development within Arcadis and experts on systems thinking and ecology. It has only been done with these groups as the recommendations, and therefore this thesis, is directed to the first group. The third group can give valuable insights and discussion points on how ecology and systems thinking are currently perceived in urban development. From group 3, only interviewees that work at Arcadis have been invited to get optimal insights and discussions on how stakeholders currently work and could work together.

In the workshop the found conclusions and recommendations that are based on the semi-structured interviews and document analysis (Chapter 4 - Results I) have been shown and explained. A discussion has been facilitated to see how and if the recommendations can be implemented. Strengths and weaknesses that resulted from the workshop have been analysed and based on these results, final recommendations have been drawn up. The complete outline of the workshop, together with its transcript, can be found in Appendix F.

RESULTS I

CURRENT APPROACHES TO ECOLOGY IN URBAN DEVELOPMENT

This chapter describes the outcomes of the research, analyses the results of the different research methods and answers the sub-questions formulated in Chapter 1. Also, preliminary recommendations are drawn, which will be validated in the following chapter.

4.1 THE PROCESS OF URBAN DEVELOPMENT

The process of urban development in the Netherlands normally has four main phases: the initiative, feasibility, realisation, and maintenance phase (fig. 12). The initiative phase is intended to investigate whether the area development is desirable and whether there are better alternatives. This outlines the basic principles for the development and concerns a general program and spatial assignment (*globaal programma en ruimtelijke opgave*). Instruments used to make this trade-off are structural vision documents (*structuurvisies*). If these instruments are not available, then other research tools like a quick scan can be used. A quick scan globally maps out the environmental aspects, such as noise, external safety, archaeology, and ecology (Ministerie van Infrastructuur en Waterstaat, n.d.). These quick scans can be done in case of new developments and for areas that are going to be redeveloped. When it is decided that an area will be (re)developed, the process moves into the feasibility phase, which is built up into three sub-phases: the definition, design, and preparation phase. During the definition phase, the government draws up an urban planning schedule of requirements (*Stedenbouwkundig Programma van Eisen* (SPvE)) based on policy and the environmental situation and aspects. Further on in the process, the SPvE is referred to as an environment-specific structural vision (*gebiedsgerichte structuurvisie*) and is used as a leading document. In the design phase, the urban design will be created in the following consecutive steps: a functional design, a preliminary design, and a final design. Often after the preliminary design phase, also the development plan (*bestemmingsplan*) is drawn up. Lastly, in the preparation phase, the architectural and technical designs are made, and the environmental permit application (*omgevingsvergunningsaanvraag*) is prepared. The realisation phase focuses on the actual implementation of the urban design as determined during the feasibility phase. The management phase is aimed at maintaining the development (Ministerie van Infrastructuur en Waterstaat, n.d.).
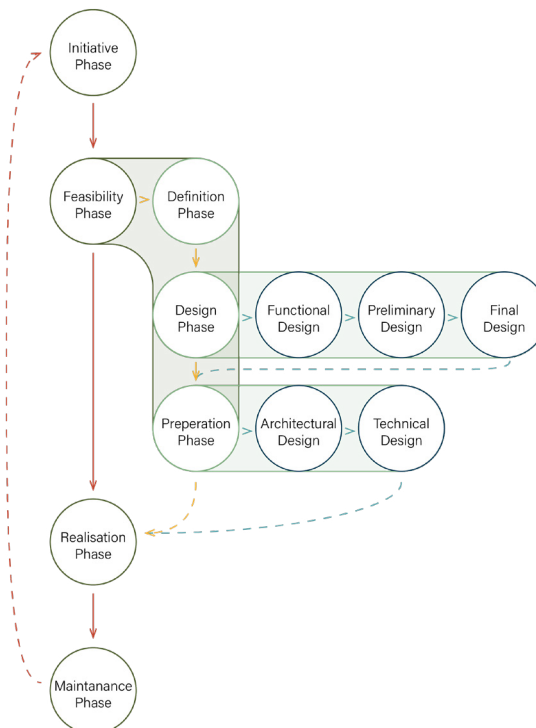

Fig. 12 - Overview of the current urban development process

4.1.1 ECOLOGY IN THE PROCESS

Ecology comes forward in almost all the phases of urban development, but in different ways and definitions, creating the current ecological paradigm that influences how ecology is perceived. The analysis and sources of municipal, provincial, and governmental documents on which the following results are based can be found in Appendix E.

Initiative phase

In the initiative phase, ecology is especially important in the ambitions and visions set by municipalities, and it is often referred to as biodiversity, green, or nature. In vision documents, municipalities describe the current state of ecological connections, biodiversity and green and/ or their goal of maintaining the current state and improving on biodiversity and green. Only a few municipalities explicitly describe how and where green and biodiversity is to be improved or write about not only maintaining but also ecologically or natural maintaining green and biodiversity. This is, as defined by the municipality of Amsterdam (2020), a form of management in which the aim is to increase biodiversity and to give flora and fauna the opportunity to develop through natural processes. The focus in management is then not to maintain the current greenery, but to actively guide it towards a different composition of the green. After analysing when which terminology is used in municipal documents (Appendix E), it was particularly striking that small and middle-sized municipalities often write about nature and ecology as something that exists outside the city and that only natural and ecological qualities should be created and improved within cities. Making it seem like there is no real ecology and nature inside them. Bigger municipalities do use these terms when creating a vision of urban areas, which could be due to smaller municipalities having fewer experts and less money to spend and, therefore, less knowledge of the changing paradigm of developments in the discipline of urban ecology. Besides, a lot of municipalities, no matter the size, write about green in their visions but do not explain what 'green' looks like. Is a whole paved area with a few trees on it considered a green space, or just when there is a certain amount of ground vegetation present? Only the municipalities of Amsterdam and Breda give a clear overview of all different concepts used and how they define it. Breda even defines the concept of green in this list - living vegetation - and makes a clear distinction between different types of green (Breda, 2021). Ecological green is, for example, specifically the type of green that has as its main objective to improve biodiversity and natural processes that go with it. In this sense, ecological green has a greater added value for the ecological system than 'normal' green. This shows that it can be very important for municipalities to clearly define what they mean with certain concepts. Not only how municipalities define certain concepts differs, but there is also a difference where and how they use them. Large and medium-sized municipalities often have drawn up either specific documents for green and biodiversity, or green visions are written as a separate chapter in general environment and future visions. They consider the entirety of the ecological system and talk about creating networks and improving on green and biodiversity. Smaller municipalities do not incorporate specifically ecology but do include green and biodiversity, which are mostly mentioned together as one, in their visions through other themes like spatial quality. Few municipalities look at the entire ecological system and link it to other challenges or themes that are important in their area. Zooming out, we see that provinces mainly focus on nature networks spread across the province. It is the responsibility of municipalities to make more concrete plans

for these networks within their borders. This is where bigger municipalities approach ecology in a more holistic sense, probably as they have more budget and more expertise. The smaller municipalities are still lacking here:

> Int. municipal 3 - *"I think it is due to too little budget, but also too little expertise. It changes very fast, too fast, I think. Many colleagues cannot handle that."*

With 'it' changing, the interviewee meant that a lot of new laws, like the law on nature preservation (*Wet natuurbescherming* (Wnb)), and knowledge have been added to certain topics that were not or lesser important before. This new knowledge is the driver of the establishment of urban ecology as a new discipline, which can be seen as landscape developments that trigger a regime transition towards urban development where ecological systems are acknowledged. As we are exceeding some planetary boundaries already there is a need for this transition to happen quickly, but if smaller municipalities, which cover about 76% of all the municipalities in the Netherlands (Ministerie van Sociale Zeken en Werkgelegenheid, 2019), cannot keep up with the pace of this transition a knowledge and sustainability gap will be created between different areas of the Netherlands.

In the following phase the plans will be tested on laws and policies and to prevent that any unforeseen problem occurs, scans on flora and fauna can be done. The quick scan flora and fauna analyses what protected species might be present in a project area. The boundaries of the project area are followed, but it is sometimes examined in advance during the desk research whether there are protected natural areas (like the Natura-2000 areas) or parks in the neighbourhood. In the case of the first, a specific species analysis must be done, and in the case of the second, a quick scan flora and fauna is also done in the parks. However, in practice the second seems not always to be true. Although considering a bigger context helps in developing more and different kinds of intervention, which can be seen as niche developments that might change the regime, currently, it is assumed that a project will not affect surrounding areas, only the impact of the project on the project area is considered and not what is happening around it.

> Int. municipal 3 - *"It could form much greater obstacles to the project, while it is actually very far outside the project or outside the sphere of influence of. We look very carefully at the work. What are we going to do versus which animals and which plants can we possibly destroy there, or who will be bothered by us? But only within the project area. … If I can be honest, I think it is a bit vague and nonsensical to look just outside the project boundaries in the park."*

This is probably again due to money and knowledge. Employees in small municipalities have few people with ecological knowledge and do not know what the value can be of taking more into account then just the project area, that there can be more than just animals that are protected and can slow down the development process. A scan similar to the quick scan, but that does consider the surrounding areas a project is developed in, is a species management plan (*soort management plan* (SMP)). It not only looks inside the project boundaries, but it takes a broader perspective. An SMP contains measures, rules of conduct and agreements to enable spatial development, management and protection of the species concerned (NatuurInclusief, n.d.). It is not being used for every project as it is perceived as a method that is time and money intensive. Both the quick scan and the SMP are concerned with the presence and protection of species, and not with the liveability of (protected) species. If there are protected species in a project area, the quick scan is only concerned about preserving and protecting them. The scan is not

concerned about improving the habitat and its liveability. An SMP can help municipalities in looking at the bigger system and set requirements on the amount of biodiversity in a plan, but then again it is not or very little concerned with the status of the current habitat.

What can therefore be done is requiring the use of certain points systems in development projects. Arcadis has been making these systems for municipalities and they can be helpful for municipalities to easily translate measures for building nature- and green-inclusive or to draw up requirements towards project developers or architects. According to the kind of urban area and size of the project, the municipality can set a certain minimum of points that should be achieved (table 1). This way, the developer or architect has the freedom to choose his or her own mix of measures. Exemplary measures are green roofs and facades, insect stones, nesting boxes, pocket parks, clusters of native trees or shrubs and grass with mixtures of native flowers (500+ m2). All the measures are divided in the location of placement on the building level and in four different kinds of urban areas (Klasberg and Mulder, 2018):

1. Historical centre and old city district (before 1920)

2. Residential areas (1920s - 1940s), reconstruction areas (1950s and 60s), cauliflower districts (1970s and 80s), Vinex (from the 90s) and free allotment

3. Areas with high-rise and large-scale buildings

4. Business parks

Building part	Small sized project	Medium sized project	Large sized project
Facade or roof	2 points	4 points	6 points
Residence	1 point	3 points	4 points
Surrounding	2 points	4 points	6 points

Table 1 - Way of achieving points with the points system
(based on Klasberg and Mulder, 2018)

What a pitfall can be for these points systems is that developers could approach it as a checklist, where you can put up some birdhouses and plant some native trees and you can check off biodiversity. The system where the measures are put in is not considered and measures are placed at random. Developers could just put up some birdhouses without knowing if a certain bird would even nest in it and still achieve points with it. To actually improve the urban ecosystem, the points system should come after an analysis like the SMP or quick scan to know where what species live and how to improve the liveability of the habitat.

> Int. expert 2 - *"The points system is not at all intended as a sectoral story; it is intended as a trigger to start working together. That is happening now, it is of course super easy to build upon. If you add to the points system for biodiversity, a points system for heat stress, you can also score points for this and then it is super easy to build upon and connect systems."*

This quote is by the urban ecologist who has created the points system of Arcadis for the municipality of The Hague. He implies that the points system is not the end point, it is a start from which municipalities can begin to put ecology on the agenda and to connect ecology to

other systems or challenges. This would be beautiful, but if it is considered that small municipalities do not have a lot of expert knowledge, who would know that these points systems should be connected to other systems and how to do this? To really make an impact and create an ecological paradigm for urban design, the points system must go further where maybe additional points could be achieved if a measure can be linked to other challenges. Municipalities could then for example set requirements on not only the points to be achieved on the measurements, but also on the additional points to be achieved

- example of how to add on the current points system -

An analysis has been done in the project area and main environmental challenges are identified as heat stress, pluvial floodings, low biodiversity rates and poor citizen well-being (these are all more often occurring challenges in cities). By adding roof top gardens with grass, herbs, and bushes on critically warming areas, you can get an extra 3 points on top of the 4 you already got for just the roof which contributes to biodiversity loss. The same goes for adding areas of grassland at critical points for pluvial floodings, et cetera.

Tools like these points systems could be seen as a niche innovation created by experts to influence the current regime. Especially with a further developed points system, knowledge can be created and easily communicated towards stakeholders in urban development which can eventually trigger the current fragmented and linear regime towards a regime where thinking in systems becomes easier to understand and to adapt in existing processes.

Feasibility phase

The first step in the feasibility phase is constructing the SPvE, with that a plan can be drawn up with example images and texts of how an area is desired to look like (*beeldkwaliteitsplan*). These documents state, for example, the number of houses and the amount of parking places needed in the area. It indicates how people will have to enter the area and what types of connections are desired. Also, the surface area that is to be realised for various functions is determined, also for green (ToornedPartners, n.d.). As these documents are based on a smaller scale than the visions created in the previous phase, entire ecological systems are often not considered. Plans follow the visions by improving biodiversity and adding green and not decreasing the amount of flora or disturbing fauna. A pitfall can here be that green is placed at random. The project area is the only thing that is being focused on in this phase, if that was not already the case to some level in the previous phase.

The plans are tested on laws and policies by the government, in the case of ecology, the Wnb is in place. This law came into effect on January 1st, 2017, and apart from it decentralising some tasks it has several prohibitions. For example, the removal of certain plants and the disturbing of some animals and their habitats is only allowed in certain situations and under certain circumstances, but this requires an exemption (possibly as part of an environmental permit (*omgevingsvergunning*)) (Wnb, 2017). Other exemptions are the responsibility of provinces, they determine what is and is not allowed in and with nature for their areas. When all plans are

tested the urban design is drawn up by landscape architects (landscapers) and urbanists. Here it should be mentioned that from the landscape perspective ecology is incorporated in the design process and its systems are considered.

> Int. Arcadis 2 - *"… you always look at networks. It is not just about those 3 willow trees; it is also about the entire landscape. … And even though we place new buildings, you still look at how we can also strengthen those green structures. Ecology, recreation, visibility, it is all nicely wrapped."*

This quotation is from the interviewed landscaper and implies that he and his colleagues always do an analysis of the area the project is in. This would mean, that even if there are no visions or requirements set, apart from actual laws, they try to improve certain networks in the landscape. These networks concern historical land uses, but also current networks of flora and fauna. Landscapers than try to improve these by, for example, building bridges between ecological areas. They already try to influence urban developments in a more ecologically direction using knowledge on ecology and sustainability principles. They are incorporating a new regime to think in systems and where the planetary boundaries are acknowledged. But although landscapers do integrate their designs with ecological systems, it is noted by ecologists and other stakeholders of urban development, that they assume to have the same knowledge as ecologists have. Some interviewees said that ecologists have more knowledge on the entire system and habitats and landscapers on species, while the landscaper said it to be the other way around. This could be overcome if they would work together and maybe even let ecologists assess urban designs on certain topics. Besides, creating ecological inclusive designs would only be helpful if, in the following phases, these goals are acknowledged and carried out as well. If ecological areas are connected through several green spaces that were planned to be designed to improve biodiversity, and after realisation maintenance mows everything away because there was not a clear ecological maintenance plan or their budget is finished, then it can be expected that the ecological connection will be disrupted. Or if stakeholders in following phases just do not have the right expertise on how to technically design or implement these green areas for them to become a bridge between ecological areas, then the goals also will not be met. Like municipalities, there will be crucial gaps if this knowledge is not developing in each phase at the same rate. If a new regime has been incorporated in one phase but not in others, elements will not align, will not become stabilized as a new dominant regime, and plans and designs will hardly ever be carried out properly especially not in the long term.

Realisation and maintenance phase

In the realisations phase it is important that everything is realised and implemented correct. Chye (2012) has also incorporated successful implementation in his five rules of how to integrate systems thinking, which makes the following phase even more important, the maintenance phase. It is noted by several stakeholders at Arcadis that the people from maintenance are often involved too little. As mentioned before, you can design the most ecologically inclusive project, but when it is not maintained well the whole project will not work. Ecological designs should have ecological maintenance plans, but if the city's maintenance department has a too small budget or if they simply think it is too much work, ecological plans will be cut to the ground.

It can therefore be important that maintenance is not just approached as a last phase in the process, but that they are involved earlier and throughout the process in different phases as well.

> Int. Arcadis 5 - *"The plan should sometimes be adjusted in the planning phase. But when that does not happen you see that the area is developed, it is managed for a few years according to the way the managers think it should be and the moment they see that it entails a lot of effort and therefore costs, they start to adapt the maintenance plan."*

Almost all municipal interviewees mentioned that maintenance already has a very small budget, which is in some cases even shrinking. This is difficult as municipal interviewee 2 explained, that ecological maintenance is on the short term more expensive than regular maintenance where green spaces are just mowed. This again emphasizes the need to involve maintenance during previous phases, especially during design phases. But as municipal interviewees 1 and 5 have mentioned, this is not as easy as it sounds. The society and government have been fragmented in the period of the enlightenment (Orr, 2016) and this is still the case also from a practical point of view.

> Int. municipal 1 - *"There is a lot of logic behind this system. Manageability for example, you must be able to conclude good agreements. Human brains are severely limited, so we also like it when there is a line around it. Systems thinking is far too complicated for many people. You have textures and you have building blocks, e.g., networks of cycle paths, network of walking paths, networks of outside urban structures and within urban structures, which must be connected to each other. But you also have fields in between and those things have a different approach, a different scale and other control factors, which are not yet managed."*

4.2 CHALLENGES AND OPPORTUNITIES

Having gained more knowledge on the current regime of how ecology is approached and defined in the different phases of urban development, challenges and opportunities were sought for changing this regime ultimately leading to a transition towards a new paradigm which influences our perception of ecology. Semi-structured interviews have been used and after coding and analysing these (Appendix C) it can be concluded that the most important challenges are:

- That people consider other themes or subjects as more important;

- that there is too little budget available for either ecology or sustainability in general;

- that ecology is a soft concept which makes it difficult to make strict demands;

- and that maintenance is too little involved in the process, which results in ecological plans not surviving after realisation.

The same goes for the opportunities, there are four main opportunities which can be linked to each other as well as to the challenges:

- The right value of ecology has to be created;
  - which can be done by involving an ecologist;

- ◦ or by creating awareness and the right knowledge;
- and strict demands should be made on ecology, as there are on traffic and safety.

The following section will analyse how the opportunities and problems are connected, and missing linkages are identified.

4.2.1 MISSING LINKAGES

Other interests, soft concept, and too little budget

Int. Arcadis 5 - *"The tricky part about area development is that it depends on who the party is. A developer, for example, often has a prospect only until the completion of the area. He or she may have bought a piece of land for that many million. He wants to have a certain revenue; he wants a minimization of costs. The game of costs and revenues is what a developer looks at and the saleability of the homes. That is very important to him."*

The challenge of integrating ecology in urban development that stakeholders might have other, for them, more important interests is mentioned most often and can be difficult to overcome due to the budget and existing regulation on other domains and themes: *"Usually, the customer also has their backs against the wall because they have simply been given a certain parking standard from an alderman and he has to substantiate everything for that alderman from a financial point of view."* (int. Arcadis 1) We are currently in a regime where the laws and requirements, like they exist on traffic and safety, are lacking for ecology. As noted in the previous section, municipalities might have drawn up visions and goals on green and biodiversity, but they almost never write about ecological systems and minimal requirements. Many interviewees mentioned that it is difficult to draw up these tough requirements on ecology because it is such a soft concept.

Int. Arcadis 6 - *"… it is not hard matter. Not hard science, which makes it much harder to quantify. But also, partly because a lot of people do not suffer from it as quickly if it isn't there or they do not realize it enough. At least not immediately, look if you are stuck in traffic a lot, then everyone will understand that. Then there is very easy money to widen the road because everyone suffers from it."*

Quantifying ecology might be difficult, but not impossible. It can be quantified by approaching it through a different way, maybe through ecosystem services, heat stress, drought, or biodiversity. One way of quantifying biodiversity for example is the SMP, but also other tools exist and are being developed that can help. These tools can be seen as new innovations that support small niche networks to make other stakeholders aware of a new regime. As developers do not always see the economic viability of improving ecological systems in cities, it can be useful to either create a link with other goals or visions or to monetise it. The Bankable Resilience Tool (BaRT) from Arcadis is an exemplary tool that can help here. It is a tool that provides insight in the societal costs and benefits of resilient measures for a healthy living environment. It provides the basis to set up a financing strategy by linking costs and benefits to the stakeholders and to make an informed decision where ecology can be put high on the agenda (Dircke et al., 2019). As this tool is made by Arcadis and is relatively new, not many people have been working with it yet or even know it exists.

A tool similar to BaRT is The Economics of Ecosystems and Biodiversity (TEEB) City Tool. It is developed in 2013 and acknowledges and records the value of ecosystem services and biodiversity. The TEEB City Tool is a way of estimating the monetary and societal value of certain ecosystem services. In a project, the tool calculates beneficial impacts of green and blue solutions. For example, what role do green roofs play in saving energy? What impact does green have on the quality of air, on storage of rainwater in soil and on the carbon dioxide sequestration of trees? What effect does the creation of a park have on value of nearby homes (Kennisportaal Klimaatadaptatie, n.d.)? Answering the last question can also be a way of preventing ecological gentrification. If it is indicated that housing prices rise a lot, questions can be asked what the consequences are for a certain neighbourhood. Tools like the BaRT and TEEB City Tool sound very promising for creating a value that is interesting for developers and might also help in quantifying ecology for municipalities to make stricter requirements, but what can happen with limiting ecology to its technological features, is that the entire system will be forgotten. This is also a challenge with the previously mentioned points system. For ecology to be implemented effectively, it should not be approached as some patches of green to be added.

> Int. municipal 4 - *"What you notice is that ecology is approached very technically, just like a street lantern, for example, we just put a piece of ecology here… But where that street lantern also only functions if a power cable runs to it, that is the network, ecology also does not. You cannot see the cable, but that cable ensures that the street lantern functions. You cannot say, here is ecology and not there, because ecology is insects and plants that pollinate each other, etc. So, you also must have a green network for that. … It is often very technically approached, like yes, we also have room here for some ecology or something."*

If these tools are to be niche developments with impact, they must be used and recognized by stakeholders of urban development and linked to entire (urban) ecological systems. But as long as there is not any kind of value on ecology for stakeholders in the process, it is not likely that these tools would be recognized and used and therefore would not be innovations that would trigger the needed change towards a new regime.

Missing value

How people currently value ecology and act on this value is the socio-technical landscape we are in. Already in the vision and ambition documents of municipalities analysed in the first section of this chapter it became clear that people approach ecology in different ways. Also, the value that people put on ecology differs. According to the interviewees, the ecosystem services, and the fact that ecology is the basis of life are qualities that are most important. Also creating a better and healthier living environment and risk management are qualities that are mentioned. Comparing ambition and vision documents of several municipalities it can be said that they prioritise the health, social and climate adaptation services ecology provides. Although many people know or see what the great added value is of ecology, it is still approached as an afterthought or burden. This is also noted when analysing the current landscape we are in. The paradigm where ecology is something distinct form humans is gradually changing to one in which it is understood that urban ecology is a distinct field from ecology and that humans are neither excluded from, nor in control of nature. People recognize the value of ecology in cities and especially experts see it as the basis of life, but this value is not fully accepted yet as it is not

approached as such. A first step in guiding the transition towards a new regime and landscape can therefore be to find out what the right value is for a client. This value does not necessarily have to be the same as you think ecology has. The value of ecology as the basis of life is only mentioned by the ecologists or the stakeholders with high affinity to ecology, but municipalities indicate that risk management is a more important character of taking ecology into account (table 2). Bridges should be created between different values which might influence urban design in a more ecologically direction.

Value of ecology	Arcadis	Municipalities	Experts
Basis of life	6	x	3
Ecosystem services	2	1	2
Quality of living environment	x	2	1
Risk management	2	3	x

Table 2 - What is the value of ecology?

Int. Arcadis 8 - *"We have to change the story line from ecology or nature as a burden to something with a very high value. We must be able to tell the right story, relate it to your client so it makes sense for them. What is the 'why' for the client?"*

There are several methods and tools that can help with creating this right value. One is for example to involve an ecologist earlier in the process. What is happening now, is that often ecologists or people who are expected to have similar knowledge are only asked to add some green or biodiversity when the plan is already fixed, and nothing can be changed anymore. This way little impact is created in the ecological system and the developers or designers *"have only listened to the customer and not looked critically at the general interest of the end user"* (Int. Arcadis 2). By involving an ecologist or at least someone with knowledge on ecological systems in the right phase of the process, more knowledge and value can be communicated to clients or developers. What could be difficult here though is that many people want to be involved earlier in the process and that as soon as they are, they complain about the plans being too vague and them not being able to say anything about it yet (int. Arcadis 3). So, a balance should be found between being involved earlier and being able to say anything about the plans. In what phase is the knowledge you have valuable for the client and the project? Also, not all ecologists are verbally strong enough to convince others in chances ecology has. According to interviewee expert 2, there are also still ecologists who are only concerned about endangered species and cannot or do not translate that story into a story which can be interesting for the client. When involving an ecologist, it should therefore be very important that the 'right' one is involved, the one that is able to create the right story. Educating ecologists on how to use language can be therefore a powerful tool in urban development and this can help in creating a value of ecology that is true to ecologists. But as noted before, this is not necessarily the value that can be most interesting for others. It is therefore important to ask the right question to find out what the core problem is of the area and specifically what the core goal is for the client. *Who are you developing for and who benefits from the development? What do these parties need and how can you give them a place in the planning process?* (int. Arcadis 5) If the core goal is making revenue and creating a healthy living environment, you should ask why? Why is there currently no healthy living environment and why do people not want to live here? Then it could be a conclusion that the ecological system in the area is in disbalance and is not working well. This way the burdens that where initially seen about ecology, might be changed into chances. This could also help in convincing municipalities to do look over the project border and take the entirety of the system into account instead of 'just' assuming that a project does not affect other areas.

Tools that can help in creating a monetary value are the BaRT and the TEEB City tool. But as noted before, these take a technical approach towards ecology which does not consider the entire ecological and urban system. A tool that does take the entire system into account is the Decision Support System (DSS). This is a method that helps in understanding the complexity of cities. The model offers the possibility to create knowledge and information about the various systems in areas (Chan et al., 2016). Compared to the previously mentioned tools, DSS connects the systems and can therefore give insights into the underlying problems of a dominant issue. This can help policymakers to see the connected challenges and conflicting interventions which is a way to not restrict policies to one cause for environmental degradation and take other urban subsystems into account. If a dominant issue is for example that a healthier living environment must be created, then the underlying issue can be more complex than 'just too little green'. It could be that the entire ecosystem is malfunctioning as there is too little connection with other systems (in- or outside the city boundaries).

Int. expert 5 - *"That is using models, just causational chains behind a domain. Ask why it is that people are unhealthy, then you get the chain. Then you see that a certain cluster comes from the eco corner, or it does not come from the eco corner, and it comes from somewhere else. Do we have poor air quality? That way you can relate them to each other. If we research an area, someone has to take all themes into account, equally, and we do not that."*

A DSS can be seen as a way of creating a digital twin of a city, a digital representation of a city which currently considers only the quantitative aspects of cities. This way, social or other qualitative aspects are forgotten. A model is currently being created where also qualitative data is used. This Decision Support Model (DSM) exists of three things:

1. Knowing how all the elements and systems in the city works and how they relate to each other;

2. how are these elements experienced by citizens?

3. And what is the physical appearance of cities?

This way you create knowledge on how the city lives, works, and interacts and you make all determinants equal. Although this tool has already been successfully applied and used for the municipality of Groningen (Bulterman & van der Velden, 2016), it is still in its infancy and needs steps towards digitalization for it to become a real-time monitoring, predictive and prescriptive analytics and learning model (int. expert 5). Also, the DSM is being created for analysing and connecting more urban systems, but what a risk can be here is that analysis paralysis might occur. By wanting to consider all the systems you might lose the overview and start to over-analyse a neighbourhood or city. This emphasizes that the 'why' question is even more important and should always be kept in mind when using these tools.

More tools that help put a value on ecology exist, but there are some pitfalls that should be considered. People know the existence of most tools, but do not know how they work. It takes

time to get to know them and to merge them in your way of working, but time is something stakeholder often do not have (workshop part. 1). If they do know how a tool works and use it practice, stakeholders might see themselves as experts and think they have the right knowledge or can create the right value. But then the risk is that the ecological system is forgotten and a technical approach to ecology is kept (int. municipal 4). Another pitfall is that there is too much information, tools, and experts that people simply do not know what knowledge they need and where it can be retrieved. Arcadis for example, has a lot of ecologists but many project managers do not know where to find them or who to contact (int. Arcadis 6).

> Int. Arcadis 6 - *"Unfortunately it often happens that there are people who have learned a trick and that they lay down a random plan that you could find in any garden that worked well. … We really do have them, but you just must have the luck or the awareness that you have such people in your house and that you can bring them in."*

It could help in this sense to create a clear overview of which tools can be used for what purposes and for what value and an overview of who within the company you can contact for what information (also about tools) and make it easily accessible and findable. This last one does not necessarily have to be an overview of specialists but can also be an overview of who has information on sustainability in the process. Table 3 is created to indicate what the pros and cons are for the tools mentioned before related to (urban) ecological systems.

Tool	Purpose	Pros	Cons
Quick scan	Scans if there might be protected species present in a project area.	It is quick and does not cost a lot. Early in the process overview of endangered flora and fauna not being in the area.	Does not look further than the project area and does not consider (greater) ecological systems. Often only exists of desk research. Is only concerned with protected species.
Based on		Int. expert 4	Theory and int. municipal 3 and expert 4
SMP	Contains measures, rules of conduct and agreements to enable spatial development, management and protection of the species concerned.	Takes an entire area into account which is helpful to be aware of impact and for future projects.	A very big project and can cost a lot.
Based on		Int. exp 2 and 4	Int. expert 4

Table 3 - Overview of tools to use (continued on the next page)

Tool	Purpose	Pros	Cons
Points system	A system where municipalities can set a certain minimum number of points that should be achieved in a project. Certain measures have a certain number of points.	Easily translate measures for building nature and green inclusive or draw up requirements on ecology. Developers or architects still have the freedom to choose their own mix of measures.	Ecology can be reduced to its technical features and approached as a checklist, where you can put up some birdhouses and plant some native trees and you can check off biodiversity.
Based on		Int. expert 2	Theory and int. municipality 4
BaRT	Monetising ecology by providing insights in the societal costs and benefits of resilient measures for a healthy living environment.	Helps in creating a value that can help convincing clients or developers to include ecology.	Ecology being approached technically, and systems are forgotten.
Based on		Dircke et al. (2019)	Theory and int. municipality 4
TEEB City	Sheds further light on the importance of green in relation to economic worth and social benefits.	Helps in creating a value that can help convincing clients or developers to include ecology.	Ecology being approached technically, and systems are forgotten.
Based on		Kennisportaal Klimaatadaptatie (n.d.)	Theory and int. municipality 4
DSS	A method that helps in understanding the complexity of cities. It offers the possibility to create knowledge and information about the various systems in areas.	Takes the multiple systems of cities into account and can help in getting to the why of a client.	Only considers quantitative measures of cities and no qualitative ones like social aspects.
Based on		Theory and int. expert 5	Theory and int. expert 5
DSM	A method that helps in understanding the complexity of cities. It offers the possibility to create knowledge and information about the various systems in areas.	Takes the entire city's systems into account and can help in getting to the why of a client. Also, considers qualitative determents. This way you can switch from how the city lives, works and interacts and you make all determinants equal.	Is still in its in its infancy and needs steps towards digitalization for it to become a real-time monitoring, predictive and prescriptive analytics and learning model
Based on		Int. expert 5	Int. expert 5

4.3 USING SYSTEMS THINKING

Transitioning to a systems thinking approach in urban development gives, as with ecology, certain challenges, and opportunities. Three main challenges came forward in interviews: there is no interest in other systems, no communication between disciplines and too little knowledge about the systems of cities. Already in the initiative phase, systems are sometimes treated as separate subjects that have separate visions. Only three of all analysed municipalities explicitly relate visions they have on nature and biodiversity to other systems and describe how it all is connected and what measures have impact on what systems (table 4). The municipality of Amsterdam, for example, analyses and describes topics like greenery, energy, affordability of housing and social safety together. As there are so little municipalities who take the relationship between systems into account, it cannot clearly be just because there is less money and less expertise. In this case it is probably because municipalities simply work sectoral and thematical and there is little communication between these sectors and themes.

Size of municipality	Connecting urban systems
Small	x
Medium	1
Large	2

Table 4 - Number of municipalities that acknowledge the relationships between different urban systems

Int. municipal 4 - *"Municipalities function very thematically, all separate sectors and separate columns."*

But this does not mean that they cannot be advised systematic. It can therefore be helpful to, just as with ecology, from the start ask a different question. Not what everyone is doing from their own theme, but what is the common goal? *"Why are we building? Because people want to live in the city? Yes, that is why you need housing. And what makes people want to live there? That may be because it is easily accessible, or it is a lively city, or the climate is pleasant to be in."* (int. municipal 4) When developing you can always go back to this goal and show the value of having an integral approach. This way disciplines can start seeing chances in others instead of the burdens. Currently people that work on infrastructures always only care about traffic and safety. If for example a city centre must become car free, space will become free. Infrastructural people will then lobby from their own interests for more space for bicyclists or pedestrians, while others would lobby for more public space, green space or maybe even buildings. This problem is common because there still is too little communication between disciplines.

Int. expert 1 - *"The gap between the civil engineer and the urban planner and ecologist, they do not yet speak the same language."*

Having a clear why and a common goal is therefore important to make the various experts speak in the same language. In this process of creating a common vision where all systems are integrated, knowledge is needed. Currently, even if this knowledge is there, it is only used in later phases than the initiative phase where the visions are constructed.

Int. Arcadis 7 - *"This also means that good integrated advice must take place in the process of the integral vision formation, and this is now often introduced by planners, urban planners and architects, who have too little feeling for the current reality of area development."*

This might be true, but urban planners and designers are currently seen as the people who should influence urban developments in more ecologically directions using their knowledge on

ecology and sustainable principles. On the other hand, this does not mean that they cannot ask ecologist to help in communicating this knowledge. Ecologists, who can use language as a tool and know how to talk to clients, do have knowledge about their own underexposed theme, but also to what it relates to. Also, the DSM can be a very helpful tool again. It can help in creating a common goal, but also in creating knowledge about the different systems that are in place in a certain area.

4.4 CONCLUSIONS

The tools and methods described to close the gap between challenges and opportunities can all be seen as niche innovations that can try to trigger a transition towards a new regime which is the start of the greater transition towards fully incorporating a new way of perceiving urban ecology. Similarities can be found when comparing the challenges and opportunities of ecology and the systems thinking approach. They either cope with the same challenges or become an opportunity for the other. Similar challenges are that there is too little interest in other systems, like the ecological system, too little knowledge, and too little communication between disciplines. The below overview is a summary of preliminary recommendations that are based on the challenges and opportunities of involving ecology and using a systems thinking approach. It describes what challenges they address and what pros and cons are for a systematic approach. These preliminary recommendations can be interpreted as first steps forward towards a new ecological paradigm for urban design.

Involve maintenance in the process

Challenge it addresses	ecological plans that that in practice do not work because of maintenance.
Pros	involving maintenance departments in the process can help in realising and keeping ecological plans as they were meant to be. They can help in advising what would work for them or what will not and what they have budget for and for what not.
Cons	no distinct cons have been identified except that municipalities have been and worked fragmented for a very long time, it can therefore be difficult to break this system and start working in a different way.
	it can be imagined that if maintenance departments are involved earlier in the process, that they start seeing only barriers and think everything is too expensive, resulting in no ecological plans being created.
Requirements or actions	it could help not involving maintenance in every step that has to be taken, but only let them analyse and test the designs that have been created to see if there are aspects that are not feasible at all. This way a balance is created in being involved earlier and being able to say anything about plans.

Quantifying or monetising ecology through tools like SMP, BaRT, and TEEB City Tool

Challenge it addresses   there being too little budget for ecology and that ecology is a soft concept, thus not being able to make strict requirements or value for developers.

Pros   easy to create the right value for developers and relate it to their business case. Ecology can be connected to the economic sub system in cities, and it can become easier for municipalities to set strict requirements to ecology like is done on safety and traffic regulations.

Cons   ecology is reduced to its technical features, resulting in the entire (urban) ecological system not to be accounted for. For tools to be effective niche developments, stakeholders must know they exist and how they work, this costs time which is often not available.

Requirements or actions   to make sure the other urban sub systems are also accounted for, it is important to relate the outcomes of the tools to other systems. Apart from providing information and instructions about tools on how and when to use them, training session could be organised so minimum time is needed when educating stakeholders about the tools.

Involve an ecologist earlier in the process

Challenge it addresses   other interests, missing value, and too little knowledge.

Pros   many ecologists have knowledge on ecological systems and can therefore link it easier to other systems which helps in convincing developers.

ecologists know what values including ecology can have for a project and are more likely to see the opportunities rather than the burdens.

Cons   not all ecologists are vocally very strong and are able to tell the right story that transmits the opportunities ecology can have.

a lot of disciplines and stakeholders would like to be involved earlier, but when they are they say that the plans are still too vague.

Requirements or actions   educate ecologists in a way that they get more knowledge on how to create and tell a story that becomes interesting for developers and make it clear to stakeholders which ecologist knows information about what subject. A balance should be found between being involved earlier and being able to say anything about the plans. Ecologists could then for example help in the initiative phase by giving advice on vision documents, and in the design phase by testing urban designs on ecological feasibility.

Find out what the core problem in an area is and the main driver for the client to develop somewhere

Challenge it addresses	other interests, missing value, and too little communication between disciplines.
Pros	having other interests can, from an ecological perspective, be overcome by value creation which can happen when ecology is seen as one of the dominant subsystems in cities. A way of making people aware of ecology as an important subsystem is through asking different questions, to figure out what the main motivation of the developer is and then by setting a common goal.
Cons	no clear cons of this recommendation have been indicated, but it should be noted that the common goal can be not at all ecology related, it can than become very difficult to convince others why its system should be considered.
Requirements or actions	the power of language should be used wisely here. If the common goal is nothing ecology related, then bridges should be found between the goal and the system of ecology. It helps if it is known which ecologists use language as a tool and know how to talk to clients and to educate ecologists on how to do this.

Int. expert 2 - *"Systems thinking starts with not only knowing your own bottlenecks, but also those of the other. It has to do with value creation and in the end your tool is of course just green, whatever it is and that can be anything. I always explain it as a cube. You have all these squares, and of course I am always working on the green square. But I am not crazy, I also see the whole cube and that you can use the green for the blue, so with water retention or with heat stress or with whatever. If you use that very well, you will convince everyone and if you then also say 'very nice that you do something with a roof garden but if you do it like this then it is also interesting for biodiversity and then you can immediately solve such and such problems.' Well then everyone wants to do it."*

Decision Support tools

Challenge it addresses	other interests, missing value, and too little knowledge.
Pros	tools, like the DSS and DSM, can help in making systems thinking more accessible, and give insights into the underlying problems of a dominant issue which often is a malfunctioning ecological system.

Cons	existing models often only consider quantitative data, linking only systems that can be expressed in numbers like the economic system to health and safety data. Social and ecologic, often qualitative, data are then not included, especially the data on how elements are experienced by citizens.
	it takes time to get to know these tools, especially as it is still in its infancy and needs steps towards digitalization for it to become a real-time monitoring, predictive and prescriptive analytics and learning model.
	analysis paralysis might occur.
Requirements or actions	the DSM is a model that does consider qualitative data, linking all urban sub-systems together. But it needs more work to be fully acknowledged and incorporated in the process of urban development. For people to actually work with the model informative sessions can be held that explain and teach stakeholders the existence, how they work and can be used.
	always keep the common goal in mind and ask yourself during the analysing process: *"am I still doing it for the cause of the common goal?"*

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Chapter 5

RESULTS II

VALIDATION OF PRELIMINARY RECOMMENDATIONS

A validation of the recommendations listed in the previous chapter (Chapter 4 - Results I) has been held through a workshop with various actors in the process of urban development and experts on systems thinking and ecology. Apart of validating the results, the recommendations have been related to the process of urban development. This is relevant because in this way an indication can be made who can be held responsible for certain actions which is essential for the tools and methods to be integrated and used. This results in a higher chance for the recommendations to trigger the desired regime change towards a systematic approach which considers all three sub systems of cities for urban development.
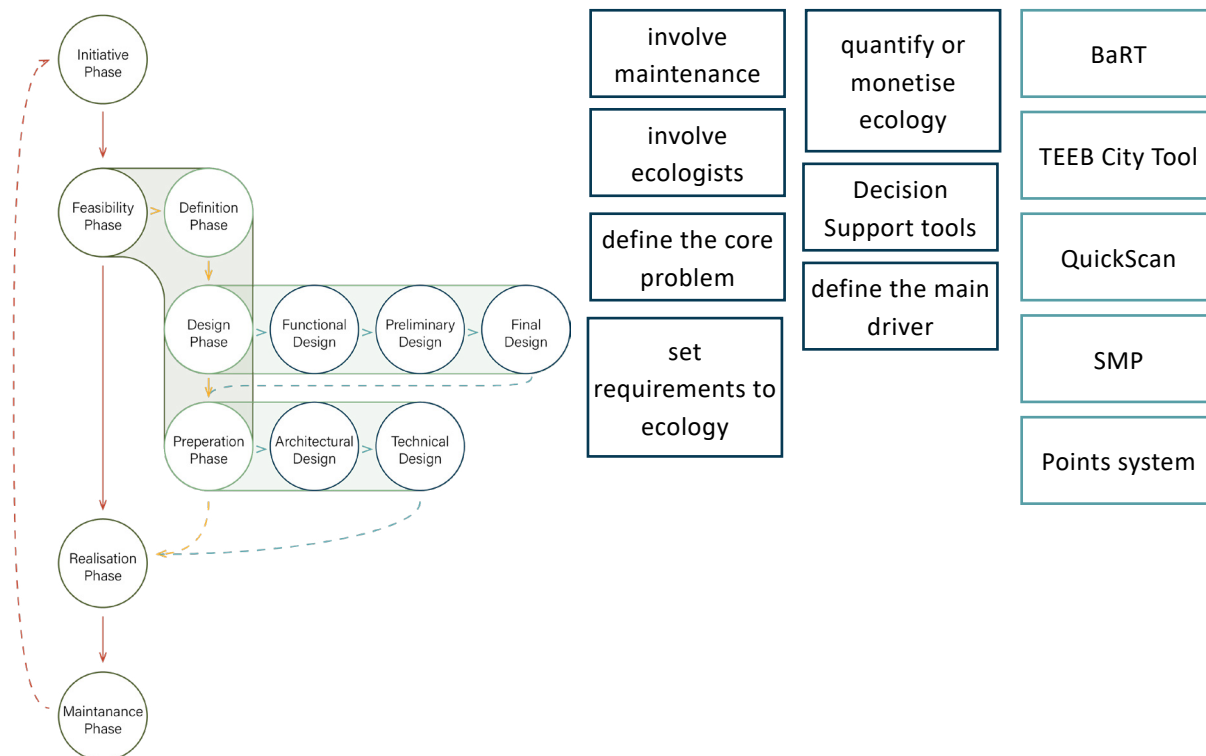
Fig. 13 - Input of the workshop

Fig. 13 shows the input of the workshop, based on this it is indicated where which opportunities have the chance to work and who can be held responsible for it to be implemented. The transcript of what is discussed in the workshop can be found in Appendix F. Fig. 14 shows a summary of the main take aways and indicates in what phase which recommendation has opportunity and gives a brief indication who could be held responsible. The results are divided into two parts: before the process and during the process.

> Workshop, part. 3 - *"…the closer you are to that initiative phase, the greater the impact can be in the field of ecology"* (min. 00.29.35)

5.1 BEFORE THE PROCESS

A main discussion point in the workshop was that it is very important to be in the process before it has even started. Defining the core problem and the main driver are recommendations that are most effective before visions even have been drawn up.

> Workshop, part. 8 - *"If we are going to move forward more, so together with the customer answer the question what is actually going on here, then you get a completely different approach to your step-by-step plan. My idea is that we anticipate and act on customer demand. I also think that a shift is taking place, that we want to get into the process much earlier and want to approach 'quality of life' from our motive. The question becomes much broader this way."* (min. 00.27.57)

Therefore, a new phase before the initiative phase should be created where questions are asked to figure out what is going on in the area. Why is this happening? And what is the end goal? This way, more can be achieved than needed by the law or asked by the client. It is about giving advise on how to create a context specific vision for whole areas, not just project based. In this pre-phase the entire system can be considered and relations can be found between the challenges and conflicts of different systems on different scales. It can then be easier to show what qualities ecology can have in relation to, for example, the social, economic, or maybe even educational systems. This is where the DSM (decision support model) can help, to create the knowledge and information needed about the various systems in specific areas. If it is used before the process has already started, more impact could be made in the rest of the process, trigger regime change from the start, and get to an urban development process where doughnut economics is acknowledged. It should be noted here though, that, as many workshop attendees mentioned, it is very important to work context specific. This means not just analysing common challenges and opportunities at the project scale, but also at the bigger scale, only then systematic change can occur.

> Workshop, part. 7 - *"I am just absolutely in favour of advocating an area-based approach. But you must have the right scale, if you have an area-oriented approach of one hectare, you cannot do much. If they are entire city districts or part of the city, you can do a lot. So, you also must find the right scale."* (min. 00.15.02)

The difficult thing here is, is that clients' questions are not drawn up like this and do not approach companies like Arcadis before visions exists. How are you going to make clients aware that you offer services that help in creating visions from a systems thinking approach, while also making them aware of the need for change. Participant 8 indicated that you should start with big partners your company already has or is going to get. It is easier to make them aware of a company's capacities and abilities than at smaller clients. As soon as the bigger partners are aware and start asking for services already before the process, the chance exists that smaller clients will follow, creating a domino effect of a start in regime change.

In this new phase it can also be very helpful to give municipalities and maybe even provinces advice on policies (participant 5). The law is a powerful tool to make ecology more important, as they eventually make the regime, and tools are being created, like the points systems, that help in creating requirements and policies on how ecology should be approached in projects.

5.2 DURING THE PROCESS

Beautiful as it is, waiting for companies to ask for consultancy services before the process would not trigger the regime change quick enough, we are already exceeding planetary boundaries which must be reversed as quick as possible. Although this is true, as one of the project managers indicated, it is important to always keep in mind that if you are at the beginning or at the end of the process of urban development, you can always at least make known what the potential is in the ecological field, at every phase in the process (part. 6). This does not necessarily have to be a success but at least you create a bit of awareness at the customer level, which can have impact in future projects. This way you might also be planting seeds at clients to ask consultancy services earlier or even before the process and create opportunities needed for regime change. The ecologist (part. 7) responded that this is very true, but it does not happen yet. Most of the ecologist just do what they are asked to do and what they are used to do. It

will never be the question of the client to do more and that is why ecologists should think much more in terms of existing opportunities, find elements or subjects you can relate ecology to in every phase of the process.

> Workshop, part. 7 - *"I have been working at Arcadis for years, I am very stubborn, but always try to create a plus. And that has always worked for me. I always play open card to the customer. I say look, you must do at least this from the law, but with a little bit of this or that, it is also possible to create added value here. Do you want that or not? And I have only heard yes."* (min. 00.54.07)

Initiative phase

During the initiative phase, tools like the TEEB City Tool and BaRT can be helpful to create a business case for ecology and to get it higher on the agenda of developers. Another way of getting ecology higher on the agenda is by setting strict requirements on the subject. In the new phase which starts before the initiative phase, help or advice can be given towards municipalities on how to set requirements, for example through points systems and SMPs (species management plans). In this phase the quick scan flora and fauna is also executed which is a tool only concerned with protected species and is done form the perspective of the law, to avoid problems. Especially the quick scan is not executed from the ambitions to realize something with a high biodiversity or a high ecological value (part. 6). This emphasizes the point that the law is a powerful tool, but when involving ecologists who know how to use their language to create opportunities, the quick scan could also possibly create more chances than just what is required from the law which helps with drawing up an integral SPvE in the next phase.

> Workshop, part. 7 - *"Compile a joint planning schedule of requirements, in which you not only show where the legal necessity is, but also how you can connect functions. Systems thinking will get you there."* (min. 00.16.58)

Feasibility phase

Throughout the different phases the feasibility phase consists of, it can then be very helpful to create more opportunities with a framework agreement (*raamovereenkomst*). This is an agreement between a client and, for example, Arcadis with the aim of managing multiple future projects over the course of a couple of years.

> Workshop, part. 3 - *"With a framework agreement you can show in a project where you are working on a final design that in the field of ecology this and this and this is something, we cannot do anything about that but no problem, because there will be more projects from that framework agreement, in which you hope to be able to make a difference by making the project leader aware of this and taking it up for follow-up projects."* (min. 01.12.07)

This is in line with what earlier has been said, creating awareness and planting seeds about the changing regime in current projects can help developers deal with this in future projects earlier. Also, it might seem as if nothing is to be done anymore, but you could, from a systems thinking perspective, still attempt to connect ecology to other themes and demonstrate how

ecology could contribute to the themes which can create opportunities for ecology. Another opportunity with a framework agreement is the possibility to link projects. Currently it happens that neighbouring projects are approached as separate in every way possible. Separate quick scans on flora and fauna are done and separate project visions are created. This, while valuable linkages could be created between projects, especially for ecology as this theme does not end at the project border.

In the design and preparation phase, architects think they already consider the ecological systems in their designs and preparations. But they are mainly concerned with what is already there, and how this can be preserved. This is all according to the Wnb, nothing more is done, and nothing is added.

> Workshop, part. 7 - *"Of course, you can only preserve it by eventually focusing again on the same species that are already there ... With that you comply perfectly with the law, and you can continue with that. But you do not really add much."* (min. 00.49.53)

Ecology might be high on the agenda for the designers, but the way it is can be improved. Involving an ecologist can help here. For example, the ecologist can walk around in the project area and immediately know what opportunities there are in an area. He or she can think along in the process, but also can test the urban plan and see if things can be improved or approached differently. The same goes for maintenance departments and companies, in this phase they can indicate what is possible budget wise and what is not. This applies also to the realization phase, where it is important by executers to involve ecologists if they notice if something is not working or is not able to be realised.
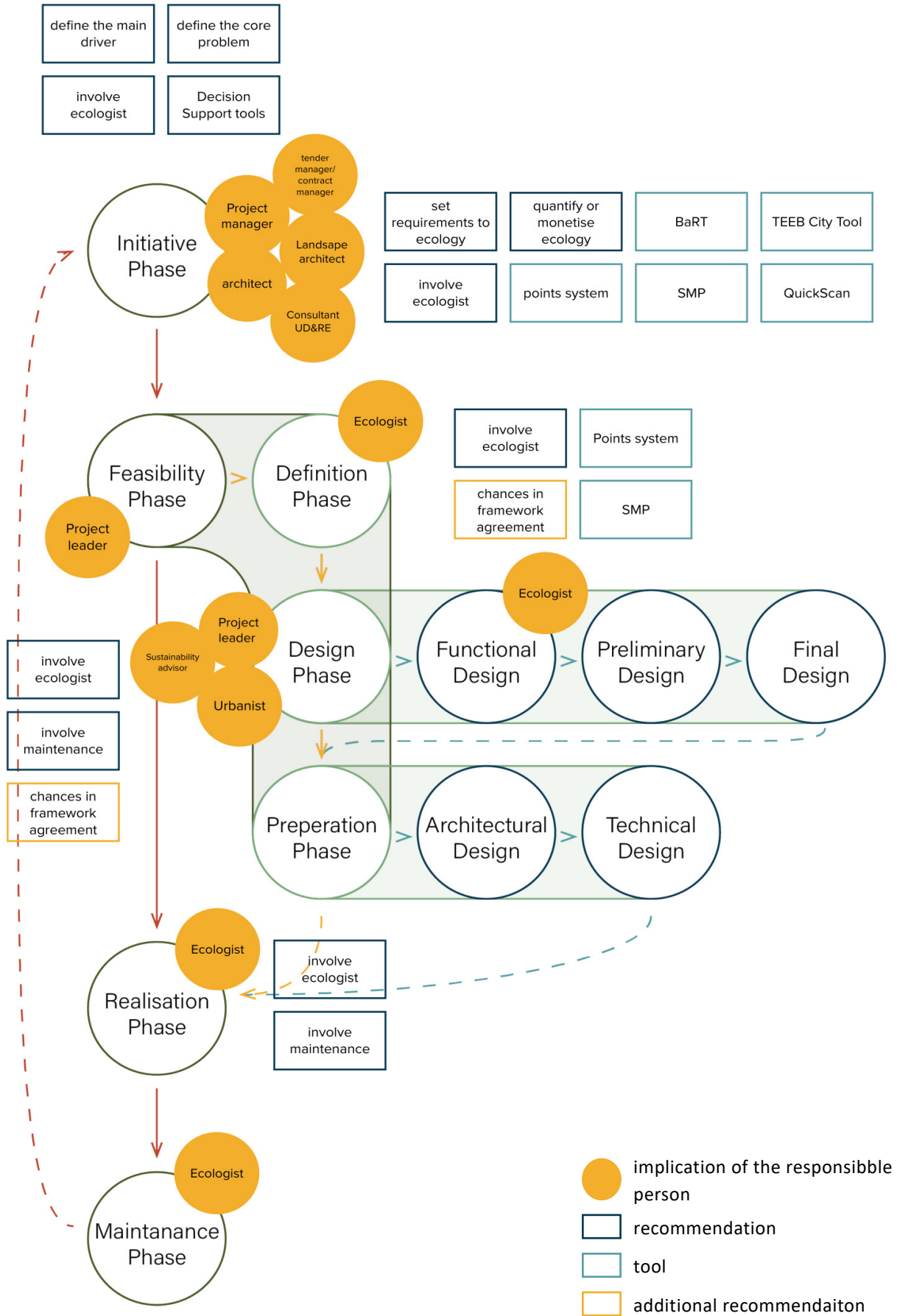
Fig. 14 - Conclusion results II

Chapter 6

DISCUSSION AND CONCLUSION

The executed research and theoretical framework are combined to tie all the findings together and to offer a comprehensive conclusion which summarizes the research project and answers the main question introduced in the introduction through final recommendations. This is followed by an overview of the limitations of the study and recommendations for further research.

6.1 INTERPRETATIONS

A transition to a sustainable urban development process happens, according to Geels (2005), through interactions between the landscape, regime, and niche level. External influences are needed to create small networks of actors in the niche to develop more sustainable alternatives to the ones present in the current regime, in this case the linear or fragmented approach to urban development. The goal is a new approach to urban development where the norms and rules in this new regime are based on a new paradigm consisting of the doughnut model of Raworth (2018) and systems thinking. Lawhon and Murphy (2012) describe a way of how ecological politics can be integrated into the MLP framework and Bai et al. (2016) and Shye (2012) have introduced ways to use a systems thinking approach towards urban development. Together they give nine steps, which creates a theoretical view on how to transition towards a regime where cities are developed from a systems thinking approach where ecology is more important. This thesis adds an in-depth look and recommendations on steps that need to be taken within the niche and socio-technical regime levels to get to the transition towards a new perception of ecology in cities. Below, the theory-based steps will be compared to the more concrete steps that have resulted from this research.

1. Context

The first step of how systems thinking can be approached is that the context should be considered. This step has not only been acknowledged by theory (Bai et al., 2016; Lawhon and Murphy, 2012) but has also been mentioned multiple times during the workshop and interviews. As workshop participant 7 indicated, systematic change can only happen when context-specific challenges and opportunities are analysed at the project and on a more extensive scale. Taking a wider view helps in linking social, economic, and ecological systems, which helps in understanding the regime a project is embedded in which might trigger new innovations and interventions. This should already happen before the development process has started. The context specific challenges should be sought so integral solutions and vision can be created. Currently it is often assumed that projects do not affect the urban systems of the city a project is embedded in, resulting in, in especially smaller municipalities, that wider contexts are not considered. This is probably due to there being too little money and expertise on urban systems within those municipalities. It is therefore crucial to create this knowledge so it can be used throughout the process which then slowly pushes the regime to change. Involving ecologists in this process can help as they can often have a more expansive view of a project and better understand and see windows of opportunities that might create regime change by creating linkages with other systems. Niche developments, like decision support tools or the SMP, can help municipalities and developers to consider a wider context in different phases of the process. Although these tools are time intensive, they can help with several following steps, like creating integral visions, setting common goals, and finding connected causes, challenges, and conflicts, which might yield time in later phases. Another tool that could help municipalities with pushing developers to create context specific projects is the points system. Important to note is that if these tools are to become niche developments that trigger change, they must be used and recognized by stakeholders, and specifically the points system, should be linked to other urban systems and challenges. Considering broader contexts also emphasizes the need for a new approach towards the quick scan flora and fauna, where currently there is a focus on project boarders and 'just' endangered species. Quick scans are often done from a political point of view

and to be in line with the law, but if ecologists already try here to create chances in relation to the surrounding areas instead of saying only what is not possible, new opportunities can be created from early stages on.

2. Vision creation

Visions should indicate what the desired future of an area is (Bai et al., 2016). Municipalities draw up vision documents in the initiative phase, where it can be important to create a long-term ambition and already acknowledge interconnected urban systems and with that also, the ecological system (Chye, 2012). Currently only few bigger municipalities look at the entire ecological system and even fewer try to link it to other themes, which is probably again due to a lack of money and expert knowledge. It could therefore be helpful to provide consultancy services before visions have been created to find out what main drivers for municipalities are or could be to develop in a certain area. This way also smaller municipalities can get an understanding in the importance of ecology and the connected values it can have with other systems. Through framework agreements companies can make known and create windows of opportunities at the client level to create visions where all systems are connected, ultimately benefiting the transition towards the desired regime.

3. Acknowledge connected causes, challenges, and conflictions

While creating visions or developing urban areas, it is not only important to think long-term, but also to recognize the interconnected causes of challenges in areas and what conflicting interventions could be. According to Lawhon and Murphy (2012), policymakers should consider broader, interconnected social and economic systems rather than focusing solely on one cause of environmental degradation. This could also be related to stakeholders of urban development. If everyone keeps their own discipline or theme as most important, an integral design will never be created, and ecology will never become more important. The entire system can already be considered at the pre-initiative phase, and relationships between the challenges and conflicts of various systems on various scales can be discovered. It will then be simpler to demonstrate the benefits of ecology in comparison to other systems. Decision support tools that consider all urban data, not just quantitative data, could help in gaining insights in all systems and what underlying problems and connected challenges are.

4. Setting clear and common goals

After acknowledging what connected causes, challenges and conflicts are, common goals should be recognised and set which is in the current regime very important if ecology is to be made more important (Bai et al., 2016; Chye, 2012). Setting common goals is a way of implementing a systems thinking approach when creating ecological inclusive designs. The goals should be set at the beginning of the process and be caried out in the rest of the phases. It will not work if in the design phase, for example, architects start to work with complete other goals which in the following phases are not acknowledged. It can also help municipalities, who work sectoral and have little communication between sectors, to create a basis from where can be communicated and negotiated when decisions must be made. Although connected challenges can be identified, it can still be difficult to set common goals related to ecology as developers are not always able to see the economic viability of improving ecological systems in cities. Tools like BaRT or TEEB City Tool can be helpful to monetise and create a business case around ecology or to relate the theme to other goals. Decision support tools can here again be helpful to get from the core problem to a common goal of the client and other stakeholders, including citizens.

5. Acknowledge the consequences of interventions

With a systems thinking approach the consequences of the set goals should be considered (Bai et al., 2016; Lawhon and Murphy, 2012). When showing what impacts including ecology has on the existing regime and how this can be changed ultimately benefiting the environment in many ways, stakeholders might be easier convinced about a goal or approach. Besides, when knowing what impact a certain development has, more informed decisions can be made ultimately creating opportunities towards the new regime.

6. Language as a power

Power is a crucial component for persuading others to agree with a particular viewpoint and language can be a crucial tool for conveying this power. Understanding how language is used and how networks are created can help to explain why certain alliances form around transitions as well as how decisions are made (Lawhon and Murphy, 2012). In the process of urban development language can especially be a powerful tool for ecologists when they are involved more in the process. Power in this sense is needed to convince developers to include ecological systems to eventually change the existing regime. As long as developers do not value ecology as important as other systems, it is about being able to tell and sell a good story. The interviewed ecologist emphasized this power and what can be reached with it. But not many ecologist exist or are involved who know how to tell the right story and use language properly to create opportunities for ecology. There are many ecologists who can only say what is not possible instead of what is possible and where greater chances exist. If this story is changed into what is possible and what chances there are in an area, developers will be convinced easier.

7. Create flexible designs

Any development established must be adaptable to deal with any future issues because they are not fixed in time (Bai et al., 2016; Chye, 2012). It should therefore be emphasized that when using tools like BaRT and TEEB City Tool, they should always be put in a bigger context and be linked to other systems. If ecology is always reduced to its technical features, its systematic qualities will not be exposed resulting in urban areas that still might not have a healthy urban ecosystem. Urban ecosystems could be basis for flexible designs as nature itself is flexible and can bounce back from unhealthy periods like we currently are in. Designers should be held responsible here to develop urban areas where urban ecosystems are preserved and improved to influence urban developments in a more ecologically direction. It can help to involve the ecologist again to think along or to test designs on the feasibility.

8. Successful implementation

Plans or developments that have been designed form a systems thinking perspective is beautiful, but only if they are implemented and executed successfully (Chye, 2012). If during the process maintenance systems are not acknowledged for and the common goals are vanished to the back, especially ecological plans would then disappear. It can here be useful to involve maintenance departments in design processes to assess designs on what is possible with the budget or abilities they have.

9. Involve a wide range of stakeholders

The steps and recommendations described before, create a way forward towards a new regime where the paradigm of urban ecology is excepted. They should be pushed and established by small networks in the niche. This is emphasized by the need for involving ecologists in every

phase of the process and maintenance in the design process. Even if you think you have enough knowledge it can be helpful to involve real experts as is noted by the interviewed landscape architect. The small networks currently exist mainly of ecologist and systems thinkers but should expand to other stakeholders of urban development like project managers, developers, and municipalities too. Therefore, a wider variety of stakeholders is considered in addition to ecologists and maintenance departments, which forces people to think more broadly and deeply about themes (Bai et al., 2016; Lawhon and Murphy, 2012). This way it is possible to transition to a new landscape of sustainable urban development where doughnut economics are the norm and not just the economic system is valued but is on equal level as the social and ecological system.

By comparing the research that has been done with existing theories, many similarities have been acknowledged. This indicates that recommendations described in the following section can not only be applied at the case company Arcadis, but can also be applied in a wider context, e.g., other companies or even other countries.

6.2 CONCLUSION

What is the potential of systems thinking for making ecology more important in the process of sustainable urban development in the Netherlands?

A systems thinking approach can have potential in several ways for making ecological systems more important in urban development and ultimately drive the transition towards a new landscape where ecology is perceived as something equal to humans. Different steps can be taken in the phases of urban development where different tools, methods or stakeholders can be involved to either create new niche developments or new insights in a desired regime.

Already before the process of urban development has started, in a pre-initiative phase, questions should be asked to find out what the main drive of developers and core challenges in urban areas are. Bridges can this way be created to make context specific and integral visions in the initiative phase, ultimately benefiting the ecological system. Including ecologists in this pre-phase can help in finding connected causes and challenges as they often know how to link their system to other dominant systems in an area and create the right value of ecology for developers. It is important that these ecologists know how to use language as a powerful tool and know how to create chances instead of only see burdens. Decision Support tools that consider not only quantitative data of cities, but also qualitative data can help in building bridges between systems by making systems thinking more accessible and give insights into the underlying problems of a dominant issue.

For ecology to become more important, ecologists should be involved throughout the process. They can help municipalities drawing up the laws and requirements on ecology in the new regime which can make the theme as important as, for example, safety rules. Niche developments that can assist in the initiative phase are points systems and SMPs. For points systems to work effectively and from a systems thinking perspective, they should be connected to other urgent challenges or dominant systems in an area. SMPs currently are mainly about preserving of what species are there, and not about how to improve the ecological system. The

same goes for the quick scan which is used in the initiative phase to avoid problems with the nature preservation law (Wnb). Connecting SMPs and quick scans with the points system could create new opportunities where it is analysed what is there and how this can be improved. Other tools that are useful in the initiative phase are tools like TEEB City Tool and the BaRT. These tools are niche developments that help creating monetary value of ecology for developers stuck in the current regime. They link ecology to other goals and acknowledge the value of ecosystem services compared to other themes. It should be noted that if these tools are to be niche developments with impact, they must be used and recognized by stakeholders and not be approached as an end goal. Through these tools ecology could be reduced to its technical features and entire systems can be forgotten, it is therefore very important that outcomes should always be linked to entire (urban) ecological systems.

In the feasibility phase, from a systems thinking perspective, chances should be created within framework agreements. Projects could be linked, and common goals could be established which is especially for ecology important as it does not know any boundaries and goes on further than the project. Also, in framework agreements awareness could be created in ongoing projects, where it might seem that minimal change is possible, about the changing regime which can trigger developers deal with this in future projects earlier. When the design and preparation phase start, it is important to keep in mind that flexible designs should be created because they must be adaptable to deal with any unforeseen future issues. Systems thinking creates linkages between different systems and acknowledges the importance of the ecological system. Ecology is a regenerative system, therefore designing from a systems thinking perspective would create flexible designs for urban areas. Involving ecologists in the design process and making them assess designs is a way of making sure that ecological systems are considered and interpreted correct, which should result in improved urban ecosystems.

In the following phases, focus should be on the successful implementation of these flexible designs. Maintenance departments are a crucial part in the process as they are the one responsible for ecological plans to work and be maintained ecologically. It can therefor be useful to involve maintenance so they can assess designs on their feasibility. If it is concluded that plans are not feasible it can be discussed together with the ecologists how alternatives can be created to still create improved ecological systems. Finally, throughout the phases a wide range of stakeholders should be involved which forces people to think more broadly and deeply about themes.

The above has shown how and what the potentials are of systems thinking in the different phases of urban development. This eventually benefits the desired transition towards a landscape where the paradigm around urban ecology is fully accepted which results in the perception of ecology as something that is equal to humans and is therefore always on equal level or even more important as the social and economic system.

Workshop, part.7 - "Ecology is part of the total area development. Just like the physical side, it also has a social and economic side" (min. 01.13.55)

6.3 LIMITATIONS AND RECOMMENDATIONS

6.3.1 GENERAL LIMITATIONS AND RECOMMENDATIONS

A limitation to the research lies in the case study of Arcadis. The research has been executed form the perspective of Arcadis, which has created a possible bias as the company already has a drive or whish towards a systems thinking approach and has a lot of ecologists and expert knowledge. An assumption has been made that Arcadis is a perfect exemplary company, but other companies might not have as much expertise or use different approaches towards urban development. Therefore, other companies could provide interesting views towards the topic as well.

Another assumption that has been made is that there is nothing wrong with the current process of urban development. This process has been the basis of the research and it has only been analysed what must be changed inside the phases. Although a conclusion is that a new phase should be added, it could be interesting to take a step back to see if the whole process could be approached differently for systematic change to be made easier or quicker.

A case study of the municipality of Huizen was included in the research's initial outline. Arcadis has a framework agreement with the municipality which currently has three on-going projects. Time restraints has led towards the case study to be dropped. The study might have provided detailed information on how the recommendations could be put into practice and on how certain stakeholders respond to certain actions. This could help in defining even more clearly what the new regime looks like and how to transition towards it.

As this research has shed light on what the potential is of systems thinking, it has made firsts steps to make concrete what actions need to be taken to make ecology more important and transition towards a new socio-technical landscape. One of these suggested actions is making a context specific business case of ecology. It can be very relevant research to figure out how this can be done and maybe to develop a generic framework that can help in making the business case. It can be helpful to make use of the tools introduced in this research or to create a new tool that combines them all. A decision support model where relations between systems are sought and costs and benefits are formulated, for example. Also, more research could be done on the phenomena of ecological gentrification and how in practice this can be overcome. This theory has been added after the data collection was finished and it could have been very interesting to study the causes and what exactly 'just green enough' means in practice.

6.3.2 LIMITATIONS AND RECOMMENDATIONS RESEARCH METHODOLOGY

Another bias that has been created is through the interviews with people from Arcadis. These interviews have mainly been held with stakeholders who have an affinity to ecology or sustainability, they already have a drive and knowledge on why ecology is important and often also already have the desire towards a systems thinking approach for urban development. Challenges have been interpreted correct, but it can be a next step to have an extra validation session of the opportunities with stakeholders who are more stuck in the current regime. The same counts for the second group of interviewees, the municipalities. Only this group has been considered as a party that needs to be advised in urban development. But another big part are private developers, a stakeholder group which is more focussed on economic growth

than municipalities. It can therefore be interesting to add to this research a fourth group of interviewees, developing organisations, to see how they view this initiated problem and drive towards transition. Also, my own role as an interviewer is something that has been overlooked. As I already believed in the systems thinking approach towards urban development, I could have steered, accidentally, interviewees to answers that I desired to hear. This has been a limitation of semi-structured interviews, which occasionally allowed me to stray from the topic or interview guide. This also means that not every respondent had provided the same answers to the same questions, which may have been avoided by adhering to a stricter, more formal interviewing procedure. This could have made it easier to acquire additional viewpoints on the same subjects. However, it should be highlighted that this might have come at the expense of the research's exploratory nature. A final limitation to this research has been that I have been the only one who coded the interviews and workshop, as well as the document that were analysed. Coding in groups can provide more comprehensive analyses and a wider range of insights.

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APPENDICES

If this research is physically read, then all linked files can be found here: https://ap.lc/IUL76

OVERVIEW OF INTERVIEWS

Click the interviews for the transcripts or go to: https://ap.lc/ihVfG)

1. STAKEHOLDERS OF URBAN DEVELOPMENT IN ARCADIS

Interviewee 1.1 - March 30, 2022   Project leader and advisor sustainability

Interviewee 1.2 - April 4, 2022   Architect, urbanist, landscape architect

Interviewee 1.3 - April 1, 2022   Project manager

Interviewee 1.4 - April 19, 2022   Project manager (has affinity with ecology)

Interviewee 1.5 - May 2, 2022   Project manager

Interviewee 1.6 - May 10, 2022   Project manager (has affinity with ecology)

Interviewee 1.7 - May 12, 2022   Senior project leader

Interviewee 1.8 - May 27, 2022   Senior urban designer (CalisonRTKL) (has high affinity and
                                    background with ecology and systems thinking)

2. STAKEHOLDERS OF URBAN DEVELOPMENT IN MUNICIPALITIES

Interviewee 2.1 - April 1, 2022   Senior project manager
                                    Municipality of Amsterdam

Interviewee 2.2 - April 21, 2022   Ecologist
                                    Municipality of 's-Hertogenbosch

Interviewee 2.3 - April 28, 2022   Project leader
                                    Municipality of Huizen

Interviewee 2.4 - May 2, 2022   Policy developer
                                    Municipality of Eindhoven

Interviewee 2.5 - May 16, 2022   Urban planner
                                    Municipality of 's-Hertogenbosch

3. EXPERTS ON ECOLOGY AND SYSTEMS THINKING

Interviewee 3.1 - April 5, 2022   Urban ecologist

Interviewee 3.2 - April 11, 2022   Senior advisor urban ecology
                                    Arcadis

Interviewee 3.3 - April 22, 2022   Ecologist

Interviewee 3.4 - April 26, 2022   Project leader nature and biodiversity
                                    Arcadis

Interviewee 3.5 - April 28, 2022   Ecologist and system analyst
                                    Arcadis

INTERVIEW GUIDE

1. STAKEHOLDERS OF URBAN DEVELOPMENT WITHIN ARCADIS

What does the current process of urban development look like?

1. What is your role within urban development projects?
2. What are different phases within urban development projects?
3. What phase do you work in?
   a. And what are your main tasks in these phases?
   b. What actions do you take?
4. Who do you work with closely?
   a. What roles?
   b. In what phase?

How is ecology approached in this current process?

1. Do you see that ecology has a priority in the question of the client?
   a. If yes, how do you make sure that this question is translated in the project?
   b. If not, do you do anything to include it?
2. What do you think is the added value of ecology in urban areas?
   a. Has this changed throughout the years?
   b. How do you make sure that this value is translated in the project?
      i. In what phase of the development process?
      ii. What are the challenges?
3. Do you see that the role of the ecologist is included in the process?
   a. In what phase?

2. STAKEHOLDERS OF URBAN DEVELOPMENT WITHIN MUNICIPALITIES

How is ecology approached in this current process?

1. What do you think is the added value of ecology in urban areas?
   a. Has this changed throughout the years?
2. Do you include this value in your policy documents, zoning plans or structure visions?
   a. If yes, how?
   b. If not, why?
3. What challenges do you see occurring when including ecology in urban development?

3. EXPERTS ON ECOLOGY OR NATURE IN CITIES OUTSIDE AND INSIDE ARCADIS

What are characteristics of ecology in cities that contribute to sustainable urban development?

1. What do you think is the added value of ecology or nature in urban areas?

What could be improved upon including ecology in urban development?

1. Do you see that this value is currently translated in urban areas?

    a. If not, why not?

        i. And how can this value be translated?

        ii. What are the challenges?

    b. If yes, how?

2. What is the importance of thinking in systems to apply ecology in urban development?

3. EXPERTS ON SYSTEMS THINKING OUTSIDE AND INSIDE ARCADIS

How can systems thinking be used in the process of sustainable urban development?

1. What do you think is the added value of systems thinking when developing cities?

    a. And how do you use this?

2. Is urban development currently being approached in a systematic way?

    a. If no, why not?

        i. And how can this be changed?

        ii. What are the challenges?

    b. If yes, how?

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CODE LIST

For quotations, click the themes or go to: https://ap.lc/x71z8.

THEME	CODE	SUB-CODE	N
Ecology			308
	Challenges		147
		Other interests	34
		Too little budget	15
		Soft concept	12
		Missing value	11
		Maintenance is forgotten	10
		It is seen as an obstacle	10
		Missing strict requirements	9
		Too little knowledge	8
		Technical approach instead of systematic	7
		Not knowing where the knowledge can be found	7
		Not able to monetize	6
		Different focus	5
		Awareness has to be created	5
		No communication	5
		Missing policy or enforcement	5
		Advisory group only comes too late in the process	5
		Not looking over the project border	5
		There is no ecologist involved in the process	4
		It is not asked so we don't do it	4
		Too many ambitions	3
		Think you have the right knowledge, but not true	3
	Opportunities		135
		Create the rigth value	25
		Make strict demands on ecology	20
		Involve an ecologist	16
		Create knowledge	10
		Create a business case	8
		Quantify ecology	8
		Ecology as a basis principle	7
		Ask the right question	7
		Know where the right knowledge is	7
		Create awareness	7
		Tools	6
		Connect the points system to other systems	5
		Involve maintenance	5
		Policy on private areas	5
		Give an example of how ecology can be applied	4

THEME	CODE	SUB-CODE	N
		Think more future minded and give less space to other disciplines or themes	4
		See the chancen instead of the burdens	4
		The same importance as other domains or themes	3
		Communication between disciplines	3
	The value of ecology		20
		It is the basis of life	9
		Ecosystemservices	5
		Risk management	3
		Improving quality of living environment	3
	Becoming more important		14
		Does not become more important	3
		In municipal policy	3
		It is more easily accepted	2
		More knowledge	2
		At citizens	2
	Why ecology should be applied		14
	Ecology in policies		5
	Ecology is integrated well		3

Systems thinking			44
	Challenges		16
		No interests in other systems	7
		No communication	6
		Too little knowledge	4
	Approach		15
		Show the value, what does it yield	5
		Involve an ecologist in the UD process	3
		Set goal	3
		Decision Support Model	2
		Ask a different question from the start	2
	Reasons why it should be implemented		15
	Missing in urban development		3
	Systems thinking is well implemented		2

Connection between ecology and systems thinking		19
	Ecology as part of systems thinking	10
	Systems thinking as solution for ecology	9

THEME	CODE	SUB-CODE	N
UD Process			17
		Integrity in the process	8
		Reason fragmentation	4
		Phases of urban development	3
		Too little thought about economic feasibility	1

CODING NETWORK

CHALLENGES

No interests in other systems	Too little knowledge	No communication

Ask a different question from the start	Show the value, what does it yield	Decision support model	Involve an ecologist in the UD process

Set goal

OPPORTUNITIES

CHAL

Not looking over the project border

Technical approach instead of systematic

It was not asked for so we don't do it

It is seen as an obstacle

No communication

Different focus

No ecologist involved in the process

Missing value

Maintenance is forgotten or is thought about too little

Other interests

Communication between disciplines

Involve maintenance

Involve an ecologist

Create knowledge/ awareness

Ecology as a basis principle

Know where the right knowledge is

Give an how ecol ap

Think more future-minded and give less space to other themes

The same as other the

OPPOR

Not knowing where the knowledge can be found

Think you have the right knowledge, but not true

Too little knowledge

Lack of awareness

Too many ambitions

Missing strict requirements

Not able to quantify or monetize

Missing policy or enforcement

Too little budget

Soft concept

Create the right value

Make strict demands on ecology

Ask the right questions

Tools

Quantify or monatize ecology

Policy on private areas

See the chances instead of the burdens

Connect the points system to other systems

Create a business case

example of ogy can be plied

importance domains or emes

GREY LITERATURE OVERVIEW

Through this link (or this website: https://ap.lc/zXZgS) the overview and analysis of all grey literature can be found. The literature concerns documents used in the different phases of the process of urban development and concerns the scales of municipality, province, and government.

WORKSHOP GUIDE

DATE   June 8th, 2022, 13h00 - 15h00

GOAL   Validate the conclusions of Results I, place them in the process of urban development and help in creating the final recommendations.

PLAN   The workshop is guided by a Mural Board which can be found in Appendix G. The most important challenges and opportunities are presented, and it is asked and discussed where the opportunities occur in the process of urban development, and which have the most potential. Step one is looking at where in the process which functions or roles are involved so that opportunities can be linked to functions, and it can become clear who can or must do what, where, and when. Step two is about discussing where these opportunities have the most potential in the process and to see which opportunities can be implemented.

PARTICIPANTS The workshop has been held with interviewees from group 1 and 3; Stakeholders of urban development within Arcadis and experts on systems thinking and ecology. The workshop has only been done with these groups as the recommendations and therefore this thesis is directed to the first group and the third group can give valuable insights and discussion points on how ecology and systems thinking are currently perceived in urban development. From group 3, only interviewees that work at Arcadis have been invited to get optimal insights and discussions on how stakeholders work and can work together.

Participant 1 - *Consultant urban development and real estate*

Participant 2 - *Global solutions director (internship supervisor)*

Participant 3 - *Group 1, Arcadis, interviewee 1 - project leader*

Participant 4 - *Group 1, Arcadis, interviewee 2 - architect, urbanist, and landscape architect*

Participant 5 - *Group 1, Arcadis, interviewee 3 - project manager 1*

Participant 6 - *Group 1, Arcadis, interviewee 4 - project manager 2*

Participant 7 - *Group 3, experts, interviewee 2 - urban ecologist*

Participant 8 - *Group 3, experts, interviewee 5 - expert on ecology and systems thinking*

AGENDA

1.   Introduction (10 min)

Welcoming and thanking participants. Sharing the mural link, going through the agenda and introducing everyone.

2.   Explanation and presentation of results (15 min)

Explanation of the focus group and introduce participants to challenges and opportunities.

3.   Validation and discussion (40 min)

Place roles and opportunities in the process of urban development and discuss the choices to find out which opportunity has the most potential. Is anything missing?

4. Conclusion (15 min)

Are we positive about how it looks like? Do we want anything to be changed?

5. Ending (5 min)

Thanking participants

TRANSCRIPT

The transcript can be found via this link (or this website: https://ap.lc/hZzvM), in which the most important statements are highlighted where the final recommendations were based upon.

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Agenda
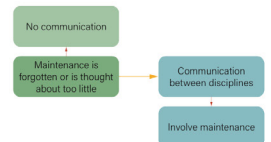
1. Introductie - 10 min
2. Uitleg en presentatie van resultaten - 1
3. Validatie en discussie resultaten - 40 m
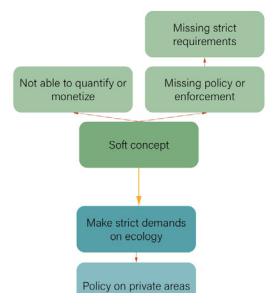4. Conclusie - 15 min
5. Eind - 5 min

Uitleg

Appendix G

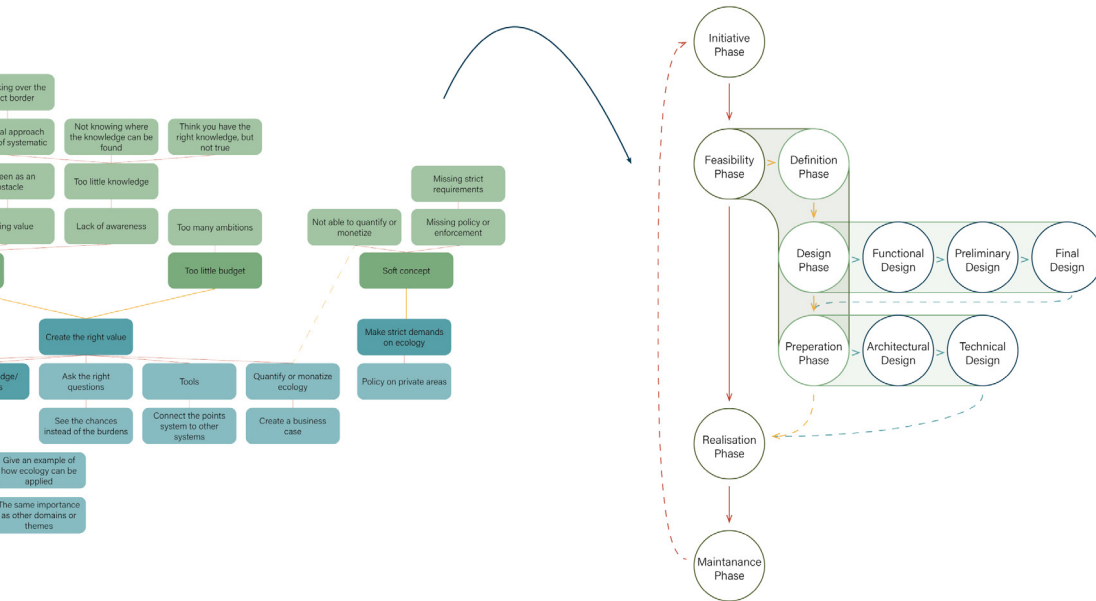# MURAL BOARD WORKSHOP

Resultaten

Onderhoud

Andere interesses en geen budget

Zacht concept

85.

Not knowing where the knowledge can be found

Think you have the right knowledge, but not true

al approach of systematic

en as an stacle

Too little knowledge

ng value

Lack of awareness

Too many ambitions

Too little budget

ng over the ct border

Missing strict requirements

Not able to quantify or monetize

Missing policy or enforcement

Soft concept

Create the right value

Make strict demands on ecology

dge/

Ask the right questions

Tools

Quantify or monatize ecology

Policy on private areas

See the chances instead of the burdens

Connect the points system to other systems

Create a business case

Give an example of how ecology can be applied

The same importance as other domains or themes

Initiative Phase

Feasibility Phase

Definition Phase

Design Phase

Functional Design

Preliminary Design

Final Design

Preperation Phase

Architectural Design

Technical Design

Realisation Phase

Maintanance Phase

Validatie

In het proces

Wie komt wanneer?

Wat komt wanneer?

Project leider

Duurzaamheids adviseur

Project manager

Landschaps architect

Steden bouwkundige

Ecoloog

Consultant UD&RE

Initiative Phase

Feasibility Phase

Definition Phase

Design Phase

Functional Design

Preliminary Design

Final Design

Preperation Phase

Architectural Design

Technical Design

Realisation Phase

Maintanance Phase

Stemmen

Goed idee en is haalbaar

Goed idee, maar meer voor nodig

Gaat nooit werken

Too many ambitions

Too little budget

Quantify or monatize ecology

Create a business case

he but

Waarde creatie

Onderhoud betrekken

Eisen stellen aan ecologie

Ecoloog betrekken

De juiste vraag stellen -> waarom wil een klant iets?

Kennis creëren

Tools - BaRT

Tool die inzicht geeft in de maatschappelijke kosten en baten van maatregelen voor een gezonde leefomgeving. Basis voor financieringsstrategie door koppelen kosten en baten aan stakeholders.

Tools - TEEB City tool

Tool rekent waarde van ecosystem services en van biodiversiteit. Niet alleen in relatie tot economische waarde, maar ook maatschappelijk. In een project berekent de tool de gunstige effecten van groene en blauwe oplossingen

Tools - QuickScan Flora Fauna (anders ingestoken?)

Tools - Soorten Management Plan

QS - per project bevestigen dat er geen dieren zitten (niet dat ze er wel zitten)
SMP - heel gebied in kaart brengen

Tools - Decision Support Model

Digital twin creëren inclusief kwalitatieve data. Hoe wordt een stad ervaren? Meerdere systemen van een stad meenemen en relaties leggen en zo tot de kern van een probleem komen.

Tools - Punten systeem

Lijst met maatregelen gericht op natuur en biodiversiteit waarbij elke maatregel 1, 2 of 3 punten waard is. Afhankelijk van de omvang en ligging van het project in de stad wordt een puntenscore voorgeschreven.

Tools - ...