Master Thesis

Maartje Bodde BSc.

To plan in the face of the unknown:

Dealing with uncertainties in Strategic Environmental Assessment

Colophon

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Abstract

Goal Uncertainties pose a challenge for the Strategic Environmental Assessment (SEA) of spatial plans. This is because political decisions are based on the outcomes of the assessment, with possible negative consequences for the environment and public health if predictions are inaccurate. This thesis examines how uncertainties can be successfully addressed, by creating and testing a conceptual framework for uncertainties and management strategies, their linkages and factors contributing to a successful application of strategies.

Research methods A qualitative approach is used provide a deeper understanding of (the management of) uncertainties in SEA. A general theoretical framework is created by using literature on SEA, uncertainties in environmental research and possible strategies to address uncertainties. The framework is tested in five case studies of spatial planning projects in the Netherlands. Semi-structured interviews are conducted with practitioners involved in the SEA process. An additional document analysis supports the findings of the interviews.

Findings A wide variety of uncertainties is identified, categorized into inherent, scientific, social and legal uncertainties. Most of these results are confirmed in the case studies, except for uncertainty in project organization. Uncertainty in the quality of methods is identified as a new type of uncertainty. Combinations of strategies are found to be successful. Especially addressing uncertainty in values and perceptions of stakeholders, where combining negotiations, customized norms and regulations and a monitoring program, ensure a sense of security for stakeholders and support for the spatial plan. It was not expected that social uncertainties would be addressed with other strategies than stakeholder involvement. As strategies are often aimed at providing just enough information, the success of strategies is mostly determined by the level of decision-making and the level of (legal) risk.

Recommendations Uncertainties can be successfully addressed if environmental limits, that result from either a worst-case scenario, stakeholder negotiations or additional research, are explicitly included in a monitoring program. This ensures a sense of security and a control mechanism for after decision-making. Recommendations to achieve this are to integrate SEA and the spatial planning process, provide guidelines for standardized tools, give a large role for experts of the NCEA during the process and after decision-making and push for a pro-active approach towards uncertainties. Lessons for future spatial development projects in the Dutch *Omgevingswet* are that similar uncertainties still exist, yet require a different approach: it is infeasible to assess alternatives and worst-case scenarios, and more successful to assess the carrying capacity, thresholds and a monitoring program.

Preface

'Life is like a box of chocolates: you never know what you're gonna get' – Forrest Gump

These words of wisdom are words to live by. In life, you don't know what you are getting into until you take a bite. Every new experience, is an experience you might not like, or it could be the greatest experience ever. This is certainly the fact when writing an MSc thesis, not knowing what to expect. The thesis that lies before you, is the result of an 8-month experience, with ups and downs, but mostly ups. The subject concerns a rather small niche within sustainable development, and I am not sure if I would have picked the subject, had I not had very inspiring discussions with several colleagues of what came to be my internship organisation: Arcadis. I was convinced about making a contribution to sustainable spatial development and a healthy living environment. And not only that, I was also able to perfectly combine my knowledge from my Bachelor's in Human Geography and Planning, and my Master's in Sustainable Development. As such, by providing knowledge on how the practice of SEA can be improved, and how it can prepare for the future *Omgevingswet*, I hope I can make a valuable contribution towards sustainable spatial development.

I am grateful I had the opportunity to speak to so many people in the field of spatial planning and SEA. I received so much enthusiastic response when asking for a brainstorm or an interview on the subject of uncertainties. Many people were willing to share their experience and perspective with much enthusiasm. Thank you for your time, and making this research project a success.

Many of the strategies that are identified in this thesis, as well as recommendations that are made, of course also apply to this research process. For example, the phasing of research in small, reiterative steps to ensure quality and progress, or the use of examples to find confirmation for what you are doing. And most of all, you do not have to do it all alone and you can ask for advice. Many other people helped during the process of this thesis. I would like to thank a few people in particular. First of all, I am thankful for the support of my parents and brothers, who always encouraged me to do the things I wished for, and who enabled me to have a wonderful student life for nearly 7 years. My boyfriend Frank, who had to put up with me during the full process of this thesis. Thank you for all your support, surprises, for 'taking me out' and for motivating me to keep going. Hens Runhaar, thank you for guiding me in the scientific process of this research. Your critical perspective and helicopter view helped me to focus on what was important, and your questions encouraged me to think twice. Karin van der Wel, thank you for guiding me during a period of 8 months, from start to end. We started together from scratch, and your views, ideas and experiences helped to shape the direction of this research. Jeroen van der Sluijs, thank you for helping me to understand and further shape the theoretical framework. Patrick Weijers, thank you for sharing your experience from SEA practice. Geert Draaijers, thank you for your perspective on suitable case studies for this project. Wim Bodde, thank you for your practical help. Last but not least, I would like to thank Rob Sjerps and Gabe van Wijk for providing me with the opportunity to study this subject and perform my internship at Arcadis.

I hope you enjoy reading my MSc thesis, and that it will indeed contribute to sustainable spatial development.

Maartje Bodde, BSc.

Utrecht, April 23rd, 2017

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List of abbreviations

EA	Environmental Assessment
EIA	Environmental Impact Assessment
SEA	Strategic Environmental Assessment
NCEA	Netherlands Commission for Environmental Assessment
AM	Adaptive Management
SV	Structure Vision
NURG	Nadere Uitwerking Rivierengebied
GIS	Geographical Information System
AA	Appropriate Assessment
DCGV	Development Company Greenport Venlo
C2C	Cradle-2-Cradle

CHAPTER 1: INTRODUCTION

1. Introduction

Strategic Environmental Assessment (SEA) is a policy tool to support decision-making regarding activities with serious impact on the environment. First introduced as a process to assess environmental effects of policies, programs and plans, it is now recognized as an instrument that can also help shape the design of those plans (Noble & Nwanekezie, 2016). It can be defined as:

'A process designed to systematically assess the potential environmental effects, including cumulative effects, of alternative strategic initiatives for a particular region…and in doing so inform the development of policies, plans or program.' (Canadian Council of Ministers of the Environment, 2009)

The tool is widely applied to assess spatial plans, as it generates environmental information to aid decision-makers in making informed, higher quality decisions for spatial development (Cardenas & Halman, 2016; Leung, Noble, Gunn, & Jaeger, 2015; Morrison-Saunders & Arts, 2004; Noble, 2000). The essence is to make predictions about future consequences of plans, even though it is generally understood that the future is uncertain. Addressing uncertainties in SEA is an important challenge, since political decisions are based on the outcomes of the assessment.

1.1 Problem analysis

SEA practice presents an interesting paradox: the more we know about our society and environment, the more we must acknowledge the large extent of uncertainty involved (Noble, 2000). Uncertainty can be defined as *"a situation in which a person does not have the required information to precisely describe, prescribe or predict an event"* (Cardenas & Halman, 2016, p. 25). The increasing size, level of abstraction and complexity of spatial development plans are an important cause for uncertainty (Liu, Chen, He, Tong, & Li, 2010). Thus, environmental impacts can differ between prediction and reality, with major consequences for the environment and public health. This is conflicting with the goal of SEA. "*If impact assessment is to be a sound decision-aiding tool, it must give consideration to uncertainties, identify means to manage those uncertainties and provide decision makers a better understanding of the consequences of their decisions*" (Leung et al., 2015, p. 121). Not dealing with uncertainty could lead to a situation in which decisions are made based on wrong information, possibly resulting in environmental disasters.

Uncertainties are often not well addressed: a large part of SEAs is inaccurate and unreliable, even though the results are presented as very certain (Cardenas & Halman, 2016; Fischer, 2007; Lees, Jaeger, Gunn, & Noble, 2016; Leung et al., 2015; Tenney, Kværner, & Gjerstad, 2006). Uncertainties are not acknowledged or communicated. Or, even if uncertainties are disclosed in SEA reports, it is not described in detail how to deal with these uncertainties.

1.2 Knowledge gap: the need for a comprehensive framework

Dealing with uncertainty in environmental assessments has been explored in scientific research to some extent, yet a review of these studies reveals that there is much more to explore.

Leung et al. (2015) wrote a state of the art review on uncertainty research. They reflect on scientific research addressing uncertainty in environmental impact assessments (Leung et al., 2015). A focus was found on quantitative uncertainty analysis, uncertainty communication and uncertainty avoidance. However, they found limited guidance in terms of a common conceptual framework for categorizing uncertainties and management approaches. The development of a framework could yield valuable insight into the range of uncertainties occurring during impact assessment. Leung et al. (2015) recommend to focus on theory building and exploring the utility of existing theories to better understand uncertainties.

Cardenas & Halman (2016) identified techniques from the literature to address uncertainties. Their analysis focuses on specific steps in decision making related to environmental assessment. Each decision-making step knows its own uncertainties. Options for the management of uncertainties are linked to specific types of uncertainties. The focus of this study is on impact assessment on the project level (EIA) and they recommend to perform additional research into uncertainties in environmental assessment on other, more strategic, levels (SEA). The scope of SEA is broad, forcing it to deal with accumulative impacts of different projects within a plan as well, especially in more complex spatial development projects (Verheem, 1992). As such, it is expected that different types of uncertainties and management strategies exist in SEA, compared to EIA. EIA is often performed for spatial plans that are more location-specific and therefore require a more detailed assessment.

Also, the framework of Cardenas & Halman (2016) for dealing with uncertainties was not tested in practice, and it is recommended to close the gap between scientific literature and practice. Morgan (2012) acknowledges there is a significant gap between best practice as presented in the research literature and application in real-life settings, resulting in a limited understanding of uncertainties and ability of research to influence in the practice of SEA.

Environmental assessment reports are also studied regarding the disclosure of uncertainties (Lees et al., 2016). Lees et al. find it is insufficiently addressed how uncertainties are considered and disclosed in practice. Communicating about uncertainties is important as there are risks associated with covering them up. It means decisions are made with incomplete knowledge, which could have devastating consequences. Lees et al. provide some useful approaches but identify a need for improved guidance to address uncertainties in SEA practice, as it is seldom addressed in detail how programs need to be set up. They recommend research that focuses on exploratory interviews with practitioners, initiators, and decision-makers how they consider uncertainty.

According to Runhaar & Arts (2015), there is no academic environmental assessment tradition in the Netherlands. Research on environmental assessment is limited, which could be explained because the tool was introduced after environmental regulations were already very mature in the Netherlands, or it is seen as an 'add-on' in the field of environmental research. However, the context of the Netherlands is interesting, because assessments are found effective and procedures are based on predefined regulations (Runhaar & Arts, 2015, p. 2). Furthermore, the Netherlands is one of few countries where an external expert commission is responsible to review the quality of assessments (Arts et al., 2012). Thus, it is expected that lessons for the successful management of uncertainties can be drawn from the, relatively unexplored, Dutch context.

1.3 Research objective and research questions

The present thesis adds to the body of literature on uncertainty management in environmental assessment by focusing on SEA for strategic plans, and exploring the utility of existing theories by applying the findings in real-life settings in case studies. This is done by designing a conceptual framework for uncertainties and successful management strategies. Exploratory interviews with practitioners, initiators and decision-makers serve to refine the framework and to find recommendations for the practice of SEA.

This thesis has two objectives:

1) To develop a framework for successfully identifying, categorizing, and dealing with uncertainty in SEA, by analysing empirical scientific literature on dealing with uncertainties in SEA.
2) To refine the framework in a practical application and draw lessons for SEA practice by applying it to case studies in the Netherlands.

The research objectives are achieved by answering the following research question:

How can strategic environmental assessment identify, categorize and successfully deal with uncertainties in spatial plans?

The following sub questions support the main research question:

1. What type of uncertainties occur in SEA and how can these be categorized?
2. What strategies are provided to deal with these uncertainties and how are these applied?
3. What factors contribute to the successful implementation of these strategies?

A definition and measurement of success is discussed in paragraph 2.4.5 (p. 22).

1.4 Scientific and practical relevance of the research

This research is scientifically relevant since it adds to the scientific debate on the management of uncertainties in SEA, and to successful strategies specifically. The project has an exploratory nature. It identifies categories of uncertainties and strategies, and strengthens the understanding and theoretical body of uncertainties by finding empirical evidence in case studies. It fills a knowledge gap on the utility of existing theoretical approaches to uncertainties on the strategic level of SEA. Furthermore, it fills a knowledge gap on successful implementation of strategies and factors contributing to or influencing the success.

SEA is meant to include the environmental impact of plans early in the decision-making process. The ultimate goal is to adverse significant negative effects on the environment and public health. According to the European Commission (2003), SEA needs to ensure '*that individual Parties integrate environmental assessment into their plans and programmes at the earliest stages, and thus help in laying down the groundwork for sustainable development*'. As such, this research contributes to sustainable development by optimizing information that is gathered in SEA.

This research is relevant for SEA practitioners because it provides knowledge and handles to improve the results of their assessment and to be more credible and legit towards stakeholders, especially decision-makers. Furthermore, it is specifically relevant for Dutch SEA practice, that is currently characterized by institutional change. A new integrated Planning and Environment Act (known as the *Omgevingswet)* will be introduced in 2019. It entails the integration of planning and environmental laws and the simplification of procedures (Altes, 2016). Noble & Nwanekezie (2016) argue that the role of SEA is sensitive to the planning context in which it operates. For example, if the legislative framework demands detailed information on a specific environmental aspect, a more detailed assessment of effects for that aspect is employed. This means that SEA integrates and adapts itself within the legislative context in which the spatial plan is formulated.

However, as Noble & Nwanekezie (2016) state it, the '*context is not an excuse for poorly conceptualized SEA'*. With the implementation of the Dutch Omgevingswet, spatial plans will change in the sense that they will be characterized by 'planning-by-invitation', flexibility and organic development. '*The government does not dictate a plan, but invites other players to put their ideas forward'* (Altes, 2016). This flexibility has consequences for the practice of SEA, that must deal with this flexibility and openness, inducing more uncertainty. Similar planning reforms occurred in the United Kingdom between 2001 and 2010, aiming to *'change strategic planning into a more proactive, creative, flexible planning practice'* (Gunn & Hillier, 2013). It led to planning practices where risks were minimized, and not dealt with proactively. This research provides valuable insights for practice into uncertainties and management options by studying current SEA practice as well as pilots for the *Omgevingswet*. The hypothesis is that lessons can be drawn for future SEA practice.

1.5 Outline

This chapter has introduced the problem of uncertainties in SEA and the knowledge gap this research project aims to address. The following chapter describes the theoretical framework by discussing important elements of the SEA process, type of uncertainties and management approaches (strategies). Chapter 3 presents the methodology that is used in this research project, a comparative case study approach, and a short introduction to the Dutch planning and SEA context. The individual case study results are presented and discussed in chapter 4, followed by the comparative case analysis in chapter 5. The research questions are answered in chapter 6 by drawing conclusions from the results and providing recommendations for future research and practice. Chapter 6 also contains the theoretical implications of this research, limitations and a general discussion.

CHAPTER 2: THEORY

2. Theoretical framework

2.1 Introduction

The aim of this research is to develop a framework for identifying, categorizing, and dealing with uncertainties in SEA for spatial plans. Predicting environmental impact of spatial plans is difficult, because of the uncertainty inherent to these predictions. Empirical research has developed many methods to quantify these uncertainties in models and deal with them. However, as we will see in this chapter, in post-normal literature it is recognized that some uncertainties cannot be quantified or solved and ask for a different approach.

The main concepts of the theoretical framework and their relation are outlined in this chapter. First, the concept of SEA will be explained. Second, a definition and categorization of uncertainties will be given based on a literature review of uncertainties in environmental research. Third, possible strategies for dealing with uncertainties are discussed regarding uncertainties they are meant to solve. Fourth, a measure of successful management of uncertainties is discussed, together with an exploration of possible factors influencing success.

2.2 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) finds its origin in the National Environmental Policy Act (NEPA) in 1969 in the United States. It was introduced to address the poor consideration of environmental aspects in proposed activities like policies, plans and programs (Fischer, 2003). SEA can be defined as a systematic decision support process aiming to identify, predict, evaluate and mitigate environmental effects of proposed actions before decisions are made (Fischer, 2007, 2012; Morgan, 2012). For spatial plans, environmental effects can be interpreted in the form of physical changes, as they are linked to specific locations.

The main goal of SEA is to take environmental interests into account in decisions of the government on initiatives and activities of public and private parties. This is achieved by gathering, analysing, and evaluating environmental information. This information can be used by decision-makers, stakeholders and environmental experts to develop, review and discuss policy options that meet decision-makers' goals and that are environmentally friendly (van Doren, Driessen, Schijf, & Runhaar, 2013).

It is widely accepted that SEA should be a systematic process, yet SEA is not a homogenous or standardized activity. SEA varies due to decision-making culture, legislation, planning systems and government structure (Hilden, 1998). Several procedural steps can however be identified as general phases in SEA (Figure 1). Stakeholder involvement is not visualized in Figure 1, since stakeholders can be involved in any of the procedural steps through communication or active engagement.

SEA functions on a rather abstract level, ensuring environmental considerations in strategic decision-making processes (Tetlow & Hanusch, 2012). The scope of SEA is therefore broad, forcing it to deal with accumulative impacts of different projects within a plan as well, especially in more complex spatial development projects (Verheem, 1992). A regular practice in Environmental Assessment is tiering: linking decisions on a higher strategic level to lower, more concrete programs and projects. This aims to ensure that decisions at SEA level are implemented in further activities (Kirchhoff, 2011). This interplay between levels of abstraction can also play a role in dealing with uncertainties, for example by moving responsibilities for dealing with uncertainty to the detailed level of land-use plans and/or permits.

Since its initial implementation, SEA is increasingly showing its contribution towards the inclusion of environmental impact in spatial plans. It leads to changes in the planning process, raises awareness of environmental implications of decisions and it has a widespread application (Tetlow & Hanusch, 2012).

Difficulties in SEA of spatial plans are encountered as well (Ascough, Maier, Ravalico, & Strudley, 2008):

- Spatial plans are complex and therefore not always well understood.
- Problems and solutions are subject to values which makes decision-making difficult.
- Stakeholders have competing interests and different levels of knowledge and expertise.
- Many solutions exist and wrong decisions can have serious impacts on the environment.
- Decision-makers often suffer from a lack of public trust.

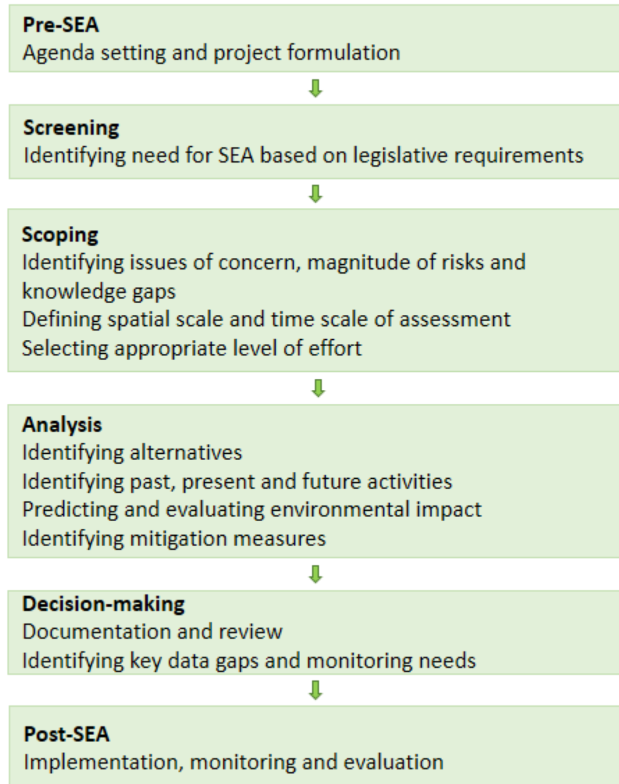

Figure 1: SEA process (Fischer, 2007; MacDonald, 2000; Zhang, Kørnøv, & Christensen, 2013).

These issues influence decision-making regarding the inclusion of environmental issues in spatial developments. In this perspective, SEA seems to be a reactive process that is subordinate to planning developments. SEA is continuously developing towards a more proactive process (Tetlow & Hanusch, 2012). It has a large potential for decision-making if it is focusing on plan-shaping activities, integrated into the planning process, and if it is flexible and fit-for-purpose. A better management of uncertainties could contribute to the potential of SEA.

2.3 Uncertainty in environmental research

SEA is concerned with the estimation and prediction of environmental effects of future activities, and uncertainties are therefore an unavoidable part of the assessment process (Larsen, Kørnøv, & Driscoll, 2013). A large part of empirical literature is aimed at uncertainties in SEA, yet this is often based on quantifiable uncertainties in models. The reality is much more complex as there are both internal (changes in environment due to the plan) and external (social, economic, and political climate) uncertainties. It needs to be assessed what these uncertainties are. This paragraph describes a definition of uncertainty, and a typology of uncertainties.

2.3.1 A definition of uncertainty

Several definitions for uncertainty are found in the literature. Walker et al. employ a broad definition that '*uncertainty is any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system'* (Walker et al., 2003, p. 5). Other definitions are '*not having the required knowledge to precisely describe an event and its characteristics'* (Cardenas & Halman, 2016); '*a lack of confidence about knowledge relating to a specific question'* (Sigel, Klauer, & Pahl-Wostl, 2010)*; 'incomplete knowledge about a subject'* (Ascough et al., 2008). Brugnach et al. (2008) add a nuance to these definitions: any deviation from complete knowledge also means that there is not a unique understanding of the system; there could be '*multiple understandings*'. Uncertainty then includes a lack of agreement amongst stakeholders, which is important since stakeholder involvement plays a large role in complex spatial plans.

Since the goal of SEA is to provide information about environmental effects of a spatial plan, uncertainty means the information that is provided is not sufficient (Figure 2). If the information provided is insufficient, an accurate impact prediction of environmental effects cannot be made, which means that effects can turn out different. Based on the above definitions, uncertainty in SEA means that there is:

‘incomplete information, false information or doubts about information on environmental effects of a spatial plan’.

Uncertainties are complex because decisions need to be made before any real evidence is available, wrong decisions can have large impacts on environment or health, the knowledge is limited due to unquantifiability and the influence of values (Van der Sluijs, 2016).

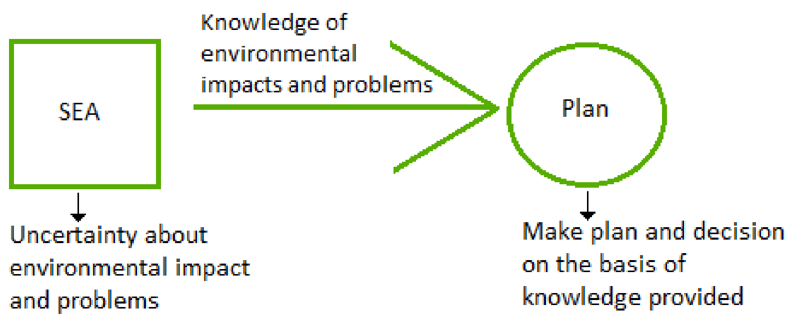

Figure 2: The relation between SEA, uncertainties and a plan *(Larsen et al., 2013)*: *SEA provides knowledge about environmental effects and this information is used to make decisions.*

2.3.2 A categorization of uncertainties

The literature on environmental research offers many different typologies of uncertainties (Table 1). There are some differences and similarities in these typologies, but it becomes mostly clear that there is not a commonly shared agreement on a generic typology.

Reference	Types of uncertainty
De Marchi 1995	Scientific, legal, moral, societal, institutional, proprietary, situational
Walker et al 2003	Location: context, model Level: statistical, scenario, recognized, total ignorance Nature: epistemic, variability
Brugnach et al 2008	Unpredictability, incomplete knowledge or multiple knowledge frames about the natural system, technical system, or social system
Pahl-Wostl et al 2007	Lack of knowledge due to limited data Understanding of the system Unpredictability of factors in the system (randomness) Diversity of rules and mental models that determine stakeholder perceptions
Maier et al 2008	Data uncertainty, model uncertainty, human uncertainty
Ascough et al 2008	Knowledge uncertainty: Process understanding, model/data uncertainty Variability: natural, human, institutional, technological Linguistic uncertainty: vagueness, ambiguity, underspecificity
Broekmeyer et al 2008	Data or methods/knowledge gaps, inherent to complexity/ecological systems, societal interpretation of effects and values
Maxim & Van der Sluijs 2011	Location in a model: content, process, context of knowledge Sources: lack of knowledge, variability, expert subjectivity, communication

Table 1: Typologies as defined in literature

The typologies differ depending on the discipline and context of where it is applied. For example, De Marchi (1995) assesses uncertainties in environmental disaster management and therefore includes a broad range of contextual and societal types of uncertainties. On the other hand Walker et al. (2003) have a more technical focus on complex ecological systems and models. Both typologies a relevant for SEA as it must deal with methodological issues concerning the assessment of environmental effects and stakeholder interests that might influence the planning process. An interdisciplinary framework is created that supports decision-making, including social perspectives on uncertainties and linkages to decision-making stages. The typology created is a borrowed composition of the uncertainties as presented in Table 1 and follows the definition of uncertainty that was described in paragraph 2.3.1. A distinction was made between incomplete information, false information, or doubts about information. This leads to a typology as visualized in Figure 3. This typology is further explained below and constitutes the basis for the theoretical framework in this research project.

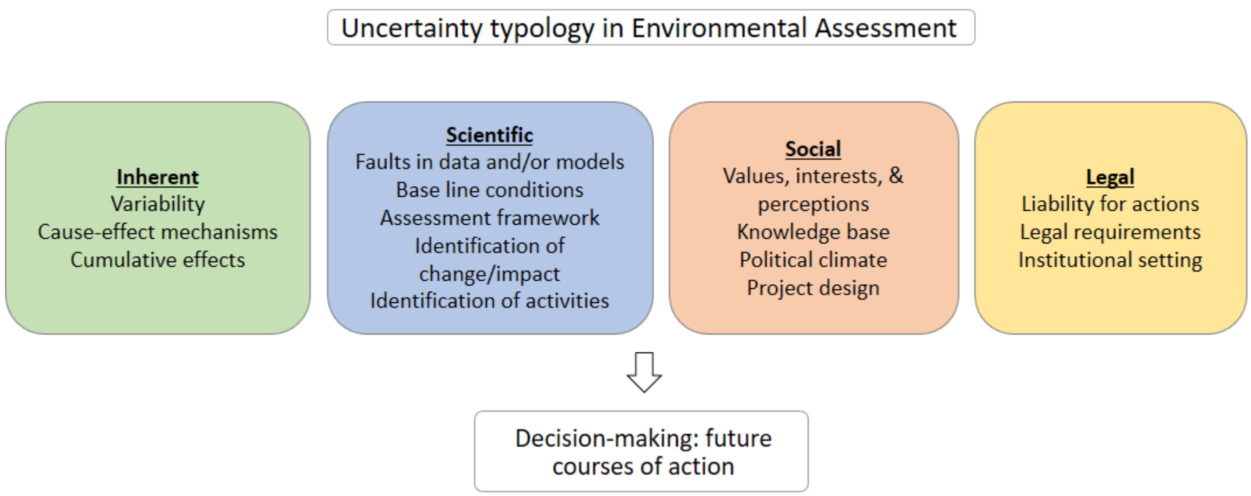

Figure 3: Typology of uncertainties in SEA

Inherent uncertainty

Inherent uncertainty is inextricably connected to the unpredictability of natural, human and technological systems. It refers to having limited or incomplete information that might not be solved by additional research or empirical efforts (Ascough et al., 2008; Brugnach et al., 2008; Sigel et al., 2010; Walker et al., 2003). *For example: uncertainty about the spread of pollution through air or water.*

Variability of the natural, human and technological system means it is unclear how the environment will react to impacts, and what system boundaries are regarding spatial and time scale. For SEA, it means that the full range of options and impacts of an activity cannot be known. Our knowledge of the natural, human, and technological system determines how we represent these properties in the environmental assessment, and how we design tools to evaluate their impact. Understanding environmental processes is important since **cause-and-effect mechanisms** are studied and impact can only be established if these relations are well understood. Causes and effects are difficult to identify in the case of very complex systems, such as climate change, where incomplete knowledge leads to inadequate representation of environmental aspects.

Uncertainties also arise in the assessment of **cumulative effects** (Phillips, 2005). Air pollution is a good example for cumulative effects: if the scale of a proposal increases, effects become indirect and increase as they complement each other, called accumulation. This can be induced from multiple sources about which data can be lacking.

Often uncertainties exist on the verge of reducibility. For example, inherent uncertainty about climate change effects can be reduced by improving data analysis, models, and parameters. However, despite of improvements to models, there will always be some uncertainty inherent to the natural system which we cannot understand. The reducibility of uncertainty strongly relates to determining how we deal with uncertainty (Sigel et al., 2010).

Scientific uncertainty

Scientific uncertainty entails having limited or false information about phenomena due to 1) technical reasons such as faults in models or data, or 2) a translation of the practical problem into the scientific problem. It is also known as epistemic uncertainty and can be reduced by performing additional research (Ascough et al., 2008). For example: uncertainty in the selection of indicators and criteria for assessment.

Technical

Data and models are extensively used in the environmental assessment process, to identify the current state of an environmental aspect and to determine the magnitude of effects due to spatial developments. Data can also help to compare alternatives and determine a preferred alternative with least significant effects. Uncertainty about data can occur due to a limited access to information, measurement errors, type of data (analysis) and presentation of data (MacDonald, 2000; Maxim & van der Sluijs, 2011; P. Phillips, 2005; Wood, 2008). Also, data might become invalid in the long-term due to greater variability, depending on the time horizon that is selected. **Faults in data** seriously influences the impact prediction in this phase.

Data about **base line conditions** is a specific issue. Baseline conditions include the developments, impacts and environmental dynamics that would occur even without the proposed activity. Baseline conditions are a critical starting point, as they provide the benchmark against which assessments are predicted. Difficulties often exist with regard to measurement errors in assessing baseline data and estimating future baseline changes without the project (Wood, 2008).

Models are simplified assumptions of the real world, but never fully accurate since it is not exactly the same as the real world (Pavlyuk 2016). Uncertainties can occur with regard to the model structure, variables in the model being analysed, cause-and-effect mechanisms and parameters (Cardenas & Halman, 2016). To study environmental effects often generic models are developed and used to find consistency in the research methodology, and overcome uncertainty due to **faults in models**. However, this also means that relevant interactions and variables that are unique to the situation are being overlooked.

Translation of the problem

Not only faults in data and models lead to uncertainty about impact predictions, uncertainties also exist in the choices of data, methods, and statistics, in other words the **assessment framework**. Science is looking for measures to represent phenomena, that may not help to solve the practical problem. It applies to SEA in the sense that indicators are selected to study environmental effects, that may not be the best representation of the real environment (Jeroen P van der Sluijs, 2016). This is strongly connected to our knowledge on environmental systems. Indicators that can be selected have different processes at different rates and scales, and have to be a representation of the actual state of the environment (MacDonald, 2000; Pavlyuk, 2016; Wood, 2008).

Furthermore it can be difficult to determine **the changes and impacts** that are attributable to that change (Cardenas & Halman, 2016; Pavlyuk, 2016; Phillips, 2005; Wood, 2008). The impact can differ in magnitude, persistency and delay effect and other characteristics. Thresholds are used to determine this, often in the form of standardized measures. The appropriateness of that threshold level is not always clear. Not all impacts can be articulated in a threshold value.

Apart from determining changes and their impact, it is first necessary to determine past, present and future activities for a spatial development (MacDonald, 2000; Phillips, 2005). To create an inventory of all activities, a large amount of effort and input is needed from different stakeholders. It is still not clear if a complete picture is then created. Especially **future activities** are difficult to include, since they occur over a longer time scale, influenced by many other factors.

Social uncertainty

Social uncertainties refer to doubts or ambiguity about information. It is caused by differences in human behaviour, values, and interpretation. The role of social uncertainties in environmental research has only *been recognized recently and the challenge is to account for human input in the decision-making process (Ascough et al., 2008). For example: norms or values that influence methods or outcomes of the assessment.*

Social uncertainties are caused by a divergence of **values, interests and perceptions** of environmental components (Cardenas & Halman, 2016; Maxim & van der Sluijs, 2011; Petersen et al., 2014; Thissen et al., 2015; Wood, 2008). There can be conflicts of interest regarding the objects to be studied, and different world views regarding what is important. This subjectivity has influence on the framing of the problem in the scoping phase. It entails the demarcation of the study, determining what is studied and what not. It also entails the selection of criteria and indicators. The system boundaries and impacts that will be assessed are a result of negotiations between stakeholders.

The **political climate** might also influence whether an environmental problem is addressed, which alternatives are considered and selected (Maier et al., 2008). Political groups or lobbyists can have a large influence on the outcome of the decision-making process. It depends on the societal context and the period. It could also mean that politicians pursue political goals and overrule environmental issues.

Knowledge frames and capacities of stakeholders are strongly related to inherent and scientific uncertainty. It entails our understanding of the environmental processes at hand, but it also entails an understanding of what information is delivered in SEA. This depends on the capacities and skills of responsible persons such as policy makers and project managers (De Marchi, 1995).

Lastly, social uncertainty can exist in the **project design** for the SEA process. This entails organizational factors, procedures, resources, and coordination among stakeholders (Maxim & van der Sluijs, 2011; Pavlyuk, 2016; Phillips, 2005; Wood, 2008).

Legal uncertainty

Legal uncertainty, has to do with the decision-making context. Decisions that are made in an SEA need to be justified and decision-making approaches depend on goals, performance measures and assessment criteria (Maxim & van der Sluijs, 2011). For example, new legislation on specific environmental aspects could pose uncertainty about how to include this in the SEA process.

The decision-making context poses uncertainty as to what information the SEA needs to deliver. The task of supplying information is imposed on the initiator of the spatial plan (Wood, 2008). Often, legal guidelines exist to address the type and amount of information that needs to be delivered in SEA to make a decision. However, uncertainty increases when the decision-making context changes due to **legal developments**. As was described in chapter 1, the SEA process is sensitive to legal developments.

Ascough et al. (2008) highlighted the need to include institutional aspects into the decision-making process. They define the formal and/or informal rules or procedures for decision-making. Also, the **institutional context** influences rights and responsibilities, and shapes the degree of power and influence (Wood, 2008). For SEA, it could mean there is uncertainty in what agreements can be made to solve other uncertainties, and about responsibilities to deal with this.

Furthermore, De Marchi (1995) describes legal uncertainty as the 'future contingencies of personal **liability** for actions or inactions. The people included in an SEA process, amongst which are the initiator, consultants and decision-makers, are often primarily concerned with making their assessments and decisions appear defensible and political palatable (Leung et al., 2015). Providing information about significant impacts in a worst-case scenario, or uncertainties in the assessment, can have consequences for the public image, social trust, legitimacy, and political acceptability. The public can use this kind of information to appeal to a proposal, or at least policymakers feel that this is the case.

2.4 Strategies for dealing with uncertainty in SEA

The subject of uncertainties has been extensively explored in the scientific community which has led to a wide variety of approaches. Approaches were first mostly channelled towards quantifiable uncertainties and reducing these through additional research and modelling (see for example Walker et al., 2003). A new paradigm emerged addressing uncertainties in a more strategic way (Thissen et al., 2015). Estimates of effects can be determined with scientific methods to a limited extent: a margin for uncertainty remains (Figure 4). This is where governance becomes relevant, as it is important to address these margins during the process of environmental assessment.

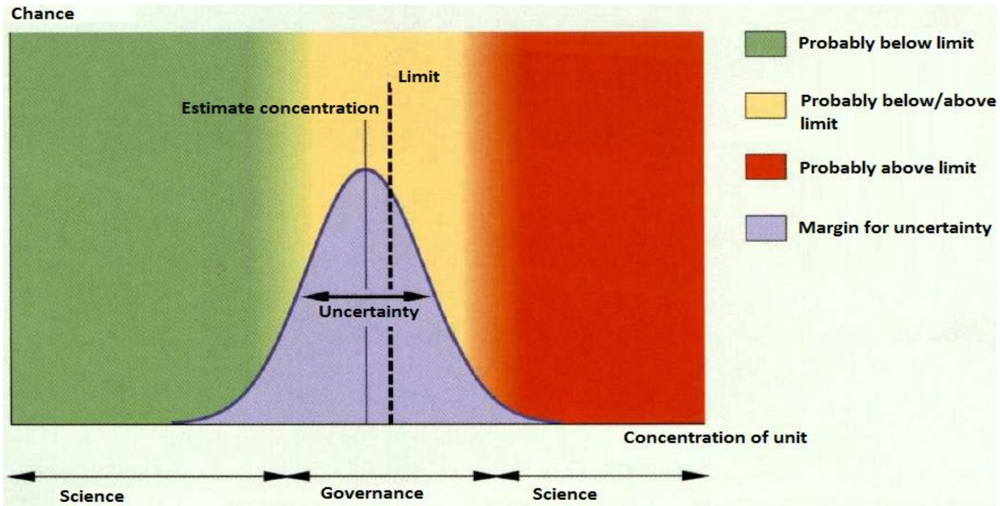

Figure 4 Limits to scientific knowledge to determine norm exceedance (Draaijers et al., 2010)

The first step in dealing with uncertainties is to acknowledge their existence, and then to manage and control the possible effects (Commissie voor de Milieueffectrapportage, 2011b). There are different strands of literature on this topic with methodological options or management options. The strategies are categorized and visualized in Table 2 and Figure 5, showing their linkages to uncertainties that are further discussed in this paragraph. The categories of strategies are adaptive management, precautionary principle, knowledge generation and stakeholder involvement. In this paragraph a short description of each strategy is given, including their goal and which type of uncertainty they aim to reduce. Figure 5 also shows a measure of success for addressing each of the four uncertainty categories. This will be further explained in paragraph 2.5. Not all uncertainties are covered by a strategy (Figure 5). This is when direct linkages were not found in the scientific literature. This research project might contribute to this knowledge gap, by identifying new linkages in the case studies. These might prove the existence of those uncertainties and identify strategies to address them.

Strategy: Uncertainty:	Adaptive management	Precautionary principle	Stakeholder involvement	Knowledge generation
Variability	X	X		
Cause-effect mechanisms	X	X		
Cumulative effects	X			
Faults in data and/or models	X	X		X
Base line conditions		X		X
Assessment framework	X		X	
Identification of change and impact	X		X	X
Identification of activities	X		X	X
Values, interests and perceptions			X	
Knowledge base				
Political climate				
Project design				
Liability				
Legal requirements				
Institutional setting				

Table 2: Overview of what strategies can be employed to address each type of uncertainty based on literature research

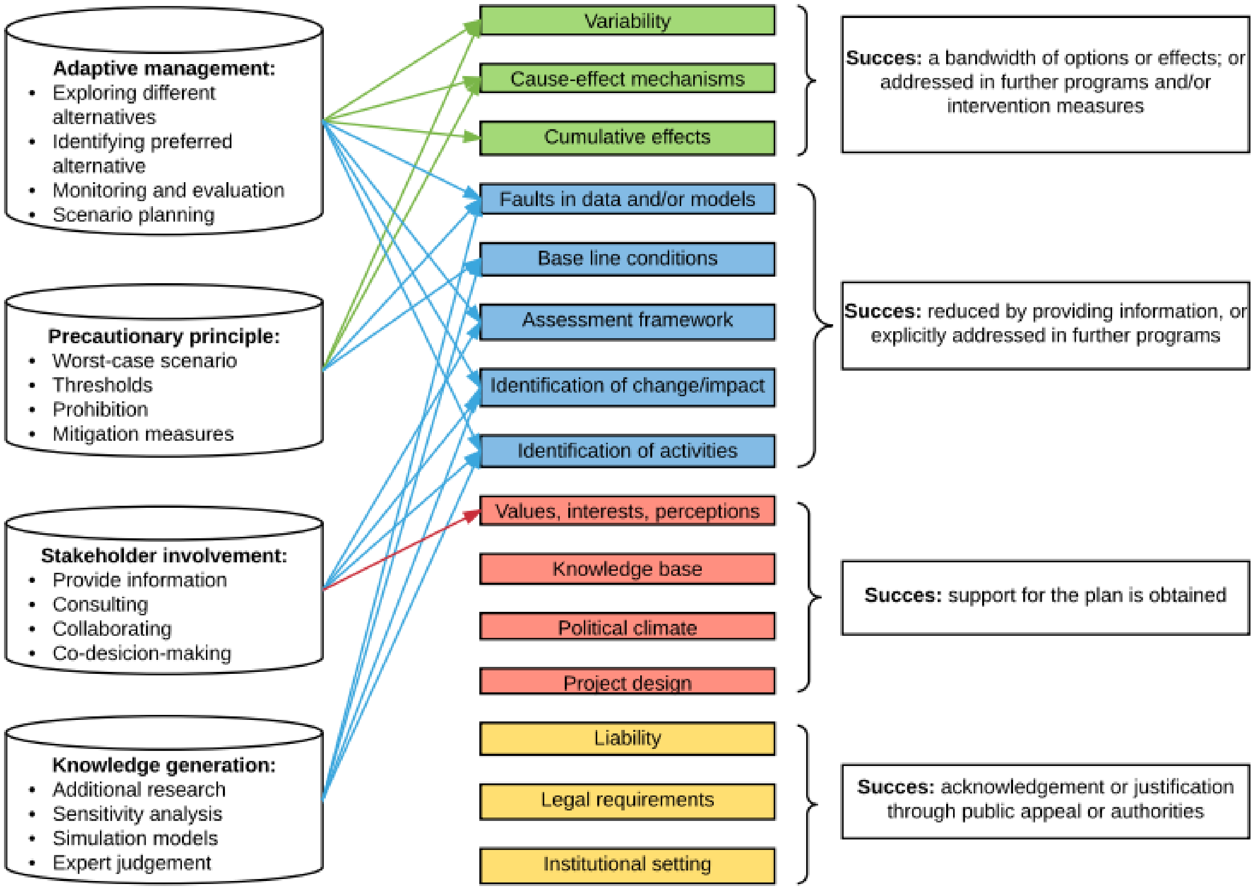

Figure 5: Theoretical framework: Linking uncertainties to strategies, based on literature research

2.4.1 Adaptive management

Adaptive management (AM) is a management approach that can be implemented when knowledge is incomplete, and managers and policymakers need to act despite inherent uncertainty (Allen & Garmestani, 2015). The goal is to reduce uncertainty, build knowledge and improve management over time. AM was first introduced by Holling in 1978 as an environmental management design that integrates environmental, economic, and social elements of an activity from the beginning of the design process. The concept is based on resilience literature in which variability in a system is accounted for with different methods and techniques, aimed at reducing uncertainty (Holling, 1978).

In empirical literature, AM approaches are mostly used to deal with inherent or scientific uncertainties (Figure 5). First, AM helps with uncertainty about the **identification of future activities** and the **identification of change and impact**. Planning activities are not always defined into detail, making impact prediction complicated (Canter & Atkinson, 2010). It does so by generating multiple management actions when effectiveness of management actions is unknown, by identifying multiple possibilities and managing the preferred alternative (Canter & Atkinson, 2010; Cardenas & Halman, 2016). Second, AM helps when there is uncertainty about key criteria, local thresholds and carrying capacity of an area (the **assessment framework)** (Canter & Atkinson, 2010; Noble, 2000; Partidário & Arts, 2005). And third, AM deals with estimates of natural **variability**, **cumulative effects** and the identification of **cause-effect mechanisms** (Canter & Atkinson, 2010; MacDonald, 2000).

Adaptive management is, like SEA, not a strictly defined, homogenous management process. Different flexible approaches with feedback of information exist. Noble (2000) describes AM as an '*exploration of different alternatives to meet a management objective, a prediction of the outcome of these alternatives, an implementation of one alternative and monitoring to learn about the impacts*'. The identification and selection of alternatives and monitoring are recurrent approaches. Allen & Garmestani (2015) also speak of the identification of alternatives, followed by evaluation. Monitoring serves as a mechanism to check for assumptions about options, impacts and assessment criteria. Furthermore, monitoring can document experiences and lessons learned from a project regarding inaccurate predictions, measurement errors, data gaps (**Faults in data and/or models)** and interpretation (Lees et al., 2016; Pavlyuk, 2016). The emphasis of monitoring is on 'measured change' and documenting cause-and-effect relationships (Morrison-Saunders, 2005). This means that monitoring is less effective when dealing with unquantifiable uncertainties, or when no information is available. It also requires an explicit monitoring protocol and a mandate for actors to intervene if negative effects occur (Broekmeyer, Opdam, & Kistenkas, 2008).

Brugnach et al. (2008) describe scenario planning and experimental approaches as adaptive management applications. The aim is to develop flexible solutions that can adapt to changing conditions and unexpected developments. MacDonald (2000) acknowledges this by describing AM as an iterative process where the current condition is used to determine subsequent actions.

The best asset of adaptive management is its capacity to deal with flexibility in future developments. It can adapt to changing events, decisions and circumstances (Noble, 2000). Yet, it requires several prerequisites, such as strong base line data and agreement amongst stakeholders. A major drawback of AM is that detectible changes need to occur before changes in management can be made. This means that when effects are irreversible, risks are high, or there is a long time span before effects occur, AM might not be suitable (MacDonald, 2000; Williams, Szaro, & Shapiro, 2009).

2.4.2 Precautionary principle

The key concept of the precautionary principle is that it protects humans and the environment against uncertain risks by means of pre-damage control (Refsgaard, van der Sluijs, Højberg, & Vanrolleghem, 2007). The principle entails that '*where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'* (United Nations, 1992). It means that harm from an activity should be prevented when there is any suspicion of harm, even when there is no strong evidence yet. The initiator will need to take mitigation measures or prove that it is not harmful (Lempert & Collins, 2007).

It applies to inherent uncertainty and scientific uncertainty as well. The approach is used in cases where there is uncertainty about the interpretation of data or natural **variability** of the system, but mostly in general when knowledge is limited (Broekmeyer et al., 2008). Furthermore, it addresses uncertainties in **models and model outcomes**, **data gaps** and **cause-effect relations** (Hoekstra, 2012; Lempert & Collins, 2007; Pavlyuk, 2016).

Employing the precautionary principle can be done in different ways. First, a worst-case scenario is often adopted (Broekmeyer et al., 2008; Hoekstra, 2012; Phillips, 2005). Choosing a worst-case scenario means to represent the conditions and impacts of a spatial plan in the most conservative way. It can limit potential negative consequences when it is not clear how to measure a specific impact, or when limited information is available on certain effects. It strengthens the robustness of decision-making as exposure will always be within acceptable limits. Second, standardized principles or thresholds are set to limit harmful effects (Lempert & Collins, 2007; Raadgever, Dieperink, Driessen, Smit, & Rijswick, 2011). These thresholds are set based on the worst-case scenario, and activities that exceed the thresholds are prohibited. Prohibition of activities is a third application of the precautionary principle. Activities are then only permitted if scientific certainty is provided that significant negative effects are excluded (Hoekstra, 2012). Fourth, the precautionary principle entails the design and implementation of mitigation measures to reduce effects after decision-making (Broekmeyer et al., 2008; Pavlyuk, 2016).

The precautionary principle is an important decision-making criterion when activities have to be assessed that are highly uncertain (Lempert & Collins, 2007). A major disadvantage is that it cannot balance competing goals and might therefore lock developments. The application of the approach is dependent on values and perceptions of stakeholders as to what environmental issues are important and what uncertainties are urgent to resolve (Hedelin, 2008).

2.4.3 Stakeholder involvement

Stakeholder involvement can lead to reductions in ambiguity, increased support for the implementation of a proposed activity and more robust decision-making (Canter & Atkinson, 2010). It is a rather generic term that can be understood in many ways. Its definition depends on the purpose and the uncertainty situation at hand, and differs by mode, degree, and timing (Pavlyuk, 2016). Scientists, experts, interested parties and affected communities are part of the 'stakeholder group'. Stakeholders that have no direct interest in activities as they are not directly affected can also be consulted to bring additional knowledge and understanding of issues and concerns.

Active involvement of stakeholders helps with uncertainties about the i**dentification of future activities, change and impact and assessment criteria**, and when the **values, interests and perceptions** of stakeholders are likely to be very different (Cardenas & Halman, 2016). This is because involving stakeholders can help to display heterogeneity among a set of stakeholders, and a better understanding of this variety and power relationships. This serves to assess the full range of possible options and impacts, and to get to an agreement on the course of action. When there is room for interpretation of environmental indicators and impacts, stakeholder involvement can help to provide more consistency and transparency by communicating about uncertainties (Broekmeyer et al., 2008).

Stakeholder involvement knows many shapes and forms. According to Pavlyuk (2016) it entails activities such as informing, consulting, reaching consensus and negotiations. Refsgaard (2007) describes stakeholder involvement as enabling stakeholders to communicate issues of concern, using (non-scientific) knowledge of stakeholders and involve stakeholders actively in the quality control of the SEA process. The application of stakeholder involvement obviously entails a degree of inclusion. The levels are identified as providing information, consulting, collaborating and co-decision-making (Cardenas & Halman, 2016). It allows values to evolve by placing emphasis on possible heterogeneity among a large set of stakeholders. According to Isendahl et al. (2010) stakeholder involvement also means to create trust among actors and to communicate mutual expectations. It is important not to pretend to be certain when one is not (false certainty) and consider interdependencies.

Stakeholder involvement is best applied at the start of a project, when stakeholders can have a large impact on finding assessment criteria and alternatives, and jointly consider the options.

2.4.4 Knowledge generation

Knowledge generation is most applicable to reduce knowledge-related uncertainty that can be solved by performing more or different research. Several knowledge generation strategies can be described, yet this is not exhaustive. Generally, any approach that yields more knowledge can be gathered under the umbrella of knowledge generation.

Uncertainties that are addressed by knowledge generation include the full range of uncertainty about **future activities, change and impact predictions, measurement errors, faults in models** and **data gaps**.

Expert judgement is used to identify options and impacts when the full range is not known (Brugnach et al., 2008; Cardenas & Halman, 2016). Inviting multiple experts to the discussion leads to transferable knowledge guidelines, benchmarking or standardization. Subjective (qualitative) information can be used when quantification is not possible.

Additional research can be performed to compensate for absence of data. With sensitivity analysis, results that are most sensitive to variability can be identified by adding variability to the model responses. This can reduce uncertainty about thresholds (Cardenas & Halman, 2016). Furthermore, data can be gathered using simulation models. Computer models aid the process of problem analysis; it allows for quantification of the effects (Brugnach et al., 2008). Simulation models can analyse dynamics of a system under consideration.

Not all research approaches necessarily complete the knowledge base. They are useful, especially in combination, for the identification of the need for more research or better data, or to design and improve monitoring plans. Employing research strategies is however an approach that requires a lot of effort. The cost, time, and urgency of a problem should be taken into consideration when choosing to do more research (Brugnach et al., 2008).

2.4.5 The successful implementation of strategies

This research aims to address a successful implementation of strategies. To do so, it is relevant to discuss when uncertainties are successfully dealt with, and what factors determines their success. However, the scientific literature provides little guidance on these topics. Some key factors for successful practice were found. These are discussed in this paragraph, and their relevance is tested in the case studies.

When dealing with uncertainties, success is not easily defined. Although the scientific literature offers several studies on what strategies to employ to address what types of uncertainty, a measure of success is not provided. Neither are there any broadly accepted standards to recognize success. Success can be framed as a measure of consistency in goals, input and output. Yet if these goals are rather vague, a declaration of success could be illegitimate. A lack of success would be easier to define, as it would mean uncertainty still exists in the same shape at the time of decision-making. Arguably, this means that to be successful, something about the uncertainty needs to change. A measure of change to determine success is also recognized by Allen & Garmestani (2015, p. 87): '*What changed as a result of action in relation to the project goals and objectives?*'. Connecting this to the goal of SEA, which is to inform decision-makers on the consequences of plans and programs, successful management of uncertainties would provide decision-makers with a better understanding of the consequences of their decisions (Leung et al., 2015, p. 121). This definition of success is still rather vague, yet Allen & Garmestani (2015) offer several indicators that help to recognize success, which are: 1) stakeholders are actively involved, 2) progress is made towards management objectives, 3) results of the assessment are used to adjust decisions, and 4) implementation is consistent with applicable laws. Because each type of uncertainty imposes a different need for information, management and progress (which is hypothesized in this thesis), different definitions of success are identified, based on the previous argumentation. Textbox 1 presents the four types of uncertainty and their definition of success.

Where discussions on the measurement of success of uncertainty management strategies was sparse, the same applies to factors contributing to this success. A few factors are identified and discussed here. However, as they have not been explored to a large extent, they are not included in Figure 5 yet. The case studies aim to improve the knowledge on successful management of uncertainties and factors contributing to or influencing the success. The results can be found in paragraph '5.2 Strategies and their success'. A revised theoretical framework is presented in paragraph 6.2.1 'Theoretical implications', in Figure 11 and Table 14. Factors that were identified in the literature review are <u>the level of uncertainty and controllability</u> (Allen & Garmestani, 2015), <u>the level of urgency and risks</u> (Broekmeyer et al., 2008), <u>knowledge and experience</u> (Hedelin, 2008) and <u>the level of abstraction and goal of the plan</u> (Weijers, 2016).

Inherent	
Definition:	unpredictability in the natural, human and technological system
What is uncertain:	the full range of options and impacts
Successful:	a bandwidth of options or effects is identified; it is explicitly addressed in further programs and/or intervention measures are explicitly available
Scientific	
Definition:	limited or false information about phenomena due to technical reasons or the translation of the practical problem into a scientific problem
What is uncertain:	outcomes of models are inaccurate or not representative
Successful:	reduced by providing information, or explicitly addressed in further programs
Social	
Definition:	doubts or ambiguity about information
What is uncertain:	differences in values, interests and perceptions influencing choices in the SEA process
Successful:	support for the plan is obtained
Legal	
Definition:	decision-making context
What is uncertain:	the justification of decisions, provision of information and acceptation of methods and results
Successful:	acknowledgement or justification through public appeal or authorities (NCEA and/or the Council of State)

Textbox 1: Types of uncertainties and their measure of success

CHAPTER 3: METHODS

3. Methods

3.1 Introduction to research methodology

This research project has two objectives: 1) to develop a framework for categorizing and successful dealing with uncertainty in strategic environmental assessments, by analysing empirical scientific literature on dealing with uncertainties in environmental research, and 2) to refine the framework and draw lessons for practice by applying it to case studies in the Netherlands.

The previous chapter has outlined the relevant research concepts. This chapter describes how the concepts are tested in a comparative case study. Five case studies in the Netherlands are selected to refine the framework. A triangulation of methods can ensure the achievement of more robust results (Verschuren & Doorewaard, 2010). Thus, a combination of literature, official publications and documents and interviews are used to find answers for the research questions. The research strategies are further discussed in this chapter.

3.2 Case study analysis in the Dutch context

3.2.1 Planning culture

A comparative case study is employed by studying five spatial projects in the Netherlands. As was described in paragraph 1.2, the Dutch context is specifically interesting because assessment are effective, and quality of SEA reports is ensured by an expert commission, which is unique (Arts et al., 2012; Runhaar & Arts, 2015). This means the Dutch context might provide lessons for the successful management of uncertainties in SEA. Since SEA addresses the environmental impact of spatial plans, a short introduction to the Dutch spatial planning context is relevant.

The Dutch planning culture is traditionally characterized as very 'blue-print like' where spatial zoning projects meticulously designate specific functions to physical locations, for example for housing, and what these houses need to look like (Buitelaar & Bregman, 2016). Areas are developed integrally at once, exercised by large project developers and actively steered by the local government. However, the economic crisis of 2008 showed that governments are vulnerable to market fluctuations, when they had trouble selling properties and finding developers. A shift in planning then occurred towards more organic incremental developments with a greater role for individual private parties (Buitelaar & Bregman, 2016). Spatial planning shifts towards a more strategic approach, where the local authority is facilitative.

The shift in planning culture will be institutionalized in a new environment and planning act (*Omgevingswet*) in 2019. The legal reforms affect the content of spatial plans and therefore also the practice of environmental assessment. The law enables more flexibility in spatial plans and poses new demands, such as planning for a longer term of 20 years (Ministerie van Infrastructuur en Milieu, 2016). In preparation of the Omgevingswet, pilot projects are conducted to explore possibilities and restrictions in new planning processes. These pilots also offer room for innovation in the role of environmental assessment regarding procedures and content. Dealing with alternatives or different scenarios, flexibility and uncertainty come up as important issues (Artz, 2015). In sum, the Dutch planning context is expected to influence SEA practices and is therefore relevant in this research project.

3.3.2 SEA in the Netherlands

The Dutch SEA process can be identified as one in which many stakeholders are involved and actively try to pursuit their influence in the trajectory (Buuren & Nooteboom, 2009). The orientation towards consensus, and the accountability of decision-makers, causes SEA processes to be rather complex.

Obligation for SEA is determined by a legal framework that identifies all SEA obligated spatial activities. Additionally, SEA is obligated if plans are designed as a framework for further planning processes, or if significant effects on Natura 2000 areas can be expected (Wet milieubeheer, 1979, Art. 7.2). The formal steps of Dutch SEA are:

1. Notification of intent by initiator to competent authority followed by a public announcement

2. Consultation with competent authorities on scope and level of detail
3. Public consultation on scoping document[1]
4. Optional: Consultation of the Netherlands Commission for Environmental Assessment[2] (NCEA) on scoping document
5. Reporting on environmental assessment of initiative and publication of the environmental assessment report and draft of the spatial plan[3]
6. Public response to draft SEA report and spatial plan
7. Obligated consultation of the NCEA on final report
8. Decision-making and publication of decision
9. Ex-post evaluation of environmental impact

Relevant stakeholders in the Dutch SEA process are the competent authority, initiator, consultancy firms, and the NCEA (Table 3). The competent authority has the mandate to decide to accept a spatial plan and its SEA. It is a governmental body that assesses the quality of the reports. The initiator is the party that comes up with the design of a spatial plan. These are also often governmental bodies, and in many occasions the competent authority and initiator belong to the same organization. Since governmental bodies are not always capable of performing SEA, consultancy firms are often hired by procurement to perform the assessment and report the results. The NCEA is an institute that has the formal responsibility to review the quality of SEA, and to provide advice on good practices. It is an independent advisory commission that mobilises experts (academics and professionals) in order to tap from expertise that is required in specific SEA cases (Runhaar & Arts, 2015). The commission has a rather dominant role in the spatial planning process as their expertise is highly regarded by both practitioners and the public.

Party	Role, tasks, interests
Competent authority	- Decision-making regarding the spatial plan, with inclusion of the SEA report. - Coordination amongst relevant authorities.
Initiator	- Design of spatial plan and achieving goals of spatial plan. - Performing an SEA, often outsourced to a consultancy. - Stakeholder involvement procedure.
Consultancy	- Performing SEA research and reporting results. - Coordination with initiator on content of spatial plan.
NCEA	- Independent advice on quality of SEA report. - Optional advice on scoping document. - Obligated advice on final SEA report. - At request the NCEA is involved during the SEA process (interim advice).

Table 3: Roles, tasks and interests of relevant parties in the SEA process

3.2.3 Case study selection

The selection of cases is based on a specified population and on theoretical assumptions. This ensures there is little extraneous variation and it focusses efforts on theoretically useful cases (Eisenhardt, 2016). A specific choice is made for environmental assessments that contribute to decision-making on a more strategic level of spatial plans, because of the assumption that more uncertainties exist on a more abstract level. The selection of case studies is also inspired by the cultural change in planning practices. The assumption is that, regarding complexity and level of abstraction, current pilot projects for the Omgevingswet are comparable to Structure Visions for regional strategic developments. Lessons might be found from Structure Visions that apply to pilot projects. Cases are selected using the following criteria:

[1] Notitie Reikwijdte en Detailniveau
[2] Commissie voor de milieueffectrapportage
[3] Ruimtelijk plan (Structuurvisie/Bestemmingsplan)

1. The planning initiatives have a relatively high level of abstraction.
2. The process of Strategic Environmental Assessment (SEA) is obligated and performed.
3. The SEA projects were conducted in the past 5 years, ensuring respondents remember the project.
4. A variety in consultancy firms that performed the SEA project, which is important to ensure a variation in knowledge base and experiences.

The selected case studies and their characteristics are presented in Table 4. More information about the case studies can be found in the chapter on results, where they are shortly introduced in combination with their results.

Case, year, and consultancy firm	Project characteristics
#1 Structure Vision Waalweelde West (2015) Arcadis Nederland BV	Initiator: Province of Gelderland Goal: Flood protection program including regional economic, urban, and ecologic development
#2 Zoning plan Binckhorst Den Haag (2015-?) Antea Group	Initiator: Municipality of The Hague Goal: Transformation of the Binckhorst into a sustainable mixed urban living area (5.000 houses)
#3 Structure Vision Almere Oosterwold (2013) & Zoning plan Oosterwold (2016) Sweco	Initiator: Municipality of Almere Goal: Sustainable development of Oosterwold into a low density living/working area (15.000 houses)
#4 Structure Vision Greenport Venlo (2012) Arcadis Nederland BV/Rho adviseurs	Initiator: Development Company Greenport Venlo Goal: Sustainable development of agribusiness (14.000 jobs)
#5 Structure Vision Eemsmond Delfzijl (2017) Arcadis Nederland BV	Initiator: Province of Groningen Goal: Industrial development of Eemsmond region (windfarms, heliport, industrial areas)

Table 4: Selected cases and their characteristics

3.3 Comparative case study operationalization

3.3.1 Methods

To explore and understand the management of uncertainties in SEA, a qualitative research approach is chosen. This is because qualitative research methods focus on understanding and interpreting processes, events or developments (Bergsma, 2003). Furthermore, a qualitative approach acknowledges the influence of the context on these processes, which is relevant for this research project as the context of Dutch planning practice largely influences the SEA process. An inductive research approach is applied, which means that specific results for the case studies are used to create a more generally applicable theory on dealing with uncertainties in SEA.

A case study is a research strategy focusing on understanding the dynamics present within single settings (Eisenhardt, 2016). A comparative case study design allows for an analysis of differences and similarities in dealing with uncertainties in SEA. A prerequisite for comparative cases is that they have one thing in common, which serves as a benchmark to assess uncertainty management strategies. For this research project, cases were selected that have a similar level of abstraction.

3.3.2 Data collection

Data collection was done in a flexible and iterative way: intermediate analyses between interviews revealed helpful adjustments to data collection that could directly be employed in following interviews, and flexible methods allow to take advantage of emergent themes and unique case features.

It is important to talk to key actors that represent different parts of the SEA process to gain a comprehensive view of the process and the measures. The selection of respondents is based on a variety of stakeholders, to ensure different perspectives on uncertainties in SEA are covered in the data collection. It is expected that different parties have a different perspective based on their role, tasks, and interests in the SEA process (Table 5). Access to spatial development projects was obtained through an internship at Arcadis and via the Netherlands Commission for Environmental Assessment (NCEA).

Name	Affiliation	Organisation	Date of interview
EXPERT INTERVIEWS			
1.	Secretary[4]	NCEA	November 1, 2016
2.	Senior researcher	Utrecht University	November 11, 2016
3.	Senior advisor SEA	Arcadis NL	November 21, 2016
CASE I: WAALWEELDE WEST			
4.	SEA Project manager	Arcadis NL	January 23, 2017
5.	Project manager & SEA coordinator	Province of Gelderland	January 26, 2017
6.	Secretary	NCEA	January 27, 2017
7.	SEA specialist	Arcadis NL	January 30, 2017
CASE II: BINCKHORST			
8.	Policymaker	Municipality of The Hague	November 29, 2016
9.	Project manager Omgevingsplan	Municipality of The Hague	November 29, 2016
10.	Strategic consultant	Antea Group	December 8, 2016
11.	Secretary	NCEA	December 22, 2016
12.	Legal advisor	Municipality of The Hague	December 23, 2016
CASE III: OOSTERWOLD			
13.	Secretary	NCEA	December 8, 2016
14.	SEA practitioner & SEA Project manager	Sweco	January 10, 2017
15.	SEA coordinator	Municipality of Almere	January 25, 2017
CASE IV: GREENPORT VENLO			
16.	Project manager SEA	Arcadis NL	December 19, 2016
17.	Project manager SEA	Development Company	December 21, 2016
18.	Secretary	NCEA	March 7, 2017
CASE V: EEMSMOND DELFZIJL			
19.	Project manager SEA	Arcadis NL	January 13, 2017
20.	Project manager SV Eemsmond Delfzijl	Province of Groningen	January 20, 2017
21.	SEA coordinator	Province of Groningen	January 20, 2017
22.	Secretary	NCEA	March 7, 2017

Table 5: List of respondents

The interviews are semi-structured, enabling the comparison of cases with some flexibility in the interviews for subjects that come up during the conversation. This open questioning bears the risk that relevant uncertainties are overlooked, forgotten or not found relevant by respondents. To ensure quality in the interviews, a document analysis of official publications is performed prior to the interview. These documents contain a very rich database with specific knowledge on the projects. This analysis includes planning documents, the results of the SEA and advisory documents of the NCEA for each case. These results could be used in the interview to ensure relevant uncertainties were discussed, by slightly steering the conversation (for example by asking if there are any more uncertainties the respondent can think of, if relevant uncertainties identified in documents were not discussed yet). Furthermore, interviews with secretaries of the NCEA ensure quality in the case studies as they based their answers on the advisory reports of the NCEA and they are an authority in the practice of environmental assessment.

A topic list guides the semi-structured interviews (See Appendix 8.1). First, respondents were invited to name uncertainties. Depending on their answers, further questions were asked about the cause for these uncertainties and the problem they posed. Respondents were then asked to identify the two or three most important uncertainties in their experience (based on role in decision-making and degree of knowledge about the uncertainty). This served to further structure the interview. The perceived important uncertainties were further discussed

[4] Werkgroepsecretaris. The person responsible for the advisory report of the NCEA.

regarding strategies that were employed to solve them, the goal of the strategy, what resources were used and to what extent the goal was achieved. Lastly, a focus in the interviews was on a reflection of the strategies. Respondents were asked if they would have done anything different or better in retrospect and whether uncertainties were resolved or remained.

3.3.3 Validity and reliability

Empirical results found in the case studies are only valuable if they are valid and reliable. A research method is valid if it has studied what it is supposed to study, and reliable if results are not distorted by assumptions and prejudice of the researcher (Bergsma, 2003). The validity and reliability of this research project is ensured by triangulation of data collection, consultation of the NCEA, feedback of respondents, and the analytical tactics. This is further explained below

Different data collection methods were applied to ensure more robust results. This entails a combination of different types of documents, being scientific papers as well as publications from the planning and SEA practice. In preparation of the interviews relevant documents were studied, including planning documents, SEA reports and NCEA advisory reports. These documents were also used to find further evidence for statements in the interviews on uncertainties and strategies. Furthermore, expert interviews were conducted to refine the theoretical framework and find a focus for the case study analysis. The findings of the theoretical analysis of scientific literature were discussed with two experts, one consultant and one researcher (Table 5). This served to find confirmation for the typologies that were identified. Additionally, the NCEA was involved in shaping the research and finding relevant case studies.

The structure and content of the interview was first tested with a colleague at the internship organization. The researcher specifically selected a test respondent with knowledge on SEA, but who was not involved in any of the case studies. The test interview served to find out if questions were clear for the interviewee and to see whether the questions yielded the type of information the researcher was looking for. Adaptations to the interview topic list could be made accordingly. Furthermore, the interviews were recorded and transcribed to reduce the chance of wrong interpretation in the transcripts. Reports of the interviews were sent to the respondents and they were given the opportunity to respond to the interview report regarding its representation of the interview and their perceptions.

Lastly, analytical tactics were employed to reduce subjectivity of the researcher. Conclusions drawn by researchers can be premature or even false, because people leap to conclusions based on limited data, are influenced by the vividness or by elite respondents or drop disconfirming evidence (Eisenhardt, 2016). The key to overcoming this 'information-processing bias' is to look at data in different ways. Therefore, two tactics are employed: 1) selection of dimensions and looking for within-group similarities combined with intergroup differences, and 2) selection of pairs of cases and listing similarities and differences between each pair. The tactics can improve the accuracy of theory building. The first tactic is employed by comparing cases along the dimension of types of uncertainty and the according strategy to deal with this uncertainty. For example, cases could prove to contain uncertainties about cumulative effects, and the analysis then focusses on different employment of strategies to solve this uncertainty. The second tactic is employed by comparing cases regarding the type of plan: structure vision or zoning plan. Structure visions and zoning plans are different spatial plans that have different legal requirements. This could pose different challenges for SEA.

CHAPTER 4: RESULTS

4. Results case studies

This chapter presents the results of five case studies, based on interviews with different stakeholders and additional document analysis. The results are analysed regarding perceived uncertainties, strategies that were employed to reduce these uncertainties and the success of these strategies. This chapter focuses on individual cases, and the next chapter will focus on differences and similarities in types of uncertainties that occur and in dealing with uncertainties. The cases are shortly introduced before results are discussed. For more background information see Appendix 8.2.

4.1 Waalweelde West

4.1.1 Introduction to the case

Figure 6: Planning area Waalweelde West (Arcadis Nederland B.V., 2015)

Waalweelde West is an area in the south of the Netherlands (Figure 6). It includes a part of the river Waal, and flood plains with high ecological value. After the river nearly flooded in 1993 and 1995, the authorities started addressing flood protection by reinforcing dikes and lowering water levels. Currently, a river flood protection program is designed, aiming to reduce the water level by 80 centimetres during a flood (Provincie Gelderland, 2015a). A Structure Vision[5] (from now on referred to as SV) is created in 2015 to guide the development of the area and to serve as an overarching framework for future projects. These projects include not only flood protection measures, but also economic, urban, and ecological activities.

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[5] A long term spatial planning strategy at regional level, aiming to outline desired spatial development in the planning area. It is a guiding document for public and private actors as to what spatial policy is in place (Commissie voor de Milieueffectrapportage, 2011c).

The spatial plan describes the proposed activities per 'building block' (See Appendix 8.2.1, Figure 12). The building blocks represent physical areas (flood plains) that are a candidate for flood protection measures. The overall goals of the SV are:

- River and flood protection: contribute to an increase of drainage capacity of the Waal.
- Ecology: contribute to the maintenance and development of Natura 2000 locations.
- Living environment: development of housing on higher terrains as well as on dikes.
- Economic development: contribute to opportunities for new business activity.
- Landscape and cultural history: maintenance and development of scenic values in the area.
- Recreation and tourism: creation of recreational areas and improvement of accessibility.
- Climate: reinforcement of river safety by implementation of flood channels, development of robust ecological areas and resilience in the built environment. (Provincie Gelderland, 2015a)

Waalweelde West is a collaboration between four municipalities (Lingewaal, Maasdriel, Neerijnen and Zaltbommel), the Provincie of Gelderland and a consortium of private parties. Decision-making responsibility about the plan lies with the Province as well as the four municipalities (Provincie Gelderland, 2015a). Several other parties were involved in the design of the SV, including Rijkswaterstaat and the Ministry of Infrastructure and Environment, and local stakeholder groups that have an interest in the spatial developments.

In the SEA report, an assessment is made of three different alternatives for each of the 21 building blocks. The alternatives are based on different sets of goals, focusing on flood protection, urban development or ecological development (See appendix 8.2.1, Figure 13). The alternatives were weighed regarding the resulting water level reduction, stakeholder interests and cost-effectiveness. In their scoping advice, the NCEA recommended this approach, together with a recommendation to motivate the need for flood protection measures and design a monitoring program to evaluate actual impact (Commissie voor de Milieueffectrapportage, 2011d). Stakeholders identified a preferred alternative in workshops, based on information about the building blocks and alternatives that was provided in a preliminary SEA report. The preferred alternative is assessed regarding its effects, e.g. water levels drop by 100 centimetres, temporary negative effects on ecological values, negative impact on scenic values, more space for housing and business parks and increased noise and air pollution due to traffic increase (all effects are listed in Appendix 8.2.1) (Arcadis Nederland B.V., 2015).

The NCEA advice on the final document was positive, as the SEA report contained the essential information to decide on the SV with the inclusion of the environmental interest (Commissie voor de Milieueffectrapportage, 2015). Stakeholders were actively involved in the design of the SV. It is recommended to hold on to information for future planning processes by developing a monitoring and evaluation program and explicitly describing the type of research necessary for future decisions. This is adhered to by including an appendix in the SV describing points for attention and mitigation measures (Provincie Gelderland, 2015b).

4.1.2 Results for uncertainties and their management for Waalweelde West

Table 6 provides an overview of the interview results of Waalweelde West. It shows the types of uncertainties, the case specific example, and who perceived the uncertainty. Categories of uncertainties are highlighted with colours in the table: green (inherent), blue (scientific), red (social), and yellow (legal). A theoretical approach to the uncertainties is presented, as well as the actual strategy that is applied in the case, the degree of success of strategies and factors influencing this. The results are analysed in this paragraph, serving to refine the theoretical framework.

Interviews took place with four respondents and are coded for reference in the text: the project leader for SEA (WW-I), the initiator at the Province of Gelderland (WW-II), the writer of the SEA (WW-III), and the NCEA secretary that was responsible for the advice on the SEA report (WW-IV).

Type	Uncertainty	Who	Theoretical strategy to apply	Applied strategy in case	Degree of success	Factors
Variability	Delta program	II, IV	Adaptive management Precautionary principle	Stakeholder involvement Avoided	Not successful: False certainty about flood protection measures	Scope of assignment
Variability	NURG[6]	III	Adaptive management Precautionary principle	Stakeholder involvement	Not successful: Exact developments remain unclear	-
Variability	Future run of the river	I, IV	Adaptive management Precautionary principle	Precautionary principle Stakeholder involvement	Not successful: Uncertainty remained, Unrest amongst decision-makers	-
Identification of activities	Time horizon and alternatives	I, II, III	Adaptive management Stakeholder involvement Knowledge generation	Adaptive management Stakeholder involvement Knowledge generation Precautionary principle	Successful: Bandwidth uncertainty Adaptations to the plan Local support	Level of decision-making Legal framework Attitude of initiator Local knowledge Integration SEA/SV Good information provision
Identification of change and impact	Effects on Natura 2000	I, III	Adaptive management Stakeholder involvement Knowledge generation	Adaptive management Precautionary principle	Successful: Identification of risks and existing monitoring programs for preferred alternative	Legal framework Advice NCEA
Identification of change and impact	Effects of increased business activity	III	Adaptive management Stakeholder involvement Knowledge generation	Precautionary principle	Not successful: No inclusion in monitoring program	-
Assessment framework	Level of abstraction	I, II	Adaptive management Stakeholder involvement	Stakeholder involvement Knowledge generation	Successful: Good quality SEA Uncertainties listed in appendix SV	Scoping document Knowledge and experience Workshops with experts Working in tables
Faults in data or models	Model uncertainties	I	Adaptive management Precautionary principle Knowledge generation	Precautionary principle	Successful: Consistency in research was achieved so that alternatives were comparable	Scoping document Advice NCEA Legal framework Standardized methods

[6] *Nadere Uitwerking Rivierengebied*: a nature protection program running simultaneously with the design of the SV.

Type	Uncertainty	Who	Theoretical strategy to apply	Applied strategy in case	Degree of success	Factors
Values, interests and perceptions	Stakeholder interests	I, II	Stakeholder involvement	Stakeholder involvement Knowledge generation Adaptive management	Partly successful: False certainty Public support	Level of decision-making Early inclusion Willing to negotiate Neutral position PM Experience project team

Table 6: Results uncertainties and strategies for Waalweelde West.
Respondents: I = SEA project leader, II = Initiator, III = SEA writer, IV = NCEA.

Inherent uncertainties

All four respondents experienced uncertainty in variability (Table 6). It leads to inaccurate impact predictions in SEA: *'You have little influence, yet we advised to take it into account in the assessment. You cannot solve this'* (WW-IV).

The Delta program is a Dutch flood protection program. Flood protection measures are versatile, yet the two most implemented measures are flood channels and dike reinforcement. The NCEA respondent stated it was advised to assess multiple flood protection measures and their effects, yet the initiators chose to focus on flood channels. It is addressed with stakeholder involvement, by communicating that it is uncertain whether or when flood protection measures will be implemented, and that changes in the Delta program could lead to a revision of the SV (Provincie Gelderland, 2015a, p. 12). Despite this communication, the bandwidth of effects of possible flood protection measures is not assessed. The NCEA secretary and initiator agree that the SEA report might have been too detailed, leading to false certainty. It is therefore **not successfully dealt with**. A decisive factor was the scope of the assignment: *'It was not our assignment to assess possible measures for dike reinforcement'* (WW-II).

The NURG is a nature development program in the Province of Gelderland, that was to be included in the reference situation of the SV. However, proposed activities depended on private measures and were unclear (Provincie Gelderland, 2015a, p. 130). The SV communicates that NURG has positive effects on ecological values and no significant negative effects. However, it is not further addressed in the SV or the SEA report. It was **not successfully dealt with**, since no bandwidth of effects is provided and it is not explicitly included in further decision-making.

The future run of the river is influenced by climate change, flood protection measures in Germany and sedimentation of the flood channels, and therefore highly uncertain (WW-I & WW-IV). Flood protection measures in Germany often entail creating higher dikes, which means water runs faster to the Netherlands. Coordination about these measures is addressed with stakeholder involvement in international river management regimes (Provincie Gelderland, 2015a, p. 50). The drainage capacity and sedimentation was calculated using the precautionary principle, by using accepted models and assumptions. However, uncertainty remained and even caused unrest among decision-makers after a scientist expressed critique on the calculations (WW-I). Uncertainty about this variability was therefore **not successfully dealt with**.

The theoretical expectation for this uncertainty is to address it with adaptive management and precautionary principle, by assessing alternatives, identifying the bandwidth of effects in worst case scenarios and monitoring actual impact. All three examples show a different approach (stakeholder involvement), that was not successful. This could be explained because it did not explicitly yield any more information for decision-makers and it is not explicitly addressed how and where these uncertainties are monitored.

Scientific uncertainties

The Structure Vision guides developments up to 2050. This induced scientific uncertainty regarding the identification of future activities: *'Who knows what developments will be implemented?'* (WW-III). SEA cannot accurately predict effects if future scenarios are uncertain. This was dealt with using all four strategies in the following way:

- Adaptive management: A systematic analysis of alternatives per building block ensured that essential information was included in the design of the SV (WW-III). Furthermore, the planning process and SEA were integrated regarding their starting documents and the preferred alternative. As such, information could be used to compare alternatives, exchange flood protection measures and identify an optimal mix: '*It was unique that SEA was to integrally part of the choices for the SV. SEA was used to identify essential flood protection measures. There were not many uncertainties because of this*' (WW-II).

- Precautionary principle: Environmental effects were assessed using worst case scenarios. This yielded insight in the bandwidth of uncertainty and risks (WW-III).
- Stakeholder involvement: workshops served to identify the preferred alternative. Groups of stakeholders with a similar interest discussed what they would want if anything was possible (maximum scenario) and what they would need at least (minimum scenario). It reduces uncertainty as the lower limits can be included in the design of the plan. In a second workshop, a preferred alternative was identified.
- Knowledge generation: input for the workshops was based on a 'living document'. It contained information about environmental effects, costs and public support. Input was delivered by stakeholders. Furthermore, a GIS[7] analysis provided insight in quantitative effects of the flood channels. Using parameters for the flood channel design a better estimation of the impact of flood channels on current agricultural land and urban sites could be made (WW-III).

In a combination of the four strategies, uncertainty about future activities was ***successfully dealt with****. It resulted in insight in the bandwidth of uncertainties, exclusion of uncertainties and local support for the plan. The strategies correspond to the theoretical expectation, except for the use of the precautionary principle, which added essential information on the bandwidth of effects. Factors contributing to this success are summed up in Table 6. The level of decision-making and legal framework were important, as these were discussed with all four respondents, who agree that providing information on significant effects and (legal) risks is sufficient at the level of this SV.*

<u>Effects on Natura 2000 locations could not be estimated</u> due to the uncertain design of the flood channels (Table 6). The SEA project leader and SEA writer described it as a legal risk to the acceptation of the spatial plan. It is addressed using strategies of adaptive management and the precautionary principle. The nature protection law demands an 'Appropriate Assessment' (AA) to study the effects on Natura 2000 locations, which is a much more detailed assessment. This is focused on the identification of significant effects, and requires to choose an alternative with least significant effects. Developments are included in an existing provincial monitoring program, and intervention measures are identified if effects turn out worse (Provincie Gelderland, 2015a). It is therefore **successfully dealt with**. Theoretically it was expected that stakeholders were involved and knowledge was generated. Stakeholder involvement could not be feasible since they cannot provide additional information on the design of flood channels. Knowledge is generated in the AA, identified as a precautionary measure. Factors of influence were the legal framework and the NCEA advice that recommended the additional assessment.

<u>Uncertainty in determining the effects of increase of business activity</u> was experienced by the SEA writer, who is actively involved in more detailed issues during the SEA process (Table 6). To address this, the precautionary principle is employed by using standardized assumptions on traffic increase and impact. Using these standard values, estimates of effects could be made on air quality and noise pollution. This uncertainty is **not successfully dealt with**; effects are still uncertain. No communication is provided on the monitoring of these effects in either the SEA report or the SV. Theoretically it was expected that adaptive management, stakeholder involvement and knowledge generation are employed to address uncertainty in the identification of change and impact. A monitoring program (adaptive management) could indeed prove to be more successful.

The integral and long term development led to <u>uncertainty about the assessment framework</u> according to the SEA project leader and initiators (Table 6). This is explained by their role in the SEA process of steering overall developments. Uncertainty about the level of abstraction for assessment was addressed using stakeholder involvement and knowledge generation. The NCEA recommended to provide relatively detailed calculations to adhere to legal requirements. Therefore, standard parameters were chosen to perform an assessment of effects. Uncertainty about these outcomes were communicated in the SV (Provincie Gelderland, 2015b). The assessment was performed by experts with knowledge and experience in SEAs for regional development and river protection measures: *'This is visible in the quality of assessment, focusing on what is important. There were discussions on the*

[7] Geographical Information System

assessment framework rather than specialists doing what is asked of them' (WW-I). Uncertainty about the assessment framework was thus **successfully dealt with**. Theoretically it was expected this uncertainty would be addressed with adaptive management instead of knowledge generation. Adaptive management would have ensured a more flexible process in which adaptations can be made, now decisions could apparently be made without this flexibility. Factors influencing are summed up in Table 6. Most important was the use of tables that forced to focus on only essential information (WW-I).

<u>Model uncertainties</u> exist because they are a simplification of reality, and because the input for models was uncertain (Table 6). The precautionary principle was used to address this, by choosing standard parameters. These ensure that, even though model outcomes are uncertain, the outcomes can at least be compared to make meaningful statements on differences in environmental effects between alternatives (WW-I). This was **successfully dealt with** as consistency in research was achieved, thus the SEA delivered decision-making information about alternatives. The use of the precautionary principle was theoretically expected. Also expected were adaptive management and knowledge generation. It is unclear what exact information is addressed in monitoring programs yet this could lead to improved practices to handle model uncertainties. Influential factors were the scoping phase of SEA, advice of the NCEA, the legal framework and the existence of standardized methods.

Social uncertainties

<u>Stakeholder interests</u> were discussed with the SEA project leader and initiator (Table 6), yet both did not experience this as an uncertainty but rather as an opportunity to find the optimal alternative. The initiator saw the successful participation process as the reason there was no uncertainty, which was acknowledged by the NCEA. The combination of the integration of SEA and spatial plan (adaptive management), the workshops (stakeholder involvement) and a living document (knowledge generation) enabled stakeholders to actively participate in the design of the SV (Table 6). Their interests were secured as they could voice what they found maximally acceptable in the plan. The result was acceptation of the plan by stakeholders and the exclusion of uncertainties due to the exchangeability of solutions. The only downside is that there is some difficulty in the next planning stages since stakeholders agreed to something that is now not being implemented (WW-IV). This uncertainty is therefore **partly successfully dealt with**. Factors of influence are summed up in Table 6. The most important factor is the level of decision-making: there is no possibility for an appeal to the Council of State about an SV, and the plan has no direct effects, as it is only a framework for subsequent spatial projects.

4.2 Binckhorst The Hague

4.2.1 Introduction to the case

Figure 7: Planning area Binckhorst in The Hague (Gemeente Den Haag, 2016b)

The Binckhorst is a neighbourhood in the municipality of The Hague (Figure 7). The district of about 125 hectares is characterized by businesses in the creative sector and IT sector. Large housing needs are predicted in demographic forecasts, which is why the Binckhorst is transformed into a sustainable mixed urban residential area, creating space for about 5.000 houses (Gemeente Den Haag, 2016a). In 2014 the municipality of The Hague started the procedure for an *'Omgevingsplan[8]',* a pilot for the *Omgevingswet*. It differs from a traditional zoning plan in several ways:

- The plan has a time horizon of 20 years as opposed to the traditional 10 years;
- It includes all aspects that represent the integral physical environment (e.g. social safety, mobility);
- Rules are not definitive, yet flexible, depending on policy dynamics[9].

The municipality of The Hague is the competent authority as well as the initiator for the Omgevingsplan. The planning process is designed in-house, yet a consultancy firm offers strategic advice. Stakeholders are invited in informal sessions to design ambitions for the transformation (Gemeente Den Haag, 2016a).

The NCEA is involved in a consulting role by providing additional advice during the SEA process. A different type of information for decision-making is required. For a traditional zoning plan, alternatives are designed and assessed, to identify a preferred alternative. Here, SEA should deliver information to decide on ambitions and rules that set the legal framework for developments. A monitoring program guides this, based on information about the current situation, new developments, environmental thresholds and intervention measures (Commissie voor de Milieueffectrapportage, 2015).

The spatial plan and SEA are integrated: the planning part includes the sets of rules for the quality of the living environment, which are the direct result of the consideration of all information in the (environmental) assessment process (See Appendix 8.2.2, Figure 14). The central pillars of the plan, that is still in progress, are a flexible set of rules, the balance approach, crash tests and a monitoring program.

- A flexible set of rules entails a combination of 'hard' and 'soft' rules. A hard rule is for example 'water quality may not be reduced', a soft rule is for example 'the design of buildings needs to fit the existing quality of scenery'. Soft rules are more open to interpretation.
- The balance approach means that different values can serve as compensation for negative effects. For example, if an activity, such as a restaurant, generates noise, the restaurant can compensate for its impact by investing in a public park. The goal is to maintain the *overall* quality in the area.
- The crash tests serve to test the set of rules. Crash tests are an evaluation mechanism to ensure any undesired activity is excluded in the rules, and that desirable activities are accepted.
- Lastly, a monitoring program is designed to monitor actual impact after decision-making.

The instruments described above serve to facilitate the transformation of the Binckhorst area from an industrial area towards a sustainable mixed urban living environment (Gemeente Den Haag, 2016a).

In the interim advice, the NCEA is content about the progress, yet identifies some shortcomings (Commissie voor de Milieueffectrapportage, 2016a). The assessment of the reference situation must be more comprehensive, as this is the most important starting point for the developments. Furthermore, the sets of rules are large and dispersed and can better be combined into 4 themes. It is also advised to create an explicit system for monitoring and evaluation.

4.2.2 Results for uncertainties and their management for Binckhorst The Hague

Table 7 provides an overview of the interview results of the Binckhorst. It shows the types of uncertainties, the case specific example, and who perceived the uncertainty. Categories of uncertainties are highlighted with colours in the table: green (inherent), blue (scientific), red (social), and yellow (legal). A theoretical approach to the uncertainties is presented, as well as the actual strategy that is applied in the case, the degree of success of strategies and factors influencing this. The results are analysed in this paragraph, serving to refine the theoretical framework. The planning

[8] New type of zoning plan offering flexibility in the procedure, including municipal rules for the physical environment.

[9] *'Dynamisch verwijzen'*: initiatives need to adhere to policy regulations, yet the policy might change.

process for the Binckhorst is still in progress, which is why not the degree of success is presented in the table, but the goal of the strategies.

Interviews took place with five respondents and are coded for reference in the text: the initiator at the municipality of The Hague (B-I), the competent authority (B-II), a lawyer responsible to write the rules in the spatial plan (B-III), a consultant involved in the design of the spatial plan (B-IV) and the NCEA secretary responsible for the NCEA advisory report on the spatial plan (B-V).

Uncertainty	Problem for SEA	Who	Theoretical strategy to apply	Strategy applied in the case	Goal	Factors
Variability	Other policies	I	Adaptive management Precautionary principle	Stakeholder involvement	Create the same mindset	-
Variability	Hypes environmental themes	IV	Adaptive management Precautionary principle	Knowledge generation	Fit legal requirements	European legislation
Cumulative effects	Cumulative effects	II	Adaptive management	*Not discussed*	*Not discussed*	-
Identification of activities	Future scenarios	I, IV, V	Adaptive management Stakeholder involvement Knowledge generation	NOT Precautionary principle Adaptive management Stakeholder involvement	Check for ambitions and effects Support for the plan	Experience/knowledge Legal framework Advice NCEA Competences PM Level of decision-making
Quality of methods	New methods	II, V	*Not identified in theory*	Adaptive management Stakeholder involvement Knowledge generation	Maintain overall quality Support for the plan Identification of monitoring needs	Experience Costs and time Legal requirements Human preferences
Faults in data or models	Environmental data	II	Adaptive management Precautionary principle Knowledge generation	Stakeholder involvement	*Not discussed*	-
Faults in data or models	Limits to models and expiration of validity	IV	Adaptive management Precautionary principle Knowledge generation	Knowledge generation Adaptive management Precautionary principle Stakeholder involvement	Less research Check for ambitions Bandwidth of effects Maintaining information	Roles and responsibilities
Assessment framework	Choosing criteria	IV	Adaptive management Stakeholder involvement	*Not discussed*	*Not discussed*	-

Uncertainty	Problem for SEA	Who	Theoretical strategy to apply	Strategy applied in the case	Goal	Factors
Values, interests and perceptions	Stakeholder interests	II, IV, V	Stakeholder involvement	Adaptive management Precautionary principle Stakeholder involvement	Inclusion of interests Sense of security Acceptation of methods	Advice NCEA Project manager Organisational culture
Knowledge base	Way of thinking	IV, V	*Not identified in theory*	Stakeholder involvement Knowledge generation Adaptive management	Support in the organization Adaptations to the plan Support Council of State	Level of involvement Objective regulations Advice NCEA
Political climate	Political climate	IV	*Not identified in theory*	Adaptive management	Prevent arbitrariness	-
Legal requirements	Legal developments	II, III, V	*Not identified in theory*	Precautionary principle Stakeholder involvement Knowledge generation Adaptive management	Thresholds Support for the plan Identify monitoring needs Intervention measures	Advice NCEA
Liability	Legal security for incumbent parties	I, III	*Not identified in theory*	Precautionary principle Adaptive management Stakeholder involvement	Thresholds Intervention measures Support for the plan	-

Table 7: Results uncertainties and strategies for Binckhorst The Hague.
Stakeholders: I = Initiator, II = Competent authority, III = Lawyer, IV = Consultant, V = NCEA

Inherent uncertainties

The initiator discussed uncertainty in variability due to other policies (Table 7), which is explained by the responsibility of the initiator to coordinate with external parties. Because regulations in the *Omgevingsplan* are affected by other policies, these need to be aligned. This could be problematic for SEA if different developments occur than expected, imposing environmental impact that was not assessed. To address this, stakeholder involvement is employed by organising workshops with policymakers that aim to create a similar mindset. This **could be a successful approach**, but *'only if awareness is raised in every level of the organisation'* (B-I).

Variability in hypes around environmental themes pose an issue according to the consultant (Table 7). The strict implementation of European standards for certain issues, such as air pollution or nitrogen deposition, causes problems for SEA as it needs to be addressed more thoroughly to fit legal requirements (knowledge generation). The risk is that false certainty is provided in uncertain situations, which will not lead to improve the environmental quality of the area (B-IV).

Theoretically it was expected that variability is dealt with using strategies of adaptive management and the precautionary principle. This could be applied here by making an estimation of risks, intervention measures and including these in a monitoring program. This is especially feasible to deal with possible outcomes of different policies that might influence the developments in the Binckhorst.

Scientific uncertainties

Uncertainty about future activities of the plan was discussed with the initiator, consultant and NCEA secretary, who are in close cooperation in the design of the Omgevingsplan (Table 7). Future activities are determined by private initiatives, thus cannot be accurately identified and assessed in SEA. The precautionary principle is found infeasible, as a worst-case scenario would provide insight into effects that might never occur (B-I). Thus, adaptive management is employed by mapping the current state of the environment, and designing a monitoring program to evaluate impact. The initiator plans to make clear agreements with the municipal council regarding intervention measures (B-I). This strategy aims to provide insight in the bandwidth of effects, and evaluate and intervene in actual effects. A monitoring program is not included in the pre-design of the *Omgevingsplan* yet (Gemeente Den Haag, 2016a, p. 54). However, respondents discussed their ideas about the monitoring program (Textbox 2).

Stakeholders should be included in this design to find support for the plan and to provide clear responsibilities (B-IV). It is recommended to cut the scoping phase into smaller steps to provide structure and negotiate with stakeholders. These strategies **will successfully reduce** uncertainty about future activities because they are controlled during the implementation of the plan. The strategies largely correspond with the theoretical approach of adaptive management, stakeholder involvement and knowledge generation. Factors of influence are summed up in Table 7. Most important are the legal framework and capacities of the team, as they are decisive in the design of the monitoring program.

Content:

- A description of the carrying capacity, aspired qualities, acceptable effects and intervention measures.
- Determine monitoring based on the planning rules and connect to existing monitoring programs.
- Describe how to monitor: e.g. measuring, complaints system, annual questionnaires, calculations.
- Create a virtual interactive tool to add every new activity. Use the balance approach to combine all aspects.
- Include possible interventions: e.g. prohibition, investing in traffic capacity, silent asphalt, or sound barriers, ask initiators for a contribution to build a public park etc.

Process:

- Focus on the end-user to prevent them spending effort reinventing the wheel.
- Clear agreements on what interventions to take when limits are exceeded and who is responsible.
- Division of responsibilities: private parties cannot deliver integral quality for the area. The municipality remains responsible for infrastructure, green, water. The NCEA could take on a new role of taking samples.

Textbox 2: Design of a monitoring program, based on interviews with the initiator, consultant and NCEA secretary

The experimental methods in the case study, which are the monitoring program, balance approach and crash tests, pose an uncertainty as well according to the competent authority and NCEA secretary (Table 7). The quality of these instruments can be questioned and might lead to inaccurate evaluation of effects. This is addressed using strategies of adaptive management, stakeholder involvement and knowledge generation (Table 7). Adaptive management is applied using the monitoring program. This needs to ensure that agreements that are made with stakeholders in the balance approach are consistent and aimed for the maintenance of overall quality of the environment. Stakeholder involvement is employed by making agreements on how to use the experimental methods. This ensures that there is support for the plan. These experimental methods also mean that research is postponed to later planning stages (i.e. permit regulation), but general effects can be estimated using expert judgement, to identify the needs for further research and monitoring early in the planning process (B-V). If solid agreements can be made and the monitoring program is set up, these **strategies can be successful in reducing** uncertainty about the quality of methods. It depends on effort, experience and legal requirements.

The longer time frame of the *Omgevingsplan* induces uncertainty about the limits to models and the expiration of validity of the research (Table 7). It is an issue because *'strong conclusions are drawn from moderately reliable results'* (B-IV). It is addressed in the following way:

- Knowledge generation: quick scans (Textbox 3). Quick scans report the current state, the maximal accepted values and the policy regulations, which are presented in factsheets (Gemeente Den Haag, 2016a). Important elements are addressed and no unnecessary research is performed.
- Adaptive management: design of the monitoring program, serving to maintain a full overview of developments during the implementation of the plan. It serves to check if ambitions are met and if environmental thresholds identified in the quick scans are not exceeded.
- The precautionary principle: norms and thresholds to identify maximum possible effects and adhere to these limits. This way, a bandwidth of possible effects is determined.
- Stakeholder involvement: maintain the information gathered in the quick scans and monitoring program via 'transfer in relay', a process in which different municipal departments are included early in the planning stage. For example, people that will be responsible to authorize permits for private initiatives are included in the design of the regulatory framework, to ensure they understand how the rules can be interpreted (B-IV).

These strategies are **successful,** because thresholds are identified that are later monitored and controlled and the information is maintained: *'uncertainty is bypassed as we determine the aspired environmental quality, and then decide to perform research or to design regulation that pre-empts research'* (B-IV). It is important to combine the strategies as they all serve a part of the solution and it cannot be said for sure if they acquire the same results applied individually. The strategies are similar to the theoretical expectation, only stakeholder involvement is new and adds a vital step towards a more effective monitoring program (by maintaining information and experience).

When performing a quick scan, the following questions are important. Determine for each aspect:

1. What do you need to know and what knowledge is already available?
2. To what extent can reliable statements be made for this aspect (with models)?
3. What needs a more detailed assessment?
4. What quality do we aspire for this aspect?
5. What actions are left to acquire this quality?

An example of the application of a quick scan for ecology: Some species require protection by law. A quick scan provides information on what species are present in the area, and determines what species need protection. This information is included in a monitoring program. When an initiative pops up, a more detailed assessment of that species is performed by the initiator, which is regulated in permits and controlled using GIS analysis.

Textbox 3: How to use quick scans

Social uncertainties

Social uncertainty in values and perceptions is experienced by the competent authority, consultant and NCEA secretary (Table 7). This can be explained by their roles in this process. For the NCEA the new kind of spatial plan has impact on their future advisory skills. The competent authority has public acceptation in mind and the consultant serves a role as problem-solver. The social uncertainties pose a problem for SEA as stakeholders can influence the assessment and its outcomes, and because stakeholders need to accept and understand what information is presented in the report. This is addressed as follows:

- Adaptive management: phasing the SEA process by sharing and publishing small pieces of information to involve stakeholders in the decision-making process. Furthermore, the crash tests are evaluative moments that offer room for negotiations on the results.
- Precautionary principle: determining thresholds of environmental impact with stakeholders. The crash tests serve as a precautionary measure to ensure limits to developments are identified.
- Stakeholder involvement: mapping stakeholder interests and making procedural agreements on how to act and react during the process.

All strategies aim to provide a sense security and include interests. It remains to be seen **whether the strategies are successful** after implementation of the plan. The theoretical expectation was that only stakeholder involvement is employed, yet is seems that applying other strategies additionally might prove more feasible. Factors influencing this are summed up in Table 7. The lawyer also indicated that the right type of people need to be included at the right moment, as some people are better in pioneering and others are better at implementation, a perspective shared by other respondents as well (B-III & B-IV).

Uncertainty in the knowledge base is experienced by the consultant and the NCEA secretary (Table 7). The experimental methods are unknown to many people in the project organization causing uncertainty about the quality of the regulatory framework (B-IV). To address this, strategies of stakeholder involvement, knowledge generation and adaptive management are employed. Stakeholder involvement is applied by a strong cooperation with the NCEA. The NCEA can provide objective, external advice on the content of the plan. This proved more valuable than consultation with other experts (B-IV). Also, adaptive management is applied by the design of an iterative process in which small results are continuously published and reviewed. This way, progress in designing the regulatory framework is ensured. Knowledge generation is applied by finding examples of other successful approaches and plans that can be learnt from. People have a natural tendency to look for successful examples (B-IV). A combination of the strategies is **successful if it indeed results** in support for the plan. Factors of influence are summed up in Table 7. Most important is the advice of the NCEA, that is viewed as an important advisory body: *'We are very happy with the advice of the NCEA. The way they are involved is appreciated by the organisation and local stakeholders'* (B-II).

Lastly, social uncertainty in the political climate is experienced by the consultant (Table 7). The flexibility in the regulatory framework is open to interpretation and could therefore be used differently by different policy makers. Regulations need to be set up in such a way that they are objective and clear and not prone to arbitrariness. According to the lawyer the plan would fail if rules can be applied arbitrarily: *'This should not be possible. The norms are clear and secure, only the application can change due to policy change'* (B-III).

Legal uncertainties

Legal uncertainty about requirements of the SEA is experienced by the competent authority, lawyer and NCEA secretary (Table 7). This makes sense since it is the responsibility of these people to address whether the design of the plan and the SEA adhere to the regulatory framework. This type of uncertainty is experienced due to the experimental character of the plan where the possibilities and limitations of the new legal framework are tested. It is an issue as SEA is supposed to adhere to legal requirements. This uncertainty is addressed using strategies of precautionary principle, stakeholder involvement, knowledge generation and adaptive management.

- The precautionary principle: identifying thresholds for environmental effects. Initiatives that come up need to adhere to these thresholds, and as such significant negative effects are prevented. 'Traditional' SEA methods such as worst case approaches and the assessment of alternatives are found infeasible by the respondents. They agree that there is an unlimited number of future outcomes for the planning area and that any worst case or alternative would not be a good representation of the real situation.
- Stakeholder involvement is applied by cooperation with legal partners, the Ministry of Infrastructure and Environment, and people authorizing permits (B-III). In cooperation, the legal requirements can be discussed and determined.
- Knowledge generation is applied in the quick scans and factsheets of the environmental aspects, and by reading the rulings of the Council of State on comparable matters (B-III). This aims to identify monitoring needs and essential elements to be included in the regulatory framework.
- Adaptive management is applied in the monitoring program that eventually needs to evaluate actual impact and provide intervention measures if thresholds are crossed.

In combination, these strategies **can result in a successful approach** to reduce uncertainty about legal requirements. Especially knowledge generation and stakeholder involvement increase the knowledge of legal requirements.

Legal uncertainty in liability towards incumbent parties in the Binckhorst is experienced by the initiator and the lawyer (Table 7). It leads to issues with the acceptation of methods and results by incumbent parties. These incumbent parties are in some cases highly polluting in the area and fear they cannot further develop their business in the future situation. This is addressed using a similar approach as for uncertainty in legal requirements: precautionary principle (identification of thresholds), adaptive management (monitoring and intervention) and stakeholder involvement (discussions with local stakeholders and collaboration with legal partners). Furthermore, it is important that objective rules are designed that are not open to interpretation. This would reduce legal and public support for the plan, as the flexible rules lose their meaning.

4.3 Oosterwold

4.3.1 Introduction to the case

Oosterwold is situated in the Province of Flevoland (Figure 8). It is an agricultural area of 4.300 hectares between Almere and Zeewolde. To solve large housing needs and shortage of space in and around Amsterdam, a regional contract was signed in 2013 to stimulate growth in the region around Almere (Gemeente Almere & Gemeente Zeewolde, 2013). Oosterwold offers room for 15.000 households, and is meant to organically develop towards a green mixed living area with a low concentration of buildings.

Figure 8: Planning area Oosterwold (Gemeente Almere & Gemeente Zeewolde, 2013)

To facilitate the development of housing, a Structure Vision was established in 2013, followed by a zoning plan in 2016. The same SEA report is used to provide information about environmental effects on both spatial plans:

*"It does not fit the content of this zoning plan and the concept of organic development to perform a detailed assessment of possible environmental effects before the establishment of the plan. This responsibility is directed to initiators. They are responsible to prove their plan fits aspired developments, based on the development principles, and decision-trees" (*Grontmij Nederland B.V., 2015, p. 30).

The zoning plan has a similar character to the zoning plan for the Binckhorst, as it is also experimenting with the flexible planning approaches made possible by the *Omgevingswet*.

The development in Oosterwold is characterized by the retreating role of the government. The responsibilities are laid on initiators to perform all (environmental) research that is required to gain a permit. An area director, that is appointed by the government, will oversee all developments (Gemeente Almere & Gemeente Zeewolde, 2013).

The SV and zoning plan describe six ambitions and ten development principles to guide developments in the area. For a full overview of ambitions and development principles see Appendix 8.2.3, Textbox 5. Ambitions include for example room for urban agriculture, sustainability and self-sufficiency of the built environment. Development principles include for example rules for the spatial division of parcels, ecological quality and infrastructural demands. The regulatory framework, established in the zoning plan in 2016, includes 'decision-trees', designed for every environmental aspect, to judge whether an initiative fits regulations, policies and ambitions for Oosterwold (See Appendix 8.2.3, Figure 15).

The NCEA advised both on the final report for the SV and for the zoning plan, and both were negative. NCEA advise is negative when essential shortcomings in the SEA report are identified. This can be used for argumentation in public appeal by the public or by the judge. It is then often advised to provide additional information, and the authority can decide whether to adhere to this advice (Olde Wolbers, Oostdijk, Wesselink, & Helder, 2012). In the final advice for the SV the NCEA stated that the proposed activities were unclear with respect to their bandwidth (Commissie voor de Milieueffectrapportage, 2013). Consequently, the maximal environmental impact of the proposed activities is unclear, and whether and how a monitoring program will be set up. The NCEA advises to write a complementary SEA including a description of environmental risks for every aspect, sensitivities in the area and bottlenecks for development, a monitoring program and mitigation measures to prevent significant effects.

The same limitations applied to the SEA for the zoning plan (Commissie voor de Milieueffectrapportage, 2015). The zoning plan was adapted and established in 2016. The NCEA did not advise on the latest developments, that include a monitoring program and additional research for nitrogen deposition.

4.3.2 Analysis of results for uncertainties and their management for Oosterwold

Table 8 provides an overview of the interview results of Oosterwold. It shows the types of uncertainties, the case specific example, and who perceived the uncertainty. Categories of uncertainties are highlighted with colours in the table: green (inherent), blue (scientific), red (social), and yellow (legal). A theoretical approach to the uncertainties is presented, as well as the actual strategy that is applied in the case, the degree of success of strategies and factors influencing this. The results are analysed in this paragraph, serving to refine the theoretical framework.

Interviews took place with three respondents and are coded for reference in the text: the NCEA secretary responsible for the NCEA advisory report on the land-use plan in 2015 (O-I), the initiator at the municipality of Almere on the structure vision in 2013 O-II), and the consultants responsible for the SEA report on the structure vision in 2013 (O-III).

Uncertainty	Problem	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
Identification of activities	Flexible end result	I, II, III	Adaptive management Stakeholder involvement Knowledge generation	Adaptive management Stakeholder involvement Knowledge generation Precautionary principle	<u>Successful:</u> Bandwidth of effects Adaptations to the plan Evaluation successful	Advice NCEA Legal status of the plan
Assessment framework	Defining ambitions and conditions	I	Adaptive management Stakeholder involvement	Stakeholder involvement	<u>Not successful:</u> Arbitrariness in assessment of initiatives experienced	Political choices
Quality of methods	Monitoring and evaluation	I	*Not identified in theory*	Stakeholder involvement	<u>Successful:</u> Monitoring program in place	Advice NCEA Resources Level of decision-making
Faults in data or models	Impact of nitrogen deposition	I, II, III	Adaptive management Precautionary principle Knowledge generation	Adaptive management Precautionary principle Knowledge generation	<u>Successful:</u> Threshold for nitrogen deposition Monitoring program	Ruling Council of State Advice NCEA Time / planning Division of roles

Uncertainty	Problem	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
						Local knowledge
Political climate	Acceptance of the plan by 2 municipalities	III	*Not identified in theory*	Stakeholder involvement	Successful: Both parties accepted the plan	Expertise Political motivation to develop the area
Knowledge base	Interpretation of the plan	II	*Not identified in theory*	Adaptive management Knowledge generation	Successful: Evaluation shows existing initiatives fit	Information provision
Legal requirements	Natura 2000	II	*Not identified in theory*	Precautionary principle Knowledge generation	Successful: Some adaptations to the plan	-

Table 8: Results uncertainties and strategies for Oosterwold.
Stakeholders: I = NCEA, II = Initiator, III = Consultants

Scientific uncertainty

All three respondents experienced uncertainty in the identification of future activities, as it is unknown what the area will look like in 20 years (Table 8). In other words, this was uncertain for the SV as well as the zoning plan in 2015. It is an issue for SEA because effects of unknown developments cannot be accurately estimated. At the time of the SV, it was addressed using adaptive management and the precautionary principle:

- Adaptive management: Two alternatives were studied: a dispersed scenario and a concentrated scenario (focusing on the spread of development). This yielded differences in effects for traffic, noise and air pollution, leading to adaptions (restrictions) in the plan (O-III).
- Precautionary principle: Worst-case scenarios for the alternatives were assessed to identify the bandwidth of effects. The initiator found this infeasible, since it would never become reality. The NCEA found the worst-case scenarios provided insufficient information about the possible bandwidth of activities and their effects (Commissie voor de Milieueffectrapportage, 2013, p. 6).

Thus, for the SV it can be said that this uncertainty was **not successfully dealt with**. As the consultants put it: '*the approach was not wrong, although a different approach would have yielded more information regarding vulnerable spots in the area*'. If they would do it again, they would map the capacity of the area and develop a monitoring tool to evaluate impact. This was not done due to time constraints, and because the municipality pushed for quick results. However, this would result in better control of developments and their uncertainties (O-III).

The uncertainty still existed at the time of the zoning plan (Commissie voor de Milieueffectrapportage, 2015). The NCEA advised to perform additional research, and to design a monitoring program to evaluate effects. The municipality responded positively (O-I). A zoning plan was established in 2016, including decision-trees, development principles and a monitoring program (Sweco, 2016). According to the initiator, uncertainties are sufficiently dealt with now that an area director is responsible to guide the parcel regulations, and follow developments in evaluations. Initiatives come up that fit the regulations. In sum, it took additional research, worst-case scenarios and a design of a monitoring program to **successfully deal with** uncertainty about future activities. It was achieved in the zoning plan in 2016. The combination of strategies is expected in the theoretical framework. The advice of the NCEA was followed up, and is decisive in steering towards a successful solution. Furthermore, the legal status of the plan is of influence, as a more detailed assessment was required for the zoning plan.

According to the NCEA secretary, who advised on the zoning plan, there was uncertainty in the assessment framework, because the municipality could not concisely define ambitions and conditions for developments (Table 8). It is important to be concise, otherwise a monitoring program would be infeasible. The NCEA recommended to determine clear boundaries and limits, but cannot be concrete about this since they are political choices (O-I). It appears that the conditions and ambitions were not sufficiently clear in either the SV or the zoning plan, as initiators experience arbitrariness in the assessment of initiatives and research needs for permits (Lekkerkerker, 2016, p. 63). Therefore, this uncertainty **was not successfully dealt with**, as it was not reduced or resolved.

The design of the monitoring program was uncertain at the time of the SV and zoning plan in 2015 (Table 8). Therefore, the NCEA advised on how to design this program. It was recommended to specify aspects, indicators and critical limits, and to use a dynamic monitoring tool that is always up to date to the most recent developments. Intervention measures are at hand if thresholds are crossed. The response of the municipality towards this advice was positive (O-I). This is visible in the zoning plan in 2016, where a more accurate monitoring program is designed (Sweco, 2016, pp. 79–81). Critical boundaries are established for traffic capacity and safety, noise pollution, external safety and ecology. The monitoring program includes the following steps:

- What developments occurred since the last check?
- Do the consequences of these developments fit within acceptable limits?
- Are any mitigation measures or intervention measures necessary to maintain acceptable limits?
- Are ambitions still realistic, or is there any need to adapt to recent developments?

With this strategy of adaptive management (monitoring program and parcel regulation) and precautionary principle (critical boundaries and intervention measures), the uncertainty about the monitoring program is **successfully dealt with** in the zoning plan in 2016. It was not at the time of the SV. Factors that were of influence were the advice of the NCEA, level of decision-making and available resources, because the zoning plan required a more detailed assessment and more time was available to design the zoning plan.

Due to faults in data and models, the impact of nitrogen deposition could not be accurately estimated (Table 8). Inaccurate prediction of nitrogen deposition also poses a legal risk, and was an issue throughout the planning process of the SV in 2013, zoning plan in 2015 and zoning plan in 2016. Addressing this issue with a worst-case scenario (precautionary principle) for the SV was insufficient, as the NCEA identified this as an essential shortcoming (Commissie voor de Milieueffectrapportage, 2013). For the zoning plan in 2015, it was recommended by the NCEA to identify measures to make sure impact is prevented, and measures to intervene if impact is significant (O-I). The real impact must be included into a monitoring program (Adaptive management).

The results are visible in the zoning plan in 2016, where precautionary measures are identified to address significant effects, thresholds are determined after performing additional research by a different consultancy firm, and by designing a monitoring program (Sweco, 2016). It is included in the regulatory framework that developments may not cause any additional nitrogen deposition, other than what is already emitted in the current situation:

'Any increase of nitrogen emissions can cause increase of nitrogen deposition in Natura 2000 locations. Significant effects cannot be excluded. Therefore, in coherence with the nature protection law, a threshold for emissions is established in the rules. This was found acceptable by the Council of State or a zoning plan in Delfzijl in 2015' (Sweco, 2016, p. 60; free translation).

Uncertainty about nitrogen deposition was thus **successfully dealt with in the end**, influenced by the advice of the NCEA and Council of State. Legal requirements were decisive in determining if sufficient information was provided.

Social uncertainty

Social uncertainties were discussed with consultants and the initiator, yet were said to be of little influence (Table 8). The two municipalities, Almere and Zeewolde, were not always equally represented during the planning process for the SV. However, there was close coordination between the managerial and administrative organisations, according to the practitioners. It was the responsibility of the municipality to deal with this, and coordination was successful as the plans got accepted by both parties. What could also be of influence here is regional or even national pressure to provide room for growth in Flevoland to solve issues with housing needs around Amsterdam (Gemeente Almere & Gemeente Zeewolde, 2013). Still, this approach is consistent with the theoretical expectation, to address it with stakeholder involvement, and it was **successful** as the plan go accepted by both parties.

According to the initiator it was uncertain how private initiators would interpret the plan and its development principles (Table 8). This is addressed with adaptive management: the area director leads initiatives and decides if they fit the required ambitions and quality. Overview is maintained in evaluations and an online discussion forum. This is **successful** since the first evaluations show that initiatives generally fit the aspired quality (Lekkerkerker, 2016).

Legal uncertainty

The initiator experienced legal uncertainty due to the legal requirements for Natura 2000 locations (Table 8). It was impossible to make statements about nitrogen deposition if future activities are unknown (O-I). It was addressed using the precautionary principle and knowledge generation. An appropriate assessment is conducted to research effects on Natura 2000. This assessment is based on expert judgement and a worst-case scenario regarding nitrogen deposition. It led to the prohibition of highly polluting activities. According to the NCEA this was insufficient information for the zoning plan as the statements were not supported with quantitative research. Additional research was performed by another consultancy in 2015. This included detailed measurements and calculations of nitrogen deposition in the area and an advice from an attorney. It led to adaptations to the zoning plan, regulating nitrogen deposition. It was finally **successfully** determined in the zoning plan in 2016.

4.4 Greenport Venlo

4.4.1 Introduction to the case

Greenport Venlo is an area between the municipalities of Venlo, Horst aan de Maas and Peel aan de Maas (Figure 9). It is located in the Province of Limburg, close to the border with Germany. Situated in the area are businesses for agrologistics, horticulture and (intensive) livestock farming.

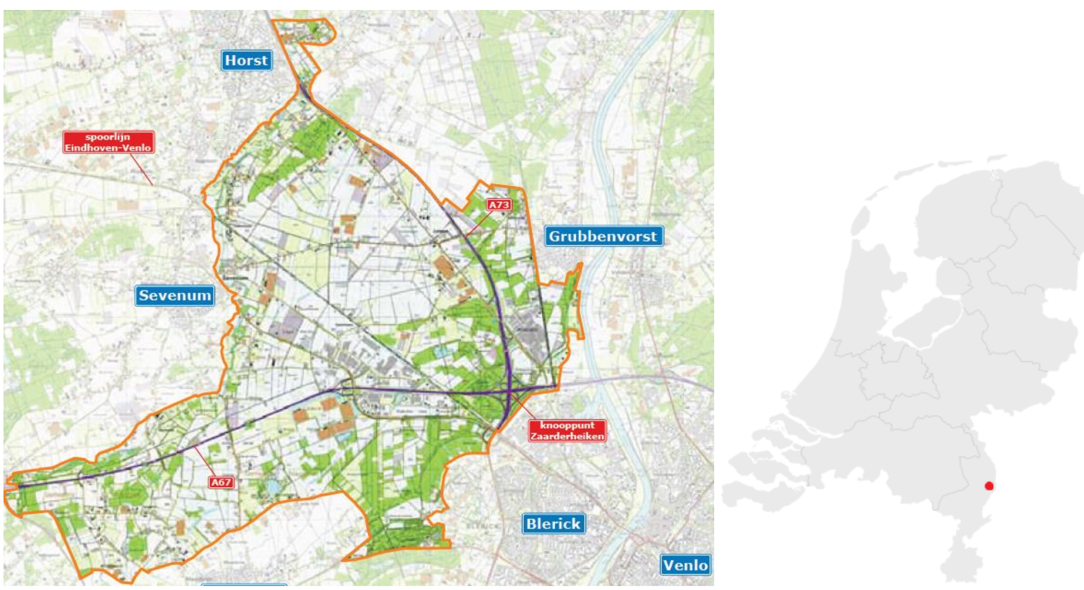


Figure 9: Planning area Greenport Venlo (Development Company Greenport Venlo, 2012)

To further exploit the economic opportunities in the area the area is to be developed sustainably from 14.000 to 27.000 jobs up to 2022. Business parks are expanded with the settlement of new companies that are active in agribusiness, logistics, and knowledge institutes. A high-quality landscape surrounds the business parks. The development is inspired by the concept of Cradle2Cradle (C2C), an economic philosophy focusing on (re)development, implementation, management, and transformation (Development Company Greenport Venlo, 2012, p. 9). Up to 2040 the area will transform 2.000 hectares of agricultural land to business parks, infrastructure, and nature (For an overview of developments per theme, see Appendix 8.2.4, Table 15).

The Structure Vision [SV] was created in 2012 by the Development Company Greenport Venlo [DCGV]. The three municipalities and the Province of Limburg are shareholders. The DCGV is responsible for the coordination of spatial developments, yet the authorities are responsible to grant permits (Development Company Greenport Venlo, 2012).

An SEA was performed to study environmental effects and possible mitigation measures of the plan (See Appendix 8.2.4, Figure 16 for an overview of the planning process). The NCEA recommended to include environmental information on different levels of detail, because the SEA serves as an overarching framework for future assessments of zoning plans (Commissie voor de Milieueffectrapportage, 2011a). SEA needs to include the probability that effects can occur (best-case and worst-case) and in what way this will be monitored, evaluated, and addressed. This advice was adhered to and resulted in the design of a preferred alternative, that was also assessed concerning its effects and led to the final SV. SEA was used to identify issues that require attention in the following planning procedures (zoning plans and permits). This is included in a suggestion for a monitoring program. However, this monitoring program will need to be further developed in consequent planning procedures (Development Company Greenport Venlo, 2011).

In an interim advice, the NCEA judged that not all essential information was included to fully integrate environmental effects in decision-making. Information was missing about effects of nitrogen deposition, effectiveness of mitigation measures, the reference situation, and cumulation of effects on health. After this advice, additional assessments were performed: Appropriate Assessment for Natura 2000 locations and a Heath Effect Screening. In the final advice, the same essential information was still missing (Commissie voor de Milieueffectrapportage, 2012). The NCEA argued that calculations for nitrogen deposition need to be included.

4.4.4 Results for uncertainties and their management for Greenport Venlo

Table 9 provides an overview of the interview results of Greenport Venlo. It shows the types of uncertainties, the case specific example, and who perceived the uncertainty. Categories of uncertainties are highlighted with colours in the table: green (inherent), blue (scientific), red (social), and yellow (legal). A theoretical approach to the uncertainties is presented, as well as the actual strategy that is applied in the case, the degree of success of strategies and factors influencing this. The results are analysed in this paragraph, serving to refine the theoretical framework.

Interviews took place with three respondents and are coded for reference in the text: the NCEA secretary responsible for the NCEA advisory report on the spatial plan (GP-I), the initiator at the DCGV (GP-II), and the consultant responsible for the SEA report on the spatial plan (GP-III).

Uncertainty	Problem	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
Variability	Economic developments	III	Adaptive management Precautionary principle	Adaptive management Precautionary principle	Successful: Bandwidth of effects	-
Cause-effect	Spread of pollution and use of averages in models	III	Adaptive management Precautionary principle	Precautionary principle Adaptive management	Successful: Included in monitoring program	Level of decision-making
Identification of change and impact	Effect estimation nitrogen deposition	I	Adaptive management Stakeholder involvement Knowledge generation	Stakeholder involvement Knowledge generation	Not successful: Agreements are made outside planning procedure	Advice NCEA Costs

Uncertainty	Problem	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
Identification of change and impact	Assessing sustainability ambitions	I, III	Adaptive management Stakeholder involvement Knowledge generation	Adaptive management	Not successful: Postponed to later planning stages, yet research needs not explicit in SV	Legal requirements
Identification of change and impact	Assumptions in predictions	III	Adaptive management Stakeholder involvement Knowledge generation	Precautionary principle	Partly successful: Not included in monitoring program	-
Quality of methods	Health effect screening	I, III	*Not identified in theory*	Stakeholder involvement Adaptive management	Not successful: Solving uncertainties was postponed	Development of manageable methods
Faults in data or models	Faults in traffic models	III	Adaptive management Precautionary principle Knowledge generation	Precautionary principle	Successful: Bandwidth of effects	-
Base line conditions	Existing business in the area	III	Precautionary principle Knowledge generation	Knowledge generation	Successful: Insight in current and reference situation	-
Knowledge base	Way of thinking/level of knowledge	II	*Not identified in theory*	Stakeholder involvement Adaptive management Knowledge generation	Not successful: Cultural change was not achieved	Mindset experts Capacities PM Integration SEA/SV
Political climate	Coordination authorities	III	*Not identified in theory*	*Not further discussed*	*Not further discussed*	-
Institutional setting	Public-private legislation nitrogen deposition	II, III	*Not identified in theory*	Stakeholder involvement Adaptive management Knowledge generation	Not successful: Protocol not implemented, legal instrument was developed	Maintenance of information Continuity in project organization

Table 9: Results of uncertainties and strategies for Greenport Venlo.
Respondents: I = NCEA, II = Initiator, III= Consultant

Inherent uncertainties

Inherent uncertainty in variability was experienced by the consultant (Table 9). There was uncertainty in future economic developments, as it was unknown what companies would settle in the area. Different types of companies have different environmental impact, which is why the impact prediction in SEA was difficult. To address this, adaptive management and precautionary principle were employed by designing and assessing different variants (GD-III). A base alternative is designed based on maximal development in the first 10 years. A 'robust' variant is designed based on maximal development thinkable until 2030-2040. These variants served to gain insight in the carrying capacity of the environment under maximal development, and where intervention measures in the long-term might be required (Development Company Greenport Venlo, 2011, p. 36). The combination of these strategies was **successful** since the uncertainty about future business activities is reduced. The use of these strategies is also consistent with the theoretical expectation.

Inherent uncertainty in cause-effect mechanisms was also experienced by the consultant (Table 9). Examples were the unknown spread of pollution through air and water, and the use of averages in models. The consultant stated there is insufficient knowledge on the workings of pollution, and generating knowledge by additional calculations will not yield any better results in impact prediction. Using a worst-case scenario, one knows the maximum possible effects. The effects can turn out in equal size or less in reality and one knows whether these are acceptable. The impact of pollution is sufficiently predicted in this way. It is also addressed using adaptive management by including the aspects in the monitoring program (Development Company Greenport Venlo, 2011, p. 80). Therefore, this uncertainty is **successfully** addressed, and in a way, that is consistent with the theoretical expectation.

Scientific uncertainties

Uncertainty in the identification of change and impact was experienced regarding the estimation of effects on nitrogen deposition (Table 9). According to the NCEA the SEA report lacked information about increase of nitrogen deposition, mitigation measures and cumulative effects. The assessment is found to be 'generic' and not sufficient. The NCEA advised twice to further assess nitrogen deposition as the consequence of the spatial plan. The initiator provided additional information, which was still found insufficient. After that, the initiator stated that *'it was too expensive to perform additional research and this would not yield any more valuable information. We wanted to solve it differently and the NCEA would not accept this.'* The initiator and consultant worked on a public-private agreement with land owners to manage nitrogen deposition (see legal uncertainty below). The NCEA advice and additional research did not reduce uncertainty about impact of nitrogen deposition and were thus **not successful**. Theoretically it was expected to use adaptive management, for example a monitoring program. This was probably not feasible due to the high costs (Table 9).

There was also uncertainty in the identification of change and impact due to assumptions in research methods in general (Table 9). This is addressed using the precautionary principle by making assumptions about a worst-case scenario. This leads to some indication as to the bandwidth of effects. Why the estimation of nitrogen deposition is addressed so much more seriously (in private agreements) and uncertainty in impact prediction in general is not, can be explained by the legal requirements of SEA. Nitrogen deposition is a legally sensitive subject that requires a far more detailed assessment as to exclude any significant effects on Natura 2000. If these cannot be excluded, the plan will not be accepted. Uncertainty about due to general assumptions was **partly successfully dealt with**, as the bandwidth of effects was identified, but not included in a monitoring program. As such, there is no mechanism in place to control actual impact.

Uncertainty about sustainability ambitions was solved by employing adaptive management (Table 9). A scenario analysis of a worst case and best case where designed (GP-III). It was difficult to integrate sustainability effects in the SEA since there are no standards developed to do this. Interestingly, the NCEA respondent states that C2C played a minor role since it was not fully included in the plan and SEA, whilst the consultant and initiator discuss the importance of it as it was the core of the initiative. How such differences emerged remains to be seen, but it can be argued that C2C did indeed not play a large role since there are no legal requirements to include sustainability in the SEA report. Therefore, no essential information was missing, to speak in terms of the NCEA advice. However, using the scenarios information was presented on the bandwidth of developments and further assessment is postponed to later planning procedures. It is assumed this uncertainty was **not successfully dealt with**, as the initiator expressed that creating a similar mindset about sustainability in the plan failed, and is *'more driven towards circular economy and C2C in subsequent spatial plans, as this is the future'* (GP-II).

A health effect screening was employed to address cumulative effects of air pollution, odour pollution, traffic increase and external safety. This method assesses overall health impact of a plan. However, this method was relatively new and therefore the quality of the method was uncertain for the consultant and NCEA secretary (Table 9). This was addressed using strategies of adaptive management and stakeholder involvement. The NCEA provided specific recommendations to improve the health effect screening (Commissie voor de Milieueffectrapportage, 2012, pp. 9–10) and advised to further assess this for the zoning plans. After workshops with stakeholders it became clear that there was indeed a need to phase developments based on scenarios and phase the research accordingly. The consultant sees a role for the NCEA to further develop methods and tools for health effect screening. Addressing the uncertainty with stakeholder involvement (workshops) was successful in reducing it, since it led to the solution to phase developments and research. However, it is not explicitly included in the monitoring program and therefore **not successfully dealt** with using adaptive management. This shows that the combination of strategies is often important in addressing uncertainties, yet both strategies need to be applied sufficiently.

Uncertainty in data and models was experienced by the consultant (Table 9). The model to calculate traffic increase was wrong due to wrong assumptions. This means that the effect estimation on for example air quality or noise is incorrect. It was addressed using the precautionary principle: a worst-case approach **succeeded** to find insight in the bandwidth of effects.

The last scientific uncertainty occurred in base line conditions. The consultant experienced it was very unclear how many and which types of companies were already settled in the area. This is problematic for SEA since the base line situation is the benchmark to assess impact of future activities. It was **successfully addressed** with knowledge generation: a large table was made to systematically address all existing activities in the area.

Social uncertainties

Social uncertainty in the knowledge base was experienced by the initiator (Table 9). A cultural change was needed to have people understand the implementation of the C2C concept. This hampered the development of aspired ambitions. It was addressed using strategies of stakeholder involvement, adaptive management and knowledge generation. Whilst engaging in discussions and workshops on the subject the initiator failed in implementing the C2C concept in all layers of the municipal organization. It is therefore recommended to integrate the spatial plan and the SEA and to challenge experts on difficult subjects via procurement demands. These last two strategies were discussed in retrospect, and can therefore not be judged regarding their success. **Stakeholder involvement was not successful** as it did not achieve the required cultural change.

The political climate was another social uncertainty, discussed with the consultant (Table 9). The coordination between authorities was sometimes difficult if agreements had to be made about where to place what type of companies. If these agreements do not fit, the authorities could run into high costs to repair this (GD-III). However, it was not further discussed how to address this due to time constraints. The Structure Vision is accepted by all parties, suggesting the differences in ambitions were overcome.

Legal uncertainties

Uncertainty about nitrogen deposition is not considered an issue of limited knowledge or doubts about the quality of assessment. The initiator and consultant wished to solve uncertainty in the assessment of nitrogen deposition by making their own agreements:

"We made agreements with landowners about how to manage land allocation in the area. This means you take measures before effects can occur. Landowners put in financial means from a development fund to take such measures. This was a cheap way for us to solve the problem. We included the intention of public-private agreements in the Structure Vision, together with an information plan to keep track of developments. "

The problem is that the agreements cannot be included in a spatial plan. Possible effects of these agreements cannot be assessed in SEA and therefore happen out of sight of SEA and the NCEA. A strict protocol was created for the issuance of parcels. However, these were not implemented, because a legal system for nitrogen deposition was developed, overruling previous arrangements. Consequently, information on the public-private agreements is lost. According to the initiator and consultant, this approach works if you can maintain knowledge and information. SEA could contribute to this issue by imposing a legal stimulus to update information regularly.

4.5 Eemsmond Delfzijl

4.5.1 Introduction to the plan

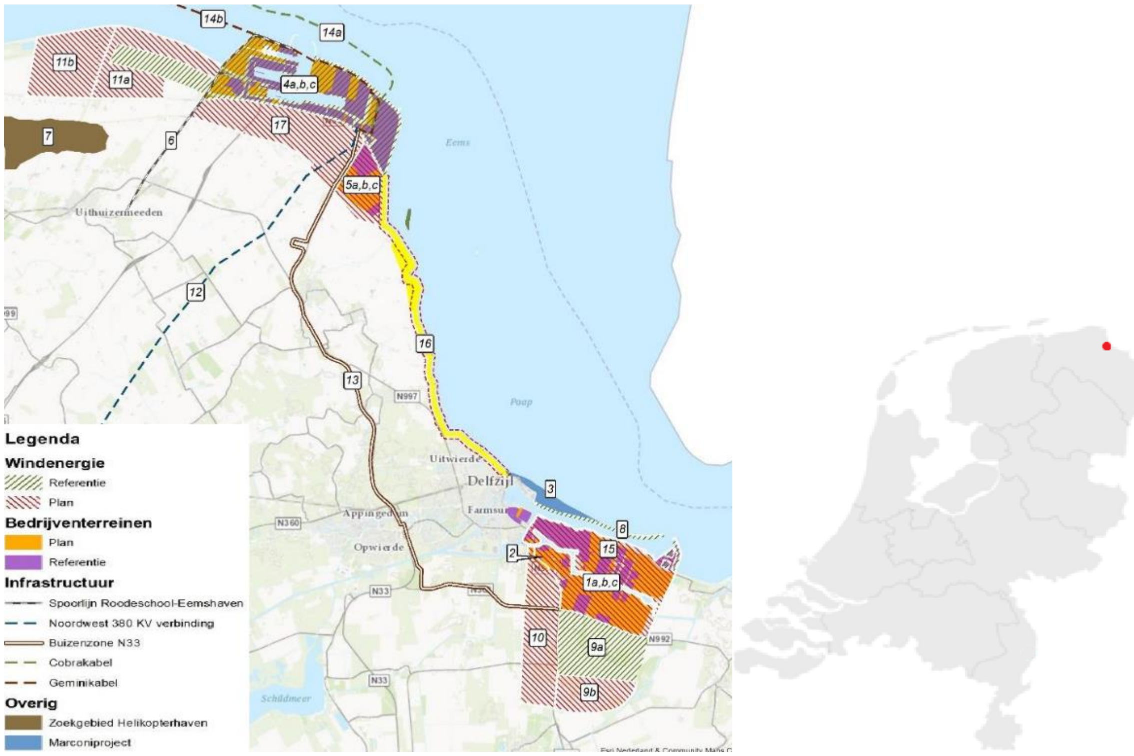


Figure 10: Planning area Eemsmond Delfzijl. Source: SEA report Eemsmond Delfzijl

Eemsmond Delfzijl is situated in the north of the Netherlands in the Province of Groningen (Figure 10). The planning area includes the harbour Eemshaven, the harbour Oosterhorn and some adjacent areas. The region is characterized by chemical industries and energy industries. Ecologically valuable areas surround the region: the Waddenzee, Eems-Dollard estuary, and the (uninhabited) islands Rottumerplaat and Rottumeroog. These are appointed Natura 2000 and UNESCO world heritage (Arcadis Nederland B.V., 2016, p. 18). Apart from economic activities and ecological values, the region includes several villages that are close to industrial areas and windfarms and experience nuisance of odour, light and noise pollution.

To stimulate economic growth in the area, a Structure Vision (SV) is established in 2017. The SV is a cooperation of the Province of Groningen, municipality Delfzijl, municipality Eemsmond and Groningen Seaports (the manager of harbours and industrial areas). The goals of the SV are:

- Room for sustainable energy
- Creating an attractive business climate
- Prevention of environmental pollution
- Increasing biodiversity (Provincie Groningen, 2017).

The spatial plan is meant as an overarching framework that determines the (cumulative) limits for environmental impact of spatial development in the region. The environmental limits are determined for a total of 15 future spatial projects, including industrial areas, windfarms, a railway, a heliport, cable connections and dike reinforcement (Arcadis Nederland B.V., 2016) (See Appendix 8.2.5, Figure 17 for an overview over proposed developments). To ensure that (cumulative) effects fit the carrying capacity of the area, location specific policy is necessary that determines the critical limits for environmental pollution. Consequently, limits are established in the SV for:

- Cumulative noise pollution (caused by windfarms and/or industrial activity)
- Noise emission per windfarm

- Cumulative odour pollution as well as the overall norm for noise pollution
- Combinations of windfarms and industrial areas concerning external safety
- Emission of nitrogen and heavy metals

The limits are included in the environmental policy for the Province of Groningen. The responsibility for the strategic implementation of the environmental policy lies with the regional environmental service (*Omgevingsdienst Groningen).* They are responsible for permits, surveillance and enforcement via a monitoring program (Provincie Groningen, 2017, p. 27).

The SEA is used to identify critical limits and design a preferred alternative. To do so, scenarios and variants were designed to frame developments, being a 'grey' and 'green' economic scenario (based on sustainability of industries), variation in size of wind turbines (3MW-7,5MW) and locations for the heliport. Such an approach was recommended by the NCEA in their advice on the scoping document (Commissie voor de Milieueffectrapportage, 2015). It was also recommended to include an analysis of cumulative effects in the region. The economic scenarios, the wind farm variants and the location for the heliport yield different environmental effects that are assessed in the SEA. A preferred alternative is found in the SEA based on these effects.

An interim advice of the NCEA was requested on the aspects of noise pollution, external safety, odour pollution and ecology. The NCEA found that sufficient information was provided regarding noise pollution and external safety (Commissie voor de Milieueffectrapportage, 2016b). Odour pollution required additional argumentation on the acceptation of cumulative effects. Ecology also required additional research into effects of heavy metals, nitrogen deposition and wind farms.

The final advice of the NCEA judged that the SEA report included environmental information to establish the spatial plan (Commissie voor de Milieueffectrapportage, 2017). The NCEA gave recommendations for further planning processes, which are to provide an analysis of landscape effects of wind farms, to assess effects of turbidity in the Eems-Dollard estuary, and to keep information accessible for future planning procedures.

4.5.4 Results for uncertainties and their management in Eemsmond Delfzijl

Table 10 provides an overview of the interview results of Eemsmond Delfzijl. It shows the types of uncertainties, the case specific example, and who perceived the uncertainty. Categories of uncertainties are highlighted with colours in the table: green (inherent), blue (scientific), red (social), and yellow (legal). A theoretical approach to the uncertainties is presented, as well as the actual strategy that is applied in the case, the degree of success of strategies and factors influencing this. The results are analysed in this paragraph, serving to refine the theoretical framework. Interviews took place with four respondents and are coded for reference in the text: the project leader responsible for the SEA process and report (ED-I), the SEA coordinator at the Province of Groningen (ED-II), the project manager (initiator) at the Province of Groningen (ED-III) and the NCEA secretary responsible for the NCEA advisory reports on the spatial plan (ED-IV).

Uncertainty	Problem for SEA	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
Variability	Type of business settling in the area	I	Adaptive management Precautionary principle	Precautionary principle Knowledge generation Adaptive management	Successful: Bandwidth of effects	Documentation prior to SEA
Variability	Earthquakes	II	Adaptive management Precautionary principle	Avoiding	Not successful: Uncertainty not changed	Dependency on national policies
Identification of change and impact	Increase turbidity Waddenzee	IV	Adaptive management Stakeholder involvement Knowledge generation	Stakeholder involvement Precautionary principle	Successful: Estimation of risks and mitigation measures	Interim advice NCEA

Uncertainty	Problem for SEA	Who	Theoretical strategy to apply	Strategy applied in case	Degree of success	Factors
Identification of change and impact	Inclusion of sustainability	II, IV	Adaptive management Stakeholder involvement Knowledge generation	Stakeholder involvement	Not successful: Advice was not implemented	Dependency on national policies Legal requirements
Identification of change and impact	Design of windfarms	IV	Adaptive management Stakeholder involvement Knowledge generation	Stakeholder involvement Knowledge generation Adaptive management	Successful: Risks and mitigation measures included in following plans	-
Identification of change and impact	Effect of heavy metals on nature	IV	Adaptive management Stakeholder involvement Knowledge generation	Stakeholder involvement Adaptive management	Successful: Included in monitoring program	Interim advice NCEA
Assessment framework	Design assessment framework	II, III	Adaptive management Stakeholder involvement	Precautionary principle Stakeholder involvement Adaptive management	Successful: Objective norms established in SV	Interim advice NCEA Legal requirements
Assessment framework	Relevance of environmental aspects	III	Adaptive management Stakeholder involvement	Knowledge generation Stakeholder involvement	Successful: Scope determined	Documentation prior to SEA
Assessment framework	Matching planning processes	I	Adaptive management Stakeholder involvement	Stakeholder involvement	Successful: Matching content	-
Values, interests and perceptions	Baseline data & assumptions about odour pollution	I, II, III	Stakeholder involvement	Stakeholder involvement Knowledge generation Adaptive management Precautionary principle	Partly successful: Stricter regulation for odour emission, remediation uncertain	Specialist advice Good cooperation between project leaders Timing
Values, interests and perceptions	Discussions on acceptable norm for noise pollution	I, II, III	Stakeholder involvement	Stakeholder involvement Adaptive management Precautionary principle	Successful: Customized regulations for noise pollution and support	Critical attitude specialists of province National pressure Advisory skills Flexibility and good cooperation
Values, interests and perceptions	Discussions on acceptable norm for external safety	I	Stakeholder involvement	Stakeholder involvement Precautionary principle Adaptive management	Successful: Customized regulations for windfarms and support	Good cooperation between specialists Advisory skills and knowledge of provincial organisation
Values, interests and perceptions	Discussions on impact on nature	I, III	Stakeholder involvement	Stakeholder involvement Precautionary principle Adaptive management Knowledge generation	Partly successful: Included in monitoring program, no support	Idem

Table 10: Results uncertainties and strategies for Eemsmond Delfzijl.
Stakeholders: I = Project leader SEA, II = SEA coordinator, III = Initiator, IV = NCEA

Inherent uncertainties

The SEA project leader experienced uncertainty in variability in the type of business settling in the area (Table 10). The SV enables the expansion of industrial areas, yet it is unknown what companies will settle there. It poses a problem for SEA since different types of companies would produce different environmental effects: *'a company in bio-fermentation could smell more*' (ED-I). It is addressed using knowledge generation, adaptive management and precautionary principle (Table 10). Economic studies predicted two different growth scenarios based: a 'grey' and 'green' scenario. These two scenarios were assessed regarding their impact in a worst-case situation. Using these strategies, information is obtained on the upper and lower boundaries of effects, and the truth would be somewhere in between, thus the uncertainty is **successfully reduced**. An influencing factor was available documentation that was prepared prior to the SEA process. This knowledge could be used to determine variants to assess.

Uncertainty in variability is also experienced by the SEA coordinator (Table 10). The uncertainty was concerned with earth quakes, an issue in the Province of Groningen due to gas exploitation. It is considered in the built environment, but not something you can include in the SEA (ED-II). Earth quakes were placed outside the scope, as this is affected by autonomous developments, tackled in other provincial and national programs and as such are not part of the SV (Arcadis Nederland B.V., 2016, p. 273). The uncertainty remains unchanged and is thus **not successfully dealt with**.

Scientific uncertainties

Several examples were named for uncertainty in the identification of change and impact: increase of turbidity in the Waddenzee, inclusion of sustainability, design of windfarms and effects of heavy metals on nature (Table 10). These were experienced by the NCEA secretary and SEA coordinator. The NCEA found these subjects insufficiently addressed in SEA, however it was not identified as an essential shortcoming.

For increase of turbidity in the Waddenzee, the NCEA advised to include this in the scope as the activities in the SV could cause turbidity (Commissie voor de Milieueffectrapportage, 2015). Then, the precautionary principle was applied to provide an estimation of these effects. A qualitative judgement is made in an Appropriate Assessment, and the risk is estimated to be limited. On top of that, mitigative measures are identified in case significant negative effects are caused. As such, the uncertainty is **successfully dealt with**.

The inclusion of sustainability was a reason for uncertainty according to both the NCEA secretary and SEA coordinator (Table 10). Ambitions for sustainability are complex and larger than this SV (ED-II). It is addressed with stakeholder involvement: the NCEA advised to include these ambitions, as they could positively affect overall environmental quality in the region. Yet, they depend on public-private agreements and are insufficiently concrete to assess in the SEA. Thus, effects of sustainability ambitions are still uncertain and not **successfully dealt with**.

As for the design of windfarms, local impact on the landscape is uncertain according to the NCEA secretary (Table 10). This is addressed with stakeholder involvement, knowledge generation and adaptive management. The NCEA advised to assess the impact of windfarm on the landscape and include a further research need in following planning procedures. It was assessed in the SEA: a specialist in landscape architecture performed expert judgement to estimate the current effects and possible mitigation measures (Provincie Groningen, 2017, p. 62). This specialist will be involved in location-specific windfarms at the time of requesting permits. Thus, the uncertainty is **successfully addressed**.

Lastly, the identification of the effects of heavy metals on nature was uncertain according to the NCEA secretary (Table 10). It was insufficiently addressed in this SEA and needs to be included in further plans and in a monitoring program (ED-IV). This advice was adhered to and the assessment of heavy metals is included in a monitoring program (Provincie Groningen, 2017, p. 103). It was **thus successfully addressed**.

The same type of uncertainty was differently addressed. The NCEA advised on all matters (stakeholder involvement), and this was adhered to for turbidity, design of windfarms and heavy metals. It was not adhered to for the inclusion of sustainability, which could be explained because this is the only subject not included in a legal framework. It is not obligated to include sustainability in an SEA. The other aspects are then addressed using precautionary principle or adaptive management, to ensure actual impact is closely monitored and controlled with mitigative measures.

Uncertainty in the assessment framework is experienced by the SEA coordinator and SV project manager (Table 10). Indicators had to be designed quantitatively to provide useful information for decision-makers, which is difficult on the abstract level of an SV. Furthermore, the scoring of indicators needed to provide clear and objective information, instead of being abstract and visionary (ED-II). It is addressed using the precautionary principle, stakeholder involvement and adaptive management. The precautionary principle is applied by choosing for nationally accepted norms (ED-III). Stakeholder involvement is applied by specifically requesting NCEA advice on aspects of which the norms were uncertain. Both these strategies led to find support for the methodology and have this confirmed. These norms were included in the strategic environmental plan of the regional environmental service (adaptive management) where they will be evaluated. It is thus **successfully addressed** in a combination of these strategies.

The <u>relevance of environmental aspects was uncertain</u> as experienced by the SV project manager (Table 10). This was addressed using knowledge generation and stakeholder involvement. Knowledge was generated in environmental research performed by the regional environmental service. It was assessed what environmental aspects would be most relevant to research in SEA in accumulation, based on the proposed developments in the region. Stakeholder involvement was used by including the NCEA in finding the most relevant themes, and by coordination with local stakeholders. This **was successful** because the scope was determined (Table 10).

Lastly, <u>matching planning process posed uncertainty</u> according to the SEA project leader (Table 10). The SV is meant to facilitate further zoning plans to implement proposed activities in the region. To get all these plans accepted, it is important to be consistent in the assessment framework. Coordination between stakeholders and consultancy firms was used to achieve this goal. The zoning plans quickly followed the SV for NCEA advice (ED-IV). Thus, it can be concluded that this was **dealt with successfully**.

Social uncertainties

<u>Social uncertainties posed the largest issues in this SEA</u> according to the initiator. There were many different stakeholders with different values and interests that wanted to influence the outcome of the SEA. It poses a problem for SEA as decision-making is very difficult when the methodology and outcomes of effects are being questioned. This was especially the case for the aspects odour pollution, noise pollution, ecology, and external safety.

The <u>methodology to assess accumulation of odour pollution was new</u> and it was difficult to assess odour pollution on the abstract level of the SV. As the results of effects of odour pollution turned out very high, limiting development in the area, the methodology was questioned. It was addressed with strategies of stakeholder involvement, knowledge generation, adaptive management and precautionary principle, all aiming to enable the development of odour emitting companies in the region.

- Stakeholder involvement: The NCEA was requested to provide interim advice. This confirmed the doubts about the quality of the research method. It was recommended to include a specialized consultancy firm for a second opinion. A consultancy firm was then hired to perform a second opinion. They found that the current odour pollution norm was sufficient to regulate odour emission, and that there was only one company exceeding this norm. Agreements were made with this company to remediate odour emissions.
- Knowledge generation: The consultancy firm performed additional research into odour emissions in the region. It showed that real the existing provincial norm was effective and sufficient.
- Precautionary principle: It was decided to adhere to the existing norm, that would prevent accumulation of odour pollution. Strict regulations are implemented and mitigation measures identified.
- Adaptive management: it needs to be monitored that odour pollution remains within the norm and that the company succeeds in remediation of odour emission.

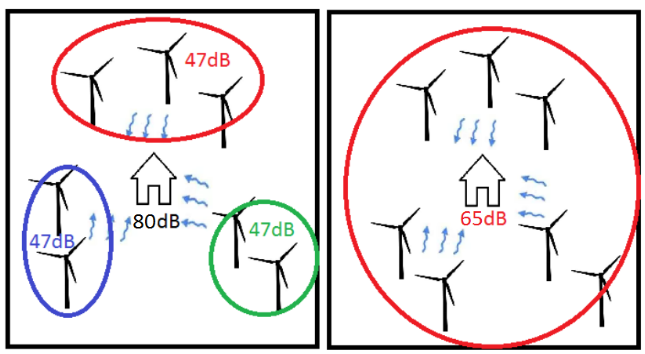
The uncertainty about stakeholder interests in odour pollution was **successfully addressed** in this combination of strategies. Agreements are made and implemented in regional policy and monitoring programs, and stakeholders support this solution (ED-III). The remaining uncertainty is whether the company will succeed in remediation of odour emissions.

As for <u>noise pollution, external safety and nature, similar uncertainty existed</u> as there were discussions on the methodology used to assess their impact (Table 10). They were addressed using similar strategies, by negotiating solutions with stakeholders that they can identify themselves with, creating tailor-made agreements, implementing these agreements in the regulatory framework of the SV, acquiring confirmation of the NCEA on the applied methods and agreements, and including them in a monitoring program (Table 10). For example, for noise pollution due to wind farms a compromise in the norm was found: to prevent accumulation of noise for residents, noise regulation will be based on the total of a wind farm, instead of individual permits (Textbox 4). Only for effects on nature, no support from stakeholders was achieved. Local nature organizations demand more research and are not satisfied with argumentation for why there is no significant impact of the SV. This could be explained by the fact that these interests go deeper and do not concern questions of methodologies or agreements, they concern differences in perspective on the ecological values in the area and the degree of protection these need to get (ED-III).

As such, it is successful for noise, odour and safety to address this with stakeholder involvement, adaptive management, the precautionary principle and where necessary some knowledge generation. This is because stakeholders are concerned with enabling the development of the area and finding ways to achieve this. As for nature, different values are at stake, which is why this uncertainty remains. Factors influencing the success of these strategies are summed up in Table 11. They are mostly concerned with advisory skills, cooperation between the consultancy firm and province and national pressure to pursue certain goals.

Subject	What is monitored	How is this monitored
Noise pollution	65dB	Regional environmental monitor
Odour pollution	Concentration of odour in ou/m^3	Regional environmental monitor
External safety	Contours for local risks	Regional environmental monitor
Heavy metals	Impact on nature and environment	Assessment in another provincial program, then include in Regional environmental monitor

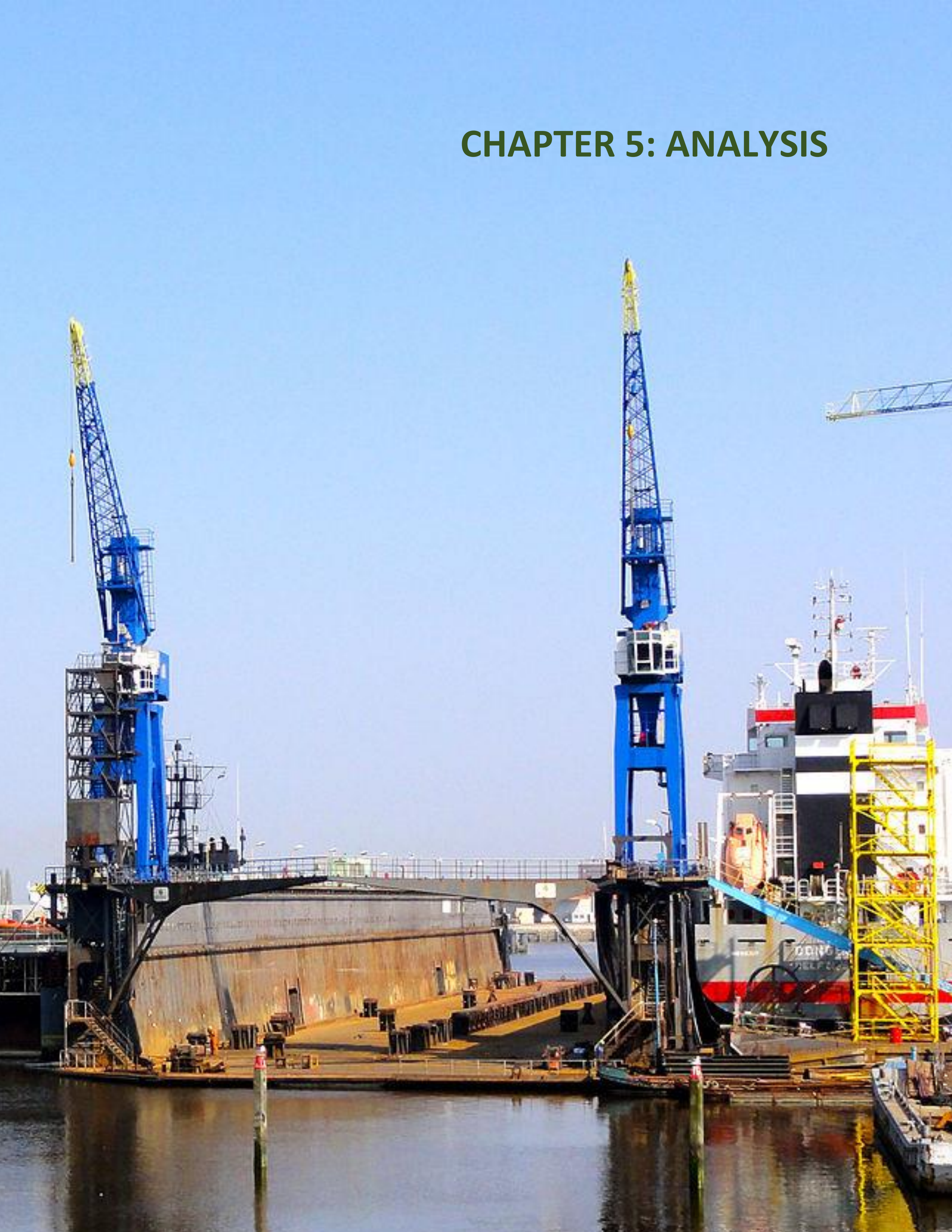
Table 11: Monitoring programs for noise & odour pollution, external safety and heavy metals (Provincie Groningen, 2017)



The figure above visualizes the regulation of noise pollution. Both situations show a house surrounded by wind turbines. The one on the left visualizes the regulation of noise pollution per permit. This means three different project developers own three wind farms. They adhere to the maximum level of 47dB individually, yet in accumulation a higher noise level affects the house. In the other situation, all wind turbines together are legally regarded as a wind farm, which means the project developers must adhere to the noise level of 47dB together. Cumulative effects on residents are prevented and wind farms can be developed in the area.

Textbox 4: Regulation of noise pollution in Eemsmond Delfzijl

CHAPTER 5: ANALYSIS



5. Case study comparison

This chapter describes an analysis of the comparison of the five case studies. The chapter is structured following the theoretical framework (Chapter 2, Figure 5) including the four types of uncertainty: **inherent, scientific, social, and legal.** The analysis focuses on the similarities and differences between strategies employed to solve the same type of uncertainty. In paragraph 5.2, strategies are reflected on regarding strong and weak points.

5.1 Uncertainties

Table 12 shows the results for uncertainties that are found in the five case studies. It shows in how many cases they are discussed, how many unique examples are named and how many times it is mentioned by respondents.

	Uncertainty	**# of cases**	**# of unique examples**	**# of mentions by respondents**
Inherent	Variability	4	8	10
	Cause-effect	1	1	1
	Cumulative effects	1	1	1
Scientific	Future activities	3	3	9
	Change/impact	3	9	12
	Assessment framework	4	6	8
	Quality of methods	3	3	5
	Base line conditions	1	1	1
	Faults in data/models	4	5	7
Social	Values, interests & perceptions	3	6	14
	Knowledge base	4	3	4
	Political climate	4	3	3
	Project design	0	0	0
Legal	Liability	1	1	2
	Legal requirements	2	2	4
	Institutional setting	1	1	2

Table 12: Results for uncertainties in the five case studies

Nearly all theoretical types of uncertainties have been confirmed in the case studies (Table 12). Although some types of uncertainty are experienced more than others, the results show that each category is perceived by respondents. Thus, uncertainties in SEA are varied, which could make it difficult for practitioners to identify and deal with uncertainties. One type is not confirmed, which is project design. However, project design played an important instrumental role in Waalweelde West and Binckhorst by designing a process that excluded uncertainties, e.g. by involving stakeholders or providing structure. It might play a role in reducing uncertainties, and since it was not experienced as uncertain in these cases, lessons can be drawn from these processes (see further recommendations).

Several types of uncertainty were only mentioned once, and therefore do not have a strong evidence base. These are uncertainty in cause-effect mechanisms, cumulative effects, base line conditions, liability and institutional setting (Table 12). It could mean they played a minor role in the SEA processes, or that they were subordinate to other types of uncertainties. This last explanation is more feasible, as respondents voiced what types of uncertainties were most prominent in the SEA process in their experience. This is something that is not reflected in the table, but did come up in the interviews. Types of uncertainty that respondents found most important are uncertainty about the identification of future activities, quality of new methods such as monitoring programs, values and interests and the inclusion of sustainability ambitions:

- For Waalweelde West, uncertainty about future activities of the plan, i.e. the flood protection measures and design of flood channels, was most important: *'Outcomes of models are subordinate to parameters used as input for the model'* (WW-III). Uncertainty in future activities caused uncertainty in models or alternatives.
- For the Binckhorst, uncertainty in future activities was also found most important, as well as uncertainty about the quality of innovative instruments to asses these. *'We have to offer stakeholders a sense of security,*

what instruments are suitable to achieve that? And if we find the appropriate instrument, how will we research it? And what is legally required of this assessment?' (B-II).

- For Oosterwold, again uncertainty in future activities was the most prominent uncertainty in the SEA process, together with the design of the monitoring program. The type of flexible planning is relatively new: *'What are you going to assess in SEA, and what can be postponed to the next planning phase?'* (O-III). The initiator recognized it was difficult as people were used to doing it the traditional way.
- For Eemsmond Delfzijl, uncertainties in values and perceptions was most important, and even found '*fundamental*' according to the initiator. These uncertainties strongly influenced the assessment of aspects, and the choices made in methodologies and outcomes (ED-III).
- For Greenport Venlo, the most important uncertainty was the inclusion of sustainability ambitions that were not understood, assessed and not included in regulations in the SV sufficiently (GD-II).

Uncertainties that came up in the most number of cases (4, Table 12) are variability, assessment framework, faults in data/models, knowledge base, and the political climate. Uncertainties that were mostly mentioned by respondents are values and interests, identification of change and impact, variability and assessment framework.

A new type of uncertainty is the quality of methods, e.g. innovative instruments in the Binckhorst, the design of a monitoring program in Oosterwold, and health effect screening in Greenport Venlo. Monitoring programs are proposed by respondents that consist of a digital dynamic tool in which all activities and environmental thresholds are kept up to date. Little experience with such tools is at hand, as was also the case for the health effect screening. Guidelines are important for the quality of such tools.

5.2 Strategies and their success

Table 13 shows an overview of all types of uncertainties experienced in the five case studies, and the strategies employed to address these. The light-coloured boxes present the theoretical expectation for strategies to show whether practical applications match with theory. The table also shows the number of applications of a strategy, and how many times this was successful. For example, stakeholder involvement is employed four times to address variability, which was successful only once (Table 13).

Strategy / Type of uncertainty	Adaptive management	Precautionary principle	Stakeholder involvement	Knowledge generation
Variability	2/2	2/3	1/4	1/1
Cause-effect	1/1	1/1	-	-
Cumulative effects	-	-	-	-
Future activities	3/3	2/2	3/3	2/2
Change/impact	3/3	2/3	3/5	1/2
Assessment framework	1/1	1/1	4/5	1/1
Quality of methods	1/2	-	2/3	1/1
Base line conditions	-	-	-	1/1
Faults in data/models	2/2	4/4	2/2	2/2
Values, interests and perceptions	6/6	5/5	4/6	2/3
Knowledge base	2/3	-	1/2	2/3
Political climate	1/1	-	1/1	-
Liability	1/1	1/1	1/1	-
Legal requirements	1/1	2/2	1/1	2/2
Institutional setting	0/1	-	0/1	0/1
TOTAL	**24/27**	**20/23**	**23/33**	**15/19**

Table 13: Results for the application of strategies in the five case studies, and their success rate

This paragraph reflects on the strategies that were employed for each type of uncertainty, their theoretical expectation and the success of strategies employed. It is also included what factors were identified that contributed to or influenced the successful application of strategies for specific types of uncertainty. For a recap of the definition of uncertainties and when they are successfully addressed, find Textbox 1 (p. 22).

Variability To address variability, each of the four strategies is employed in the case studies (Table 13). Mostly employed was stakeholder involvement, applied as either communication about uncertainty (Waalweelde West), or coordination with other parties (Binckhorst). However, this was not successful as it did not provide additional information, and could even lead to false certainty or unrest amongst decision-makers. Theoretically it is expected that variability is addressed with adaptive management and the precautionary principle, which was also applied (Table 13). This was more successful as the bandwidth of effects was identified (Greenport Venlo/Eemsmond Delfzijl). These strategies are more successful than stakeholder involvement, because they provide specific thresholds and a control mechanism in case thresholds are exceeded, ensuring the management of uncertainties after decision-making about the spatial plan. Factors identified to be influential here are the scope of the assignment (Waalweelde), European legislation (Binckhorst), documentation prior to SEA and dependency on national policies (ED). Thus, it seems that strategies to deal with inherent uncertainty about variability, that is not easily controlled, are also perceived outside the control of the spatial plan. It seems respondents find that variability issues belong to European and national levels of decision-making, instead of regional spatial plans.

Cause-effect Uncertainty about cause-effect mechanisms is addressed with adaptive management and the precautionary principle. This is in accordance with the theoretical expectation. It is successful as the uncertainty was included in a monitoring program (Greenport Venlo). Similar to uncertainty in variability, this is successful because the uncertainty will be managed after decision-making about the spatial plan. The level of decision-making was an influential factor, which means that the SV could also not go further than to identify risks and monitor these.

Future activities Uncertainty about the identification of future activities of the plan is addressed with all four strategies (Table 13). Only the precautionary principle was not identified in theory, yet it proved useful to apply worst-case scenarios to identify the bandwidth of effects (Waalweelde West). However, for the Binckhorst and Oosterwold, the initiators found the precautionary principle explicitly infeasible: *'Assessing a worst-case situation is unrealistic, as some situations are in fact restricted in the planning regulations'* (O-II). Otherwise, the application of a combination of adaptive management, stakeholder involvement and knowledge generation is successful and expected from theory. It is successful because stakeholder needs are identified, established in thresholds and included in monitoring programs, thus enabling control after decision-making and ensuring local support for the plan. Most influential here are the level of decision-making, the legal status of the plan and the advice of the NCEA, as these were identified in Waalweelde West, Binckhorst and Oosterwold. Thus, it seems that strategies are focused on delivering just the amount of information that is necessary to get the plan accepted. According to the author of this research, this is a waste of potential of the SEA, because other practices were identified in these case studies that show how SEA can be used to design tailor-made regulatory frameworks, such as Eemsmond Delfzijl. Furthermore, influential was the experience of the project team and project managers, local knowledge, and integration of the plans and SEA. This experience can be used to make more of the potential of SEA.

Change/impact Uncertainty about the identification of change and impact is addressed with adaptive management, precautionary principle, stakeholder involvement and knowledge generation in different combinations (Table 13). This is also expected in the theoretical framework except for the precautionary principle. Use of the precautionary principle, by identifying mitigation measures, is successfully done twice (Waalweelde West, Eemsmond). However, applying the precautionary principle by using standardized assumptions was not successful as actual impact measurement was not included in a monitoring program (Waalweelde West). Using adaptive management, uncertainty about change and impact is addressed in a monitoring program or subsequent planning program. Stakeholder involvement mostly consisted of including the NCEA advice in finding solutions, that led to the identification of research needs and thresholds. It was not successful if the NCEA advice was not adhered to (Eemsmond, Greenport). It seems that it is most successful if a combination is made of adaptive management with precautionary principle (to determine thresholds and monitor these), or of stakeholder involvement and precautionary principle (to identify research needs and offer mitigation measures). Again, this is mostly influenced by the legal framework and the advice of the NCEA, as was identified in Waalweelde West, Greenport Venlo and Eemsmond Delfzijl. Also, costs play a role as there need to be sufficient resources to design a monitoring program.

Assessment framework Uncertainty about the assessment framework, i.e. defining aspects and indicators, is mostly addressed with stakeholder involvement (Table 13). The application of stakeholder involvement is also expected in the theoretical framework. It is successfully applied by requesting confirmation of the NCEA for research methods and receiving this confirmation (Eemsmond Delfzijl, Waalweelde). It was not successful for Oosterwold, where the advice of the NCEA was not adhered to, leading to arbitrariness in permit regulations. In several occasions, other strategies were employed as well. Adaptive management is theoretically expected to be applied, and is successfully applied once by including norms in a regional strategic environmental plan (Eemsmond). Knowledge generation was successfully applied as well by performing environmental research prior to SEA to identify relevant environmental aspects (Eemsmond). As such, it seems the combination of adaptive management, knowledge generation and stakeholder involvement, that was also identified in theory, is most successful in addressing uncertainty about the assessment framework. This is because the combination yields information about relevant environmental aspects in accordance with stakeholder perceptions, and inclusion of these aspects in a monitoring program to control them after decision-making. Factors of influence here are mostly knowledge and expertise (of the NCEA) (Waalweelde West & Eemsmond Delfzijl). Furthermore, the scoping phase and use of prior documentation were important. It was also stated that political choice is of influence in designing the assessment framework, yet the researcher finds this cannot be used as an excuse to not assess important environmental aspects. As such, consultancy firms should use their expertise to influence the design of the assessment framework and push for sustainable development.

Quality of methods Uncertainty about the quality of methods is a new type of uncertainty, for which no strategies were identified in theory. In practice, it is addressed with adaptive management, stakeholder involvement and knowledge generation. Knowledge generation is applied by identifying monitoring needs in quick scans (Binckhorst) which could be successful if a monitoring plan is set up as well to maintain overall quality (adaptive management). Using stakeholder involvement by negotiations and making agreements with stakeholder ensures there is support for instruments and their outcome (Binckhorst). The advice of the NCEA contributes to improving the quality and finding support (Oosterwold). However, stakeholder involvement is also only successful if aspects are eventually included in a monitoring program (adaptive management) (Greenport Venlo). It seems adaptive management is thus most successful in addressing uncertainty about the quality of methods, completed with research and stakeholders. This is influenced mostly by 'social factors', identified as experience, costs and time, resources, human preferences and the existence of 'manageable methods' (Binckhorst, Oosterwold, Greenport Venlo). It could mean that uncertainty about the quality of methods is more of a social type of uncertainty, rather than scientific uncertainty. Other than that, again the legal requirements and level of decision-making are found influential in these cases.

Base line conditions Uncertainty about base line conditions is addressed with knowledge generation (Table 13). This was successful as the systematic analysis of the current situation in a table led to improved knowledge on the base line situation (Greenport). Theoretically this strategy is expected, as well as the precautionary principle, which was not applied in practice.

Faults in data/models To address uncertainty about data and/or models, all four strategies were employed (Table 13). It was successful in all applications. Adaptive management was successful because it serves as a check for aspired ambitions of the plan (Binckhorst, Oosterwold). The application of the precautionary principle was successful because it led to consistency in research so that alternatives were comparable (Waalweelde), a bandwidth of effects is identified (Binckhorst, Greenport Venlo) and a threshold was established (Oosterwold). Furthermore, the precautionary principle was applied in each of the cases, meaning this was the most successful strategy, yet still needs to be combined with other strategies summed up here. Stakeholder involvement was successful because it ensured that essential information is maintained (Binckhorst) This strategy was not expected in theory, yet is essential for the Binckhorst to maintain information about the carrying capacity, environmental thresholds and regulations. Knowledge generation was successful because it provided information about environmental thresholds (Oosterwold) and it ensured no unnecessary research is performed (Binckhorst). Factors of influence were mostly the advice of the NCEA and division of roles (Waalweelde West, Binckhorst, Oosterwold). Other than that, the legal framework proved influential again as there was influence of standardized methods and rulings of the Council of State (Oosterwold).

Values, interests and perceptions Uncertainties about values, interests and perceptions is addressed with all four strategies. Mostly employed were adaptive management and stakeholder involvement (Table 13). Theoretically it was expected that only stakeholder involvement would be applied. Stakeholder involvement led to public support, using workshops (Waalweelde), procedural agreements (Binckhorst), negotiations and NCEA advice (Eemsmond Delfzijl). Adaptive management was successfully applied by integrating the planning procedure and SEA (Waalweelde, Binckhorst) and monitoring thresholds (Eemsmond Delfzijl). Knowledge generation was not successful as it provided too much detail, causing false certainties in later planning procedures (Waalweelde). Precautionary principle provided a sense of security by determining environmental thresholds together with stakeholders (Binckhorst) and mitigation measures (Eemsmond Delfzijl). A combination of adaptive management, precautionary principle and stakeholder involvement, as employed in Binckhorst and Eemsmond Delfzijl, is most successful as it yields a sense of security for stakeholders that their values are included in the plan. Many factors were identified to be of influence, and they are generally concerned with the experience of project teams and project managers, the position of managers, advisory skills, critical attitudes of specialists and knowledge in the initiating organisation (Waalweelde West, Binckhorst, Eemsmond Delfzijl). Furthermore, for local stakeholders, factors of influence are the willingness to negotiate, a level of interdependency and urgency of values and early inclusion in the process (Waalweelde West).

Knowledge base Uncertainty about the knowledge base, i.e. understanding planning procedures or content of the plan, is addressed with adaptive management, stakeholder involvement and knowledge generation (Table 13). Adaptive management is applied by designing an iterative process with continuous sharing of results, thus phasing the research process so that people are up to date and involved (Binckhorst). Stakeholder involvement by cooperation with the NCEA ensures support in the organisation for the working process (Binckhorst). And knowledge generation is successfully applied by finding other examples and rulings of the Council of State to find support for the assessment (Binckhorst). A combination of knowledge generation and adaptive management is most successful, for example by phasing research and gathering information in small steps. Factors that contributed to this success are diverse, from the level of involvement of stakeholders (Binckhorst), and the information that is provided (Oosterwold), to the capacities of the project manager or the integration of SEA in the planning process (Greenport Venlo).

Political climate Uncertainty due to the political climate is addressed with adaptive management and stakeholder involvement (Table 13). Stakeholder involvement was applied by coordination between authorities about the spatial plan, which was successful. Although this success could also have been induced by pressure from the national level to develop the area in Oosterwold, thus relieving the housing market in and around Amsterdam. Adaptive management is employed by creating objective norms and regulations that are flexible to the policies that are in place. It remains to be seen if this will turn out successful after the plan is established (Binckhorst).

Liability Strategies of adaptive management, precautionary principle and stakeholder involvement are employed to address uncertainty about liability (Table 13). Through identifying specific thresholds (precautionary principle), including this in a monitoring program (adaptive management) and discussions with local stakeholders and legal partners (stakeholder involvement) this uncertainty is successfully addressed (Binckhorst). Theoretical strategies were not identified.

Legal requirements Uncertainty about legal requirements is addressed with all four strategies (Table 13). In the case of Binckhorst, it is explicitly the combination of strategies that could lead to a successful solution: the precautionary principle is applied by identifying thresholds for environmental effects, which is included in a monitoring program (adaptive management). This is designed with the input of stakeholders and information from quick scans. The advice of the NCEA was an important factor for the Binckhorst in addressing this uncertainty. For Oosterwold it was sufficient to combine the precautionary principle with knowledge generation, by performing an appropriate assessment and identifying significant impacts, which led to adaptations in the spatial plan.

Institutional setting Uncertainty in the institutional setting, specifically addressing nitrogen deposition at the time there was no legal framework yet (Greenport), was addressed with adaptive management, stakeholder involvement and knowledge generation. A tailor-made regulatory framework was designed and agreed upon together with local stakeholders, and included in an information plan containing the agreements. However, it was never used, because the national regulations for nitrogen deposition were implemented shortly after.

Strategies

Table 13 presents the results for the success of strategies. Each of the strategies is discussed here regarding strong and weak points of the applications.

Stakeholder involvement is most employed, as practitioners seek to find support for the plan. This makes sense because SEA serves to inform the public on the consequences of a spatial plan, and the influence of stakeholders is rather large. Environmental management problems and their solutions are often value-laden and subjective, and quantitative decision-making approaches often fail (Ascough et al., 2008). Stakeholder involvement is a strong strategy in many applications and proved to be useful for other uncertainties than just values, interests and perceptions, by finding support for solutions. For example, by addressing uncertainty about the assessment framework in Binckhorst and Eemsmond Delfzijl. However, stakeholder involvement is not the solution to every uncertainty, as variability due to policy programs or natural systems is not successfully addressed with stakeholder involvement (Waalweelde West, Binckhorst). Stakeholder involvement is strong when it is complemented with adaptive management, as information needs to be obtained. Transfer in relay is an example of how to address this successfully (Binckhorst). Stakeholder involvement is also the strategy that 'fails' the most, for example if 1) false certainty is provided or there is inconsistency, thus causing unrest, if 2) conditions and ambitions are not concretely identified, thus causing arbitrariness, if 3) agreements are not included in further (monitoring) programs, thus not providing a sense of security, or if 4) environmental values go deeper than what is at stake in the spatial plan. This last factor was an issue for Eemsmond Delfzijl, where nature protection organisations fundamentally disagree on the appreciation of values in the region and how to protect these.

The next most employed strategy is ***adaptive management***. Adaptive management is employed for nearly all types of uncertainties that were identified here, except for cumulative effects and base line conditions. It makes sense that base line conditions are not addressed with adaptive management, since adaptive management actually requires strong base line data to be successfully implemented (Noble, 2000). As applied in the case studies, adaptive management is a strong strategy for many uncertainties, as it generally results in adaptations to the plan, inclusion of aspects in a monitoring program or following planning procedure, or tailor-made agreements. This ensures that uncertainties are controlled after decision-making. It is for example not successful to only phase the planning procedure and not include any control mechanism such as monitoring (Greenport Venlo). Adaptive management also knows its weaknesses. It is weak if ambitions and conditions are not accurately, objectively or consistently described. This is essential for a monitoring program, as practitioners need to specify what is being monitored and how. Inaccurately described ambitions and conditions could also lead to arbitrariness in permit regulations, which is visible in the case of Oosterwold. As for the definition of ambitions, the NCEA can only recommend to improve such conditions, as it is a political choice how to include this in a spatial plan (O-I). The researcher thinks that the NCEA, as well as other practitioners at consultancy firms, cannot hide behind political choice and can take on a more pro-active role in such a process. They have the expertise and knowledge to influence this in favour of the environment.

The third most employed strategy is the ***precautionary principle***. It was expected this strategy would have been employed even more, since applying worst-case scenarios and environmental thresholds ensures that practitioners are always on the 'right' side of development, by preventing significant harm. Overall, the application of the precautionary principle using worst-case scenarios, appropriate assessments, standardized values and methods, identification of thresholds or mitigation measures ensured that significant impact was either prevented, controlled or contained within bandwidths. It is therefore especially as strong strategy to address uncertainty about faults in models, values of legal requirement. Only when the identified thresholds and intervention measures are not explicitly included in further (monitoring) programs, application of the strategy is not successful. Thus, it seems that the precautionary principle always needs to be applied paired with adaptive management. Furthermore, the precautionary principle might be infeasible to address uncertainties if there are too many options, as was experienced in the Binckhorst and Oosterwold. And, as the strategies of the precautionary principle heavily lean on expertise and standardized values and methods these need to be of good quality in order for the strategies to be successful.

The strategy least employed was ***knowledge generation*** (Table 13). This confirms the theoretical train of thought presented in chapter 2 that more uncertainties occur that are rather complex and difficult to quantify, and can therefore better be managed in a strategic way rather than by performing additional research or generating extra knowledge in another way. It can even be risky to provide too much (detailed) information if false certainty is then provided. However, knowledge generation is also perfectly complementary to other strategies by providing input for workshops, identification of monitoring needs or designing realistic alternatives. Furthermore, knowledge generation ensures quality of the SEA report by providing information and using expertise, and structures the assessment process.

Overall, strategies often need to be combined in order to be successful. A few of these combinations are highlighted:

- Precautionary principle and adaptive management: inclusion of thresholds in monitoring programs
- Adaptive management and stakeholder involvement: keeping monitoring information up to date through transfer ‘in relay’ and consistency in the organisation
- Adaptive management and knowledge generation: the identification of monitoring needs
- Precautionary principle and stakeholder involvement: security of interests included in thresholds

Summarizing, the most dominant types of uncertainty (mentioned most by respondents) are uncertainty about variability, identification of future activities, identification of change and impact, and values, interests and perceptions (Table 12). Of these four dominant types of uncertainties, variability and change and impact are most difficult to address, as these show less successful approaches. Variability is best addressed in a combination of adaptive management and precautionary principle, yet in practice the application of stakeholder involvement is often unsuccessfully applied. This can be explained because involving more people does not necessarily mean more relevant knowledge about an uncertain phenomenon is gathered, and finding agreement about unexpected outcomes of natural or technological systems is even more difficult. Uncertainty about variability is best reduced if it is explicitly managed and controlled in a monitoring program. A similar argumentation applies to uncertainty about change and impact, that cannot be better defined using stakeholder input. It works best to identify thresholds, whether or not based on research or values, and control these in a monitoring program. Uncertainty about the identification of future activities and values and perceptions show more successful strategies (Table 13). Here it is found that especially a combination of all four strategies is successful. The identification of future activities and stakeholder values are closely linked as they are both very influential to the outcome of the spatial plan, which could explain why they need similar approaches as well. It works best to include stakeholder values in identifying future activities and thresholds, gather information about the carrying capacity of an area, include environmental and social thresholds in the plan and control these via a monitoring program.

CHAPTER 6: CONCLUSIONS

6. Conclusions, discussion and recommendations

6.1 Conclusions

This thesis has two objectives: 1) To develop a framework for identifying, categorizing, and dealing with uncertainty in SEA, by analysing empirical scientific literature on dealing with uncertainties in SEA. 2) To refine the framework in a practical application and draw lessons for SEA practice by applying it to case studies in the Netherlands. The research question central to this investigation is:

How can strategic environmental assessment identify, categorize and successfully deal with uncertainties in spatial plans?

The following sub questions support the main research question:

1. What type of uncertainties occur in SEA and how can these be categorized?
2. What strategies are provided to deal with these uncertainties and how are these applied?
3. What factors contribute to the successful implementation of these strategies?

This chapter will answer each of the three sub questions. A refined framework is presented in paragraph 7.1.

1. What type of uncertainties occur in SEA and how can these be categorized?

A conceptual framework is created based on a literature review on uncertainties in environmental research (Chapter 2, figure 5). It is tested in a comparative case study analysis of five Dutch strategic spatial plans: three Structure Visions and two zoning plans characterized by the new *Omgevingswet*. Categories of uncertainties that were identified are inherent, scientific, social, and legal uncertainties. They respectively entail incomplete information, limited or false information, doubts or ambiguity about information and a justification of information. Most types of uncertainty are confirmed in the case studies.

Inherent uncertainties include variability in the technical, social, and natural system, cause-effect mechanisms, and cumulative effects. Inherent uncertainties that were most experienced in practice are variability in the social and natural system. Little evidence was found for uncertainties in cause-effect mechanisms and cumulative effects. Inherent uncertainty is successfully addressed if a bandwidth of options or effects is identified, or it is explicitly addressed in further programs and/or intervention measures are explicitly available.

Scientific uncertainties entail technical issues or issues with representation of the practical problem. Subcategories for technical issues are faults in data or models, and base line conditions. Subcategories in the translation of the problem include uncertainty in the assessment framework, the identification of future activities and identification of change and impact. These last two were most perceived in practice, because the spatial plans in this research project have flexible or ill-defined goals. A new type of scientific uncertainty identified is the quality of new methods. Scientific uncertainty is successfully addressed if reduced by providing information, or explicitly addressed in further programs.

Social uncertainties can be subdivided in stakeholder values, interests and perspectives, the political climate, and the knowledge base. The project organization was theoretically discussed but not confirmed in practice. Stakeholders are influential in the SEA process, and new types of assessment methods and spatial planning goals are often not well understood. Social uncertainty is successfully addressed if support for the plan is obtained

Legal uncertainties include uncertainty about the institutional setting, legal requirements, and liability. Liability and the legal requirements are mostly an issue in new types of spatial plans. Above that, regulatory frameworks are missing to regulate for example the impact of nitrogen deposition or sustainability goals. Opportunities are missed in the SEA process when these regulations are made in public-private agreements. Legal uncertainty is successfully addressed if acknowledgement or justification is obtained through public appeal or authorities (NCEA and/or the Council of State).

2. What strategies are provided to deal with these uncertainties and how are these applied?

Four types of strategies were identified and linked to uncertainties they aim to address, which are adaptive management, the precautionary principle, stakeholder involvement and knowledge generation.

Inherent uncertainties are overall best addressed with a combination of adaptive management and precautionary principle. These strategies were expected from theory. The combination is successful because thresholds and limits are defined and then included in a monitoring program, thus ensuring the uncertainties are controlled after decision-making. For example, in the case of Greenport Venlo, uncertainty about the spread of pollution through air and water was addressed with a worst-case scenario and the aspects were included in a monitoring program. In some occasions, only stakeholder involvement was applied to address inherent uncertainty, yet this was explicitly unsuccessful. For example, in the case of Waalweelde West, uncertainties about the Delta Program and NURG were only communicated in the SV, while exact developments remained unclear and turn out different in practice.

Scientific uncertainties are overall best addressed with a combination of adaptive management and precautionary principle as well, and for the same reason: to design a control mechanism. However, the precautionary principle was not expected from theory. It can even be successfully applied on its own, for example in the case of Waalweelde West. By using standardized and accepted methods, consistency in research was achieved so that alternatives could be compared regarding their effects, leading to the identification of the preferred alternative. Although at least adaptive management and the precautionary principle are applied to address scientific uncertainties, employing stakeholder involvement of knowledge generation further improves the quality of and support for the assessment. For example, in the case of the Binckhorst, uncertainty about limits to models was addressed in quick scans, monitoring, norms and thresholds and the transfer of information throughout the organisation.

Social uncertainties: Uncertainty in values, interests and perceptions is generally best addressed with adaptive management, precautionary principle and stakeholder involvement. This is because this combination ensures a sense of security for stakeholders. For example, in the case of Eemsmond Delfzijl, discussions on norms and assessment methods for noise pollution, odour pollution, external safety and ecology were addressed with customized regulations, based on negotiations, that are included in the strategic plan of the regional environmental service. Uncertainty in the knowledge base is best addressed using adaptive management, stakeholder involvement and knowledge generation. It improves knowledge and understanding through phasing, examples and expert advice, as was experienced in the Binckhorst. There is a strong cooperation with the NCEA, legal partners and other municipalities to find support for the spatial plan. It was not expected that social uncertainties would be addressed with other strategies than stakeholder involvement, yet it proves to be very successful in these examples.

Legal uncertainties are overall best addressed with precautionary principle and knowledge generation. It ensures knowledge is obtained about what information needs to be provided to pass the judgement of authorities, which is also confirmed with the inclusion of legal experts and rulings. For example, in the case of Oosterwold, where the advice of the NCEA, additional research by a consultancy firm and advice from an attorney led to the regulation of nitrogen deposition in the area, together with the confirmation of the Council of State.

Overall, strategies were confirmed for inherent uncertainties, and new linkages were found for the three other types of uncertainty. This is visualized in Figure 11, Paragraph 6.2.1. Especially combinations of strategies ensure a successful management of uncertainties. Adaptive management is a strong strategy for many uncertainties, as it generally results in adaptations to the plan, inclusion of aspects in a monitoring program or following planning procedure, or tailor-made agreements. It is weak if ambitions and conditions are not accurately, objectively or consistently described. The precautionary principle is a strong strategy to address uncertainty about faults in models, values or legal requirements. Only when the identified thresholds and intervention measures are not explicitly included in further (monitoring) programs, application of the strategy is not successful. Stakeholder involvement is strong when it is complemented with adaptive management, as information needs to be maintained. Stakeholder involvement is weak when environmental values go deeper than what is at stake in the spatial plan. And knowledge generation ensures quality of the SEA report by providing information and using expertise, and structures the assessment process, yet is weak if too much detailed information is provided on a relatively abstract level.

3. What factors contribute to the successful implementation of these strategies?

The theoretical literature provided little guidance on factors contributing to the successful implementation of strategies. Some factors were identified but not explored to a large extent, which are the level of uncertainty and controllability, the level of urgency and risks, knowledge and expertise, and the level of abstraction of the spatial plan. These were confirmed in practice. This information is mostly obtained from the interviews in the case studies and discussed in paragraph 5.2.

Overall, most evidence was found for the level of abstraction or decision-making, and the level of urgency and risk, often expressed as legal risks. Factors identified are the scope of the assignment (Waalweelde West), European legislation (Binckhorst), legal status of the plan or rulings of the Council of State (Oosterwold) and the level of decision-making (Greenport Venlo, Waalweelde West, Oosterwold, Eemsmond Delfzijl). Also, evidence was found for knowledge and expertise. Factors identified are the advice of the NCEA and advisory skills of specialists (Waalweelde West, Binckhorst, Oosterwold, Eemsmond Delfzijl), experience of the project team and capacities of the project manager (Waalweelde West, Eemsmond Delfzijl) and local knowledge and human preferences (Binckhorst). Furthermore, evidence was found for the level of uncertainty and controllability, as factors were identified that include the scope of the assignment, the dependency on national or even international policies (Eemsmond Delfzijl, Waalweelde West). Otherwise, factors were identified concerning resources, such as costs and time (Greenport Venlo, Oosterwold), and factors specifically for stakeholder involvement: early inclusion of stakeholders, willingness to negotiate and a level of interdependency and urgency of values (Waalweelde West).

6.2 Discussion

6.2.1 Theoretical implications

This research project contributes to the theoretical body of literature on addressing uncertainties in environmental assessments in several ways. A knowledge gap was identified in paragraph 1.2, described as a lack of clear conceptualization for the successful management of uncertainty in SEA for strategic plans, and the utility of existing theories in real-life settings in case studies.

First of all, Leung et al. (2015) identified need for guidance in categorizing uncertainties and management approaches in environmental assessments. The focus is on theory building and the utility of existing theories. As such, this research project first performed an extensive literature review of existing theories on uncertainties and strategies and then applied these in practice. Thus, the research provides a better understanding of uncertainties and their management strategies by showing that most theoretical type of uncertainties were confirmed in practice, and by finding new linkages between uncertainties and strategies. Uncertainty in the project organisation is not confirmed in practice, and uncertainty about the quality of methods is identified as a new type of uncertainty. New linkages found are for example adaptive management and the precautionary principle to address social uncertainties. It must be noted here that the categories of uncertainties and strategies were, although based on theory, crafted by the researcher and can therefore be arbitrary. The validity of these concepts was therefore tested in an interview with a practitioner, who confirmed the concepts that were identified.

Second, Cardenas & Halman (2016) identified techniques to address uncertainties in environmental impact assessment on the project level. They recommended to perform further research focusing on a more strategic level and best practices in real-life settings. As such, this research project looked into uncertainties and their management in SEA and focused on the success of these practices and factors influencing the success. What mostly became clear is that SEAs that were studied required less detailed assessments in the perspective of respondents, and that strategies were found successful depending on the level of decision-making and an estimation of the legal risks, especially for Waalweelde West and Oosterwold. They provide just enough information to have the spatial plan passed, and postpone more detailed assessment to later planning stages. A start is made with a measure of success of the strategies and factors influencing this. These findings become more robust if applied in further research, also in other (planning) contexts outside the Netherlands.

Third, Lees et al. (2016) found there was a need for improved guidance to address uncertainties in SEA practice, in particular for how (monitoring) programs need to be set up. They recommend to focus on exploratory interviews with practitioners. This research has assessed several case studies and performed interviews with practitioners, spatial planners and authorities. It results in further understanding of how they consider uncertainty, by showing they perceive this often as either a risk for the acceptation of the plan (nearly every case experienced uncertainty about the impact of nitrogen deposition on Natura 2000 as a risk) or as an opportunity for further improvement of the spatial plan (for example the inclusion of stakeholder values in the design of the plan in Waalweelde West and Eemsmond Delfzijl). Furthermore, this research was where necessary specific about the application of strategies, for example by discussing respondent's views on the design of a monitoring program (see for example textbox 2 and 3 in paragraph 4.2.2). This results in a better understanding of how programs can be set up.

Figure 11 below shows the results for the refined framework of best practices for dealing with uncertainties in SEA. Further details on factors determining the success is visualizes in Table 14.

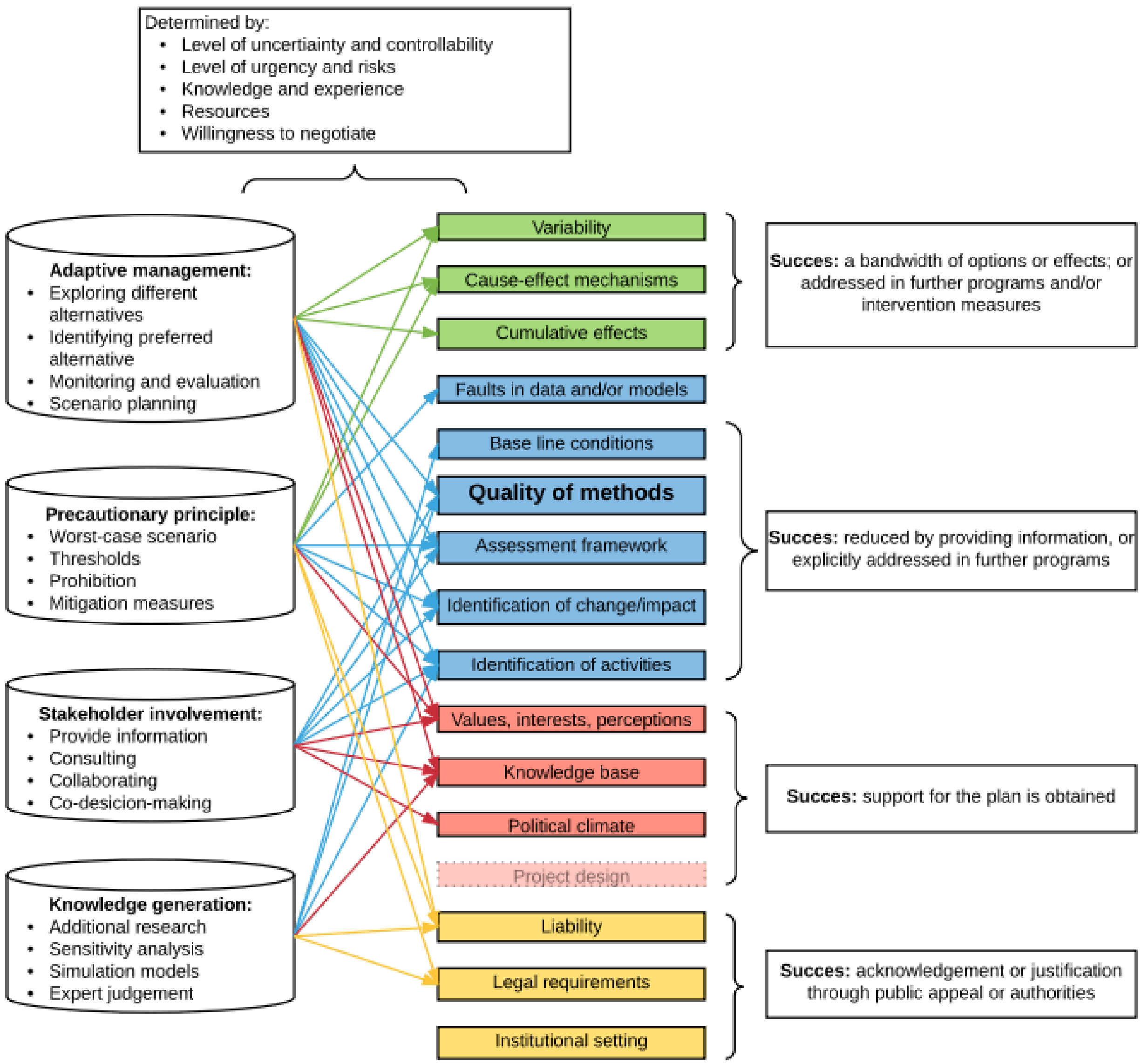


Figure 11: Refined framework for dealing with uncertainities in SEA

Uncertainty	Strategy	Success determined by
Variability	AM + PP	Scope of assignment European legislation Dependency on national policies
Cause-effect mechanisms	AM + PP	Level of decision-making
Cumulative effects	AM	-
Faults in data and/or models	PP (+AM+KG+SI)	Scoping document Advice NCEA Legal framework Roles and responsibilities / planning Rulings Council of State Local knowledge
Base line conditions	KG	-
Quality of methods	AM + SI + KG	Experience / human preferences Costs and time Legal requirements Advice NCEA Level of decision-making
Assessment framework	AM + PP + SI	Scoping document Knowledge and experience Political choice Advice NCEA Legal requirements
Identification of change and impact	AM + PP + SI	Advice NCEA Costs Dependency on national policies Legal requirements
Identification of activities	AM + PP + KG + SI	Level of decision-making Legal framework Integration SEA/SV Advice NCEA Experience and (local) knowledge Competences project manager
Values, interests and perceptions	AM + PP + SI	Level of decision-making Early inclusion/ Willingness to negotiate Neutral position project manager Experience project team & cooperation Advice NCEA Organisational culture National pressure
Knowledge base	AM + SI +KG	Level of involvement Advice NCEA Mindset experts Capacities project manager Integration SEA/SV
Political climate	SI	Political motivation to develop the area
Liability	AM + PP + KG	-
Legal requirements	PP + KG	Advice NCEA
Institutional setting	?	Maintenance of information Continuity in project organization

Table 14: Overview of succesfull strategies to deal with uncertainties, and factors that determine the succes. AM = Adaptive management, PP = Precautionary principle, SI = Stakeholder involvement, KG = Knowledge generation

6.2.2 Limitations of this research project

Even though the choices in this study are made carefully, it still contains some limitations.

This research project did not assess actual environmental impact of spatial planning projects, which is why a full overview of successful approaches towards dealing with uncertainty is not obtained. Uncertainties might seem well managed, but could still turn out very different if not closely monitored and mitigated. Thus, more information could be obtained on the quality of monitoring programs, yet this research project was not meant to focus on only one strategy.

The qualitative approach and research strategies yielded valuable insights in experiences with uncertainties that resulted in a better understanding of the management of uncertainties. However, the case studies took place in the Dutch context, interview questions were very open and semi-structured and it was not inquired what respondents themselves thought were uncertainties and if these were an issue in their project. As such, the research has a very exploratory nature. This could be improved by starting with a questionnaire that is spread amongst more respondents (even internationally) to first gather a more robust and generalizable conceptualization of uncertainties and strategies, and then performing additional interviews with a selection of these respondents to gain more in-depth knowledge. Furthermore, the conclusions drawn in this thesis have not been presented to experts to confirm their value. However, during the data collection phase, respondents were given the opportunity to react to a report of the interview, and most of them did so. In this way, some confirmation for results was still obtained.

Due to time constraints in the interviews, not all uncertainties are always discussed. This is solved by combining the information of all interviews for a specific case. Still, sometimes no strategy nor its success is identified. It was still important to obtain valuable information in the short time available. This was done by asking respondents what uncertainties were most influential in decision-making in their opinion, what uncertainties were most unknown due to limited knowledge, and/or what uncertainties required the most attention during the process. This way, two or three different types of uncertainties could be further discussed regarding their strategies. By combining the interviews, a full overview could often still be obtained. There is one drawback to this approach: it could also have led people to name uncertainties they could best remember, even if they were not important during the SEA process.

An iterative approach in this research project proved useful and could have been employed even more. Some iteration was employed in starting to write the first case analysis whilst interviews on other cases continued. This proved successful in identifying some need for further information in interviews. However, more could have been employed by starting to write a comparative analysis and conclusions earlier to continuously adapt information gathering, presentation of results and analysis of results into a more consistent story.

For the case of Oosterwold, it was difficult to obtain all information. Several people could not be reached because they no longer work at the organization. This was the case for the zoning plan at the municipality of Almere, and for the structure vision at the NCEA. The researcher tried to obtain information of the NCEA secretary that was interviewed about the zoning plan, yet this person was not able to answer questions about the SV. Oosterwold does present an interesting case as it is about a new type of planning, because it received a negative advice of the NCEA twice, and because the same SEA was used for both spatial plans. Therefore, it was decided to include the case study anyway. Using information found in documentations, an assessment of uncertainties and their management could still be made, and interesting information could be shared on how uncertainties are differently addressed in different planning stages (as the zoning plan required a more detailed assessment and the design of a monitoring program).

6.3 Recommendations

6.3.1 Recommendations for further scientific research

Following the theoretical implications in paragraph 6.2.1 several recommendations can be made for further scientific research. Further research is necessary to find further evidence for uncertainties and strategies identified in this report, especially in other contexts than the Dutch.

Since this research did not go into long-term management of uncertainties, but only the solutions that were found and applied during the SEA process, it would be interesting to perform a longitudinal study into the management of uncertainties after decision-making. For example, by exploring the design and practice of monitoring programs, or by measuring uncertainties ex-ante and ex-post, to see if uncertainties were indeed successfully contained and to what extent predictions were accurate.

Furthermore, this research has an exploratory nature. Measurement and factors for success that were identified are discussed with several respondents, yet no robust proof of these factors exists yet. It is therefore recommended to perform more scientific research into the success of dealing with strategies and the influence of the factors that were identified in this thesis. This can be done by combining quantitative and qualitative research methods, for example the use of preliminary questionnaires to find statistical evidence for success factors, and performing additional interviews to gain more understanding.

Interviews took place with respondents that were involved in the project management of SEA or that were responsible for the content of SEA. Thus, they had key positions in the design of the SEA, which made them very suitable to study uncertainties and their management. However, it is not assessed how these SEA reports are received by decision-makers or politicians, and how they experience uncertainties and how to deal with these. Since dealing with uncertainties leads to better information provision for decision-makers, it would be interesting to focus additional research on decision-makers and politicians regarding their perspective on the issue.

6.3.2 Recommendations for practice

It becomes clear from the previous section that the management of uncertainties has a strong focus on risk averse strategies. Often, creative solutions are found to keep uncertainties contained provide just enough information to pass the test of the competent authority, public appeal, and Council of State. The utility of SEA is in this perspective diminished to a tool for adhering to legal requirements. Uncertainties are experienced as a risk in the spatial planning process, and are addressed as a risk by finding a control mechanism. However, it is also seen that if an uncertainty is addressed differently, even as an opportunity, it yields more valuable results and promotes SEA to a decision-making tool (Waalweelde West, Eemsmond Delfzijl, and possibly the Binckhorst). The recommendations below serve to contribute to such approaches.

The NCEA is regarded as an important consulting agency and practitioners actively seek their advice and consent. This is visible in the methodologies of SEA, that include elements from the scoping advice (Waalweelde West), the request for interim advice (Binckhorst, Eemsmond Delfzijl, Greenport), and the appreciation of their recommendations (Oosterwold, Binckhorst). However, it also came forward in the interviews that the NCEA is not involved after decision-making and is not aware of the follow-up of the plan and environmental effects. When taking in mind the NCEA itself actively promotes monitoring and evaluation to manage uncertainties, it only makes sense that the NCEA should acquire an active role in this as well. The NCEA should have a more active role after decision-making, for example by taking samples of monitoring results.

A solid start of the SEA and planning process can eliminate uncertainties, as was the case in Waalweelde West. The integration of SEA and the spatial plan ensured that information from the environmental assessment could serve as input for the design of the plan. It was even explicitly acknowledged that this approach resulted in the exclusion of uncertainty as different management options could be weighed. Therefore, it is recommended to simultaneously start the SEA and planning process. To achieve this, practitioners need to think about the design of the process, ask experience specialists to discuss and design an assessment framework in cooperation with stakeholders, and cut the SEA process in even smaller pieces to provide structure, find support and confirmation to ensure progress. The NCEA advice on the scoping document can be used to shape this process.

Because the application of the precautionary principle is used in every case, and for many types of uncertainties, it is important to develop the standards and methods that the strategy leans on. This could be achieved by maintaining a database of experiences and sharing these among consultancy firms, so that the application of the precautionary principle improves. Overall, providing guidelines for the quality of tools and strategies in practice help to further improve the practice of SEA.

Even though successful strategies were identified in the case studies, it must be noted that every case is different and therefore these strategies might not always yield the same successful result. Overall it seems that uncertainties are not addressed with a single strategy, but rather a combination of strategies covering different elements of the uncertainty. Therefore, it is always important to identify the nature of uncertainty and address this accordingly. Furthermore, it is important for practitioners to have the freedom to find solutions in the SEA process that fit the context. For example, multiple workshop rounds might not be feasible if there is no need or urgency for negotiations amongst stakeholders. However, a legal obligation to maintain monitoring information in some way might be feasible, by providing guidelines to set up information plans. This can help to improve monitoring practices.

A legal framework does not exist for the inclusion of sustainability goals in SEA. Opportunities to include this in the environmental assessment and to improve the spatial planning process towards sustainability are therefore missed. Sustainability goals are not seen as essential information and thus not assessed in such a way by the NCEA, as was found in the case of Greenport Venlo. It could be interesting to consider possibilities for the legal inclusion of sustainability goals in the assessment framework, to improve the use of SEA sustainable spatial development. Furthermore, sustainability experts can be involved to write SEA reports rather than only spatial planners or geographers, as they can push for the inclusion of sustainability goals and measurement. Anyway, in the opinion of the researcher, consultancy firms have an obligation to use their expertise to steer towards sustainable development. It is no excuse to say that goals of spatial plans and ambitions are political choices. Consultancy firms are hired to perform an environmental assessment and need to have a critical attitude towards the initiative. This also works in a positive way: if sustainable initiatives exist outside the scope of the specific spatial plan, these could still be included in SEA.

Lessons can also be drawn specifically for future practice in the *Omgevingswet*. To assess this, two case studies were chosen to serve as exemplary cases for the *Omgevingswet* (Binckhorst and Oosterwold). By identifying successful approaches for similar uncertainties, the *Omgevingswet* cases can learn from current SV practice. Many similar uncertainties were identified in this chapter, proving that even though the institutional context for SEA in the Netherlands evolves, 'some things never change'. These are variability in the social system, the identification of future activities when planning goals are flexible, the design of an assessment framework, faults in data or models, the quality of methods, stakeholder interests, the political climate and uncertainty in the knowledge base. When dealing with these uncertainties, the following lessons can be learnt:

- The assessment of alternatives and a worst-case approach yields insight in the bandwidth of uncertainty. However, too much detail in this assessment could generate false certainty.
- Mapping sensitivities in the area and adapting the plan accordingly ensures a proactive management of uncertainties, excluding unnecessary research.
- Using standardized, quantitative indicators and engaging stakeholders in the design of the assessment framework leads to general support and acceptation of the plan.
- Faults in data or models can be avoided using quick scans and stakeholder inclusion to maintain information. This needs to be monitored.
- Phasing research helps deal with quality of models. Publishing small parts of results generates progress towards management objectives. This is also found successful to deal with uncertainty in the knowledge base.
- Creating regulatory frameworks in negotiations with stakeholders helps deal with stakeholder interests.

Uncertainties that came up in the Structure Visions, and not in the zoning plans, were cause-effect mechanisms, identification of change and impact and base line conditions. This makes sense, since a different approach is employed in the zoning plans where the starting point is the carrying capacity of the area. Therefore, a traditional cause-effect estimation is less valuable.

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8. Appendix

8.1 Topic list interviews

Voorafgaande aan het interview een korte introductie op het volgende:

- Onderwerp van de masterscriptie.
- Toelichting op het onderzoek en het doel van het interview.
- Het interview duurt iets langer dan een uur.
- Geeft u toestemming om het interview op te nemen? Uw naam komt niet in het onderzoek.
- Na afloop van het interview stuur ik een verslag waarop u kunt reageren.
- Een korte introductie op het verloop van het interview.

Deel 1: Algemene vragen

1. **Wat is uw achtergrond, en wat was uw rol in de milieueffectrapportage van [project]?**
2. **Kunt u kort iets vertellen over de milieueffectrapportage en de belangrijkste milieu issues die er speelden?**

Deel 2: Onzekerheden

Onzekerheden zijn een tekort aan kennis, de betrouwbaarheid van de kennis of meningsverschillen over de beschikbare kennis. Deze zijn onder te verdelen in inherente onzekerheid, methodologische onzekerheid, sociale onzekerheid en juridische onzekerheid.

3. **Welke methodologische, sociale en inherente onzekerheden kunt u noemen, die speelden bij de milieueffectrapportage van [project]?**
4. **Waarom was dit onzeker, en wat was er precies onzeker?**
5. **Welke onzekerheden waren volgens u het belangrijk gezien hun rol in de milieueffectrapportage?** Hierover gaat de rest van het interview.

Deel 3: Strategieën om met onzekerheden om te gaan

6. **Hoe werd [onzekerheid x] opgelost?**
    - Wat was het doel van deze oplossing?
    - Werd dat doel bereikt? Waar blijkt dat uit?
    - Welke factoren speelden hierbij een rol?
    - Wat heeft het MER eraan bijgedragen?
    - Is het milieubelang hiermee ook geborgd? Waar blijkt dat uit?
    - Op welke manier droeg de oplossing bij aan de besluitvorming en waar zie je dat aan?
    - Is er teveel of te weinig onderzocht? (Welke informatie was er nodig?)

Deel 4: Reflectie op de resultaten

7. **Zijn de onzekerheden opgelost? Waren er ook onzekerheden die bleven bestaan?**
8. **Welke succesvolle ervaringen neem je mee naar je volgende project?**
9. **Wat zou je volgende keer anders doen als het gaat om het omgaan met onzekerheden?**

8.2 Background information case studies

8.2.1 Waalweelde West

Waalweelde West is an area in the south of the Netherlands in the Province of Gelderland. The river Waal is a branch of the Rhine river, connecting the port of Rotterdam with Germany. Because of climate change, the river needs more water drainage capacity in the future.

The flood plains of the Waal are areas of ecological value, containing valuable habitats and species. Parts of the flood plains are protected by the European Natura 2000 legislation and/or by the Dutch nature protection law. Apart from water drainage and ecological values, the Waal river serves other functions such as shipping, water-related businesses, housing, tourism, and recreation. Therefore, Waalweelde West is a program for the integral, sustainable development of the area.

Near-floods in 1993 and 1995 led authorities to address flood protection (in all River basins in the Netherlands). Currently, the Waal river transports 16.000 litres of water per second and the aim is to raise this capacity to 18.000 litres of water per second in 2100 (Provincie Gelderland, 2015a). Flood protection measures aim to reduce the water level by 80 centimetres during a flood.

A Structure Vision[10] (from now on referred to as SV) is created in 2015 to guide the integral development of the area and to serve as an overarching framework for future local projects. Such projects include flood protection measures, measures for ecological protection, restructuring or expansion of business parks and the development of recreational areas (Provincie Gelderland, 2015a). Solutions for flood protection are part of a government designed plan called 'Room for the River' that aims to lower water levels in the Netherlands. At multiple locations measures are taken to give the river space to flood safely[11].

Waalweelde West is a governmental collaboration between four municipalities (Lingewaal, Maasdriel, Neerijnen and Zaltbommel), the Provincie of Gelderland and a consortium of private parties. Decision-making responsibility about the plan lies with the Province as well as the four municipalities. As a matter of fact, the municipalities have accepted the SV with amendments, for example by excluding specific flood channels (Provincie Gelderland, 2015a). Financial responsibility of proposed activities is divided between national, regional and local authorities. Especially for the flood protection measures, the national government reserved 200 million euros. For a full overview of projects, authorities and responsibilities, this report refers to the Structure Vision of Waalweelde West, pp. 122-130 (Provincie Gelderland, 2015a).

Several other parties were involved in the design of the SV, including Rijkswaterstaat, Waterschap Rivierenland, the Ministry of Infrastructure and Environment, the Ministry of Economics, and other local stakeholder groups that have an interest in the regional developments. These parties have no decision-making role (Provincie Gelderland, 2015a). The stakeholder groups were included in the design of the plan in workshops.

The spatial plan describes the proposed activities per 'building block' (Figure 12). The building blocks represent physical areas (flood plains) that are a candidate for flood protection measures. Each building block contains a description of the area and envisioned spatial changes. The overall goals of the SV are:

- River and flood protection: contribute to an increase of drainage capacity of the Waal towards 17.000m^3 in 2050, and towards 18.000m^3 in 2100. Several flood channels contribute to this goal.
- Ecology: contribute to the maintenance and development of Natura 2000 ambitions and core qualities of the *Gelders Natuurnetwerk*.
- Living environment: development of housing on higher terrains as well as on dikes.

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[10] A Structure Vision is a long term spatial planning strategy at regional level

[11] As of 2015 a new flood protection program was designed focusing on the quality of the dikes instead of room for the river. This has direct consequences for further development in the area: the SEA assessed measures for flood protection that might not become reality in the context of the new flood protection program.

- Economic development: contribute to opportunities for transport of containers, functioning as an inland terminal and attraction of new business activity.
- Landscape and cultural history: maintenance and development of scenic values in the area.
- Recreation and tourism: creation of recreational areas and improvement of accessibility of such areas.
- Climate: reinforcement of river safety by implementation of flood channels, development of robust ecological areas and resilience in the built environment.

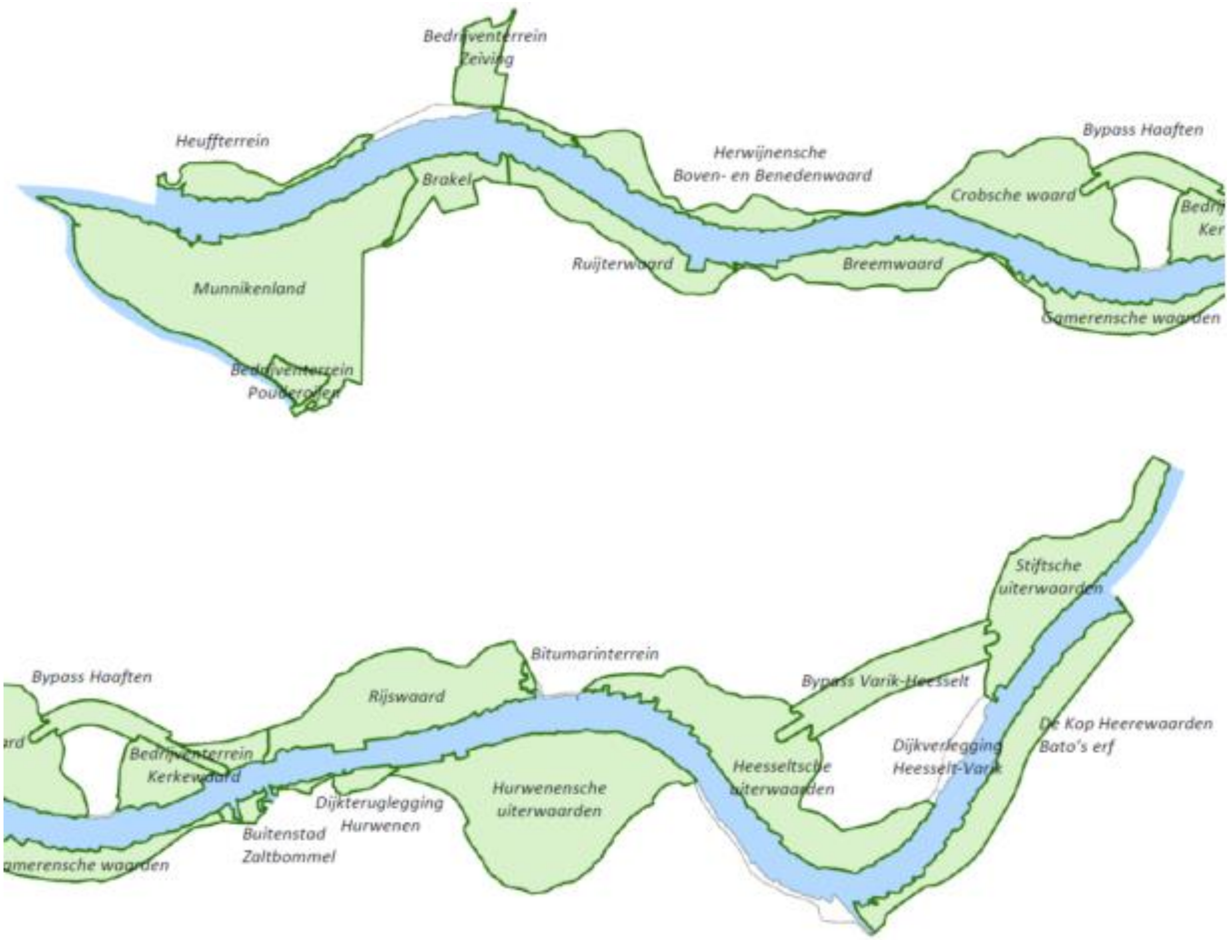

Figure 12: Buillding blocks in Waalweelde West (Provincie Gelderland, 2015a)

The environmental effects of the proposed activities in the SV were assessed in an SEA. This was done using an assessment of three different alternatives for each of the building blocks. The alternatives provide input for the spatial change in these areas based on a different set of goals (Figure 13). The alternatives are:

- Blue: development focused on the maximization of water safety and flood protection
- Green: development focused on the maximization of nature development and conservation
- Red: development focused on the maximization of economic and urban development.

The alternatives contain a combination of the variants yet with a dominance of one of the three possibilities. The variants are assessed for a total of 21 building blocks. The alternatives were weighed regarding the resulting water level reduction, stakeholder interests and cost-effectiveness. Stakeholders identified their preferred alternative in workshops, based on information about the building blocks and alternatives. By consulting stakeholders intensively during the process, local support for the plan was generated.

BLUE
Flood channel for protection;
Relocation of company;
Opportunities for ecological and recreational development.

GREEN
No flood protection;
Company prohibited to expand;
Room for nature development around the river.

RED
A small flood channel;
The company expands;
Economic riverfront development
Relocation of harbour facilities.

Figure 13: Exemplification of the three alternatives per building block (Provincie Gelderland, 2015a)

The SEA process was integrated in the planning process in the following ways:

- Simultaneous start and combination of starting document SV and scoping document SEA.
- The content of the building blocks and alternatives were continuously assessed regarding environmental effects. SEA therefore had strong influence in the choice for a preferred alternative (Provincie Gelderland, 2015a).
- The preferred alternative was evaluated in SEA regarding its effects. Negative effects are limited and can be addressed with mitigation measures.

The SEA assessed several environmental aspects, including river safety, water quality and quantity, ecology, soil, landscape and cultural history, archaeology, quality of the living environment, recreation, agriculture, traffic, air pollution, and external safety (Arcadis Nederland B.V., 2015). The environmental aspects were first systematically assessed per alternative. Following an evaluation of the effects per alternative, a preferred alternative was that would pose the least significant negative effects overall, and would still contribute to achieving the goals of the SEA. The preferred alternative was assessed regarding its effects (Arcadis Nederland B.V., 2015):

- River and safety: water levels drop by 100 centimetres. Flood channels could influence the stability of the dikes, for which mitigation measures are possible.
- Water: lower ground water levels will have some effects on agriculture and the built environment.
- Ecology: building activities in the area lead to temporary effects on ecological values, in the long term more ecological development is generated.
- Soil: more land will become available that can be sold depending on the quality of the soil.
- Landscape and cultural history: the proposed activities will have negative impact on scenic values.
- Archaeology: impact on archaeological values is possible, the expectancy of these values is low.
- Living environment: more space for housing and business parks will be created.
- Recreation: flood channels offer opportunities for more recreational activities.
- Agriculture: less agricultural land due to the implementation of flood channels.
- Infrastructure: due to the development of housing and business parks, more traffic will be generated, with consequences for traffic capacity and safety.
- Air quality: due to traffic increase, noise and air pollution increase, depending on exact activities.
- External safety: slightly negative effects, depending on the exact activities on business parks.

The NCEA respondent for this case explained that the NCEA judges an SEA by the delivery of essential information, which is framed as 1) significant environmental effects, 2) elements of the report that are not of accessory importance and 3) dependent on the decision at hand. The NCEA was involved twice, for the scoping document and the final document.

Scoping document: the advice focused on the research methodology of the SEA, by recommending what subjects should be included in the assessment and to what level of detail. It was recommended to motivate the need for flood protection measures, describe the three alternatives (blue, green, red) including their environmental effects per building block (especially ecological effects regarding Natura 2000), to include an overview of necessary decisions for the implementation of the SV and to include a monitoring program to evaluate the actual impacts of activities (Commissie voor de Milieueffectrapportage, 2011d). Uncertainties are advised to be solved by determining a margin for uncertainty (90% accuracy) in the outcomes of the model and by providing information about legal risks in the plan.

Final report: The SEA report contains the essential information to decide on the SV with the inclusion of the environmental interest (Commissie voor de Milieueffectrapportage, 2015). The NCEA found the information in the SV to be presented in a clear and systematic manner. The stakeholder process was organized successfully. The advice is to hold on to information for future planning processes by developing a monitoring and evaluation program and explicitly describing the type of research necessary for future decisions. Future decisions in the Delta program and in river protection measures in Germany are especially important as these have a large influence on the future run of the river. The advice of the NCEA to explicitly address uncertainties and points of attention for the future is adhered to by including an extra appendix to the SV. This appendix clearly describes important issues for each environmental aspect.

8.2.2 Binckhorst

The Binckhorst is a neighbourhood in the municipality of The Hague. Originally offering space for artisanal and industrial activity, the district of 125 hectares nowadays includes offices and companies in the creative sector and IT sector. Surrounded the area is a canal, a harbour, and railways including two large train stations (Central Station and Holland Spoor). A new motorway (Rotterdamsebaan) increases accessibility to the Binckhorst, yet the tunnel connecting to the Binckhorstlaan could cause environmental impact regarding traffic increase, air pollution and noise pollution in the neighbourhood.

Demographic forecasts for the municipality of The Hague predict large housing needs. A transformation of the Binckhorst district could create space for about 5.000 houses. Furthermore, the municipality aspires to develop the district further economically due to its central location and excellent accessibility with multiple transport modes. The spatial plan therefore aims to transform the Binckhorst into a sustainable mixed urban residential area, whilst maintaining a safe and healthy physical environment for residents (Gemeente Den Haag, 2016a). This is achieved in an organic and flexible way, which is why the plan is different from traditional zoning plans. The development principles of the Omgevingswet are explored in a pilot setting in the Binckhorst. This means the plan contains guidelines to facilitate spatial activity, yet has no definitive outcome. It also means the government takes a step back as a controlling authority, and invites project developers to come up with initiatives to transform the neighbourhood.

The municipality of The Hague is the competent authority as well as the initiator. Design of the spatial plan and SEA process is mostly done in-house, yet strategic advice is requested from an external consultancy firm. The NCEA is involved in a consulting role by providing additional advice during the SEA process. Stakeholders, mostly businesses residing in the Binckhorst, are invited in informal sessions to design ambitions for the transformation. These informal sessions take place about 3 to 4 times a year.

- The planning procedure started in 2014. It differs from a traditional zoning plan in several ways:
- The plan has a time horizon of 20 years as opposed to the traditional 10 years;
- It includes not only environmental aspects but also all other physical and social aspects that represent the whole physical environment (i.e. social safety, mobility etc.);
- Rules are not definitive, yet flexible, depending on policy dynamics.

The central pillars of the plan, that is still in progress, are a flexible set of rules, the balance approach, crash tests and a monitoring program. A flexible set of rules entails a combination of ‘hard’ and ‘soft’ rules. A hard rule is for example ‘water quality may not be reduced’, a soft rule is for example ‘the design of buildings needs to fit the existing quality of scenery’. It is clear that soft rules are more open to interpretation. However, hard rules can also be adhered to with different measures. Overall, the rules are subject to policy change in the municipality as a whole to maintain flexibility (Gemeente Den Haag, 2016a). The balance approach means that different values in the area can serve as compensation for negative effects. For example, if an activity, such as a restaurant, generates noise pollution in the area, the restaurant can compensate for its impact by investing in a public park. This is seen as an opportunity to include sustainability in the transformation of the Binckhorst. The goal of this approach is to maintain the *overall* quality in the area. The crash tests serve to test the regulatory framework. Crash tests can be seen as an evaluation mechanism to ensure any undesired activity is excluded in the rules, and that desirable activities are accepted. Lastly, a monitoring program is designed to monitor actual impact after decision-making.

- The ambitions that are set for the neighbourhood are the following:
- The Binckhorst will transform into a city entrance by facilitating better public transport and connections by car;
- The Binckhorst will be an economic driver to ensure future employment in the municipality, by facilitating creative business opportunities;
- The Binckhorst will be an attractive urban living environment by facilitating the development of 5.000 houses;
- The Binckhorst will develop into a sustainable and resilient area.

The spatial plan and SEA are combined into one document and their processes are intertwined as well: the planning part includes the sets of rules for the quality of the living environment, which are the direct result of the consideration of all information in the (environmental) assessment process (Figure 14). The environmental assessment contains some innovative instruments to study the effects, which are the crash tests and balance approach that were discussed above. They serve to support the feasibility of the plan and to prove the plan is not infeasible.

SEA usually assesses the impact of activities in the physical realm. In this case, the approach is reversed. The SEA for the Binckhorst assesses and evaluates the current situation and the carrying capacity of the area and uses this information to create a regulatory framework. The regulatory framework then serves to manage and control actual impact. Thus, instead of assessing impact, the SEA creates limits and thresholds to activities to exclude significant negative effects. It does this by assessing each environmental theme individually in a factsheet, regarding ambitions, current policies and thresholds. Environmental aspects are divided into 30 different themes, ranging from archaeology and soil quality, to air pollution and social security, to traffic increase and quality of public space (Gemeente Den Haag, 2016a). Unfortunately, not any more information can be provided on the SEA process as it is still in progress and subject to change.

The NCEA advised on the scoping document and published an interim advice in 2016 on the conceptual plan and SEA. A final advice cannot be discussed here since the planning procedure is still in progress.

Scoping document: the planning process (Figure 14) is judged positively by the NCEA. Some recommendations to improve the process are included in the advice. These recommendations are:

- Map used environmental space, and available environmental space for future development in the area (a thorough description of current situation is needed).
- Create a comprehensive framework to cover the aspired ambitions and legal demands.
- Experiment with different sets of ‘hard’ and ‘soft’ rules that are necessary to achieve ambitions.
- Develop a monitoring system to evaluate the achievement of ambitions and support this with possible measures to adapt to unacceptable environmental impacts.

Interim advice: the NCEA is content about the progress, yet identifies several shortcomings. The assessment of the reference situation must be more comprehensive, as this is the most important starting point for the developments. Furthermore, the sets of rules are large and dispersed and can be combined into 4 themes. Improvements can be made in the combination of ‘hard’ and ‘soft’ rules: experiment with less rules and see if ambitions are still met in crash tests. It is also advised to create an explicit system for monitoring and evaluation. The NCEA advises to pay specific attention to the following aspects: traffic safety and capacity, air quality, noise pollution, health effects.

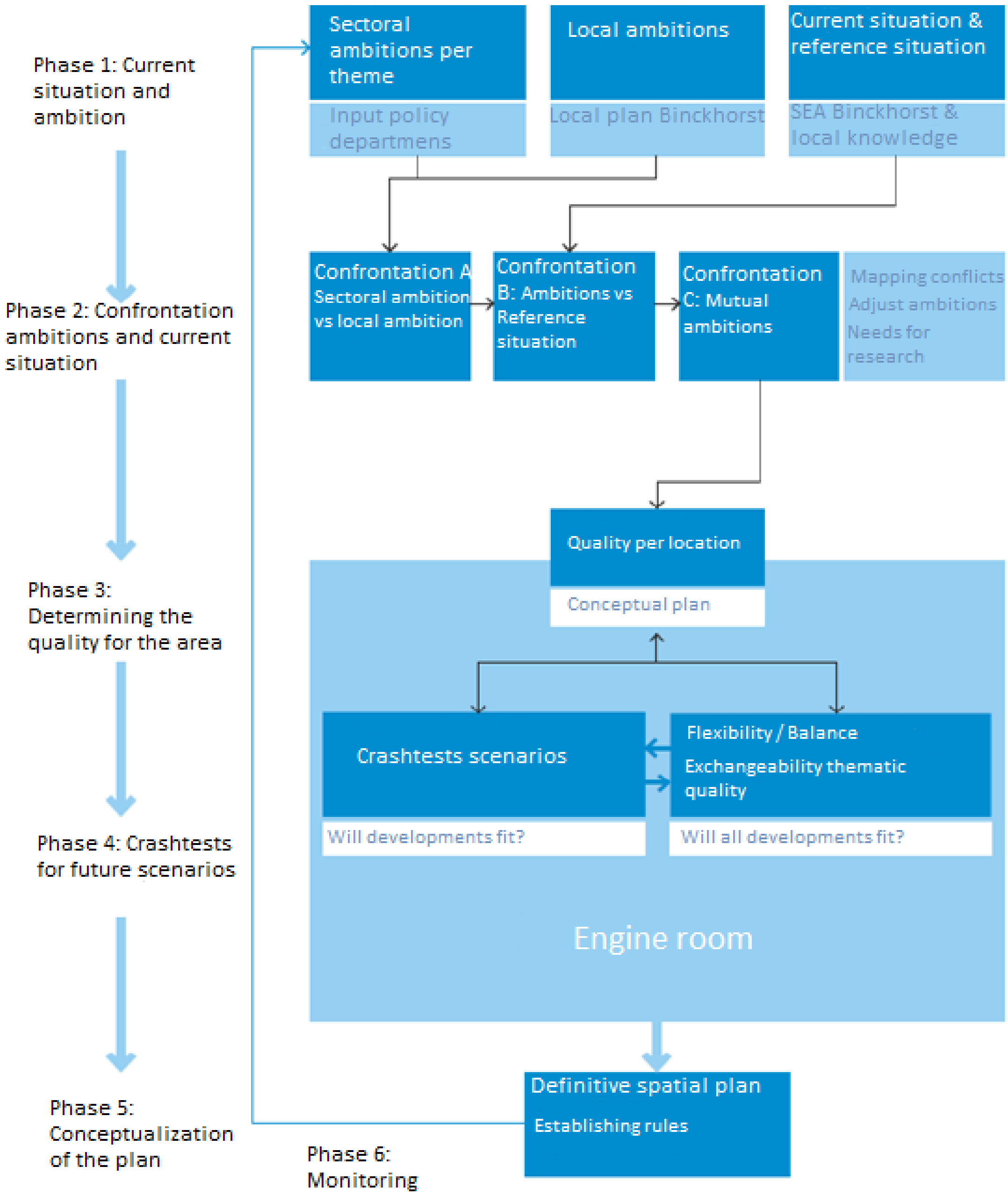

Figure 14: Planning process and SEA process Binckhorst. Source: SEA Binckhorst 2016

8.2.3 Oosterwold

Oosterwold is situated in the Province of Flevoland. It is an agricultural area of 4.300 hectares between Almere and Zeewolde. Besides agricultural business the area contains a highway and some regional roads, woods, canals and 55 windmills. A Structure Vision (SV) was established in 2013 by the municipality of Almere and Zeewolde. Oosterwold is meant to organically develop (bottom-up) towards a green mixed living area with a low concentration of buildings. Responsibilities are with the end-user. The SV and zoning plan determine principles to guide developments (Textbox 5).

AMBITIONS

1. **Maximum freedom to initiatives**: there is room for everything: from villages to solitary living.
2. **Development happens organically**: initiators have responsibility for the development of their parcel.
3. **Continuity of the green landscape** 50% of a parcel can be built, and 50% is for roads, water & green.
4. **Room for urban agriculture**: local urban agriculture will provide 10% of the local food need.
5. **Sustainable and self-sufficient**: initiators arrange public services based on circularity.
6. **Financially stable**: the government will invest in the area following to developments.

DEVELOPMENT PRINCIPLES

1. **People make Oosterwold:** the end-users decide what Oosterwold will look like.
2. **Free choice of parcels:** every initiator can choose the size, place, and shape of a parcel.
3. **Generic parcel with a predetermined division of physical space:** exemplary for how to divide the space including a building, urban agriculture, a road, public green, and water.
4. **Specific parcels with a specific division of physical space:** specific parcels deviate from the generic parcel.
5. **Rules for buildings:** surround every building with green and design according to Floor Air Ratio (FAR).
6. **Participate in infrastructure:** every parcel reserves room for a road, initiators develop road structure.
7. **Ecological qualities:** every parcel includes public green.
8. **Parcels are self-sufficient:** initiators responsible for water management, waste disposal & energy supply.
9. **Parcels are financially self-sufficient**: no subsidies can be involved.
10. **Public investments follow local development**: only after sufficient people live in the area, the municipality will invest in public services and roads.

Textbox 5: Development principles Oosterwold (Gemeente Almere & Gemeente Zeewolde, 2013)

The area offers room for around 15.000 households (Gemeente Almere & Gemeente Zeewolde, 2013). The municipality reserves parts of the area for public roads, economic and recreational activity, urban agriculture, public green, water storage and sustainable energy (Textbox 5). Initiatives must fit these demands. The SV serves as an overarching framework for future spatial developments. It means it is an assessment framework to guide further planning processes, such as the zoning plan, and eventually permits. An SEA is obligated because the SV facilitates the development of more than 2000 houses and because the area is close to Natura 2000 locations.

The SV names several conditions related to environmental aspects that need to be accounted for:

- Ecology: spatial developments may not negatively influence Natura 2000 locations. Initiatives need to be evaluated in the context of the legal requirements and mitigation measures can then be offered.
- Soil: subsidence is an important issue in the area which is why initiatives need to be thoroughly assessed.
- Cultural heritage: the Oosterwold area contains several archaeological values, yet these can be seen as an opportunity for development rather than a limitation.
- Water: the water system is vulnerable in Oosterwold due to subsidence and climate change. However, initiators are responsible to come up with resilient solutions.
- Traffic: developing 15.000 houses means traffic will increase. This is why future residents will need to keep in mind that these developments might have negative effects on air and noise pollution.

The development in Oosterwold is mostly characterized by the retreating role of the government. The responsibilities for development are laid on initiators. The government functions as a facilitator. An area director, that is appointed by the government, will oversee all developments (Gemeente Almere & Gemeente Zeewolde, 2013). This also means that financial responsibility and risks for the municipalities are reduced.

The zoning plan was established in 2016 and contains the same ambitions and development principles as the SV and is in many perspectives similar to the SV. The only difference is that this plan provides the legal framework for the rules, and it includes so called ‘decision-trees’ that guide the initiatives. The decision-trees are designed for every environmental aspect and serve to judge whether an initiative fits the legal regulations, policies and ambitions for Oosterwold (Figure 15).

Om te beoordelen of een project voldoet aan het aspect ecologie wordt onderstaande beslisboom doorlopen.

1.	Ecologische hoofdstructuur	Ja	Nee	Gegevens
	Ligt het project in de ecologische hoofdstructuur zoals aangegeven in de provinciale verordening?	Ga naar vraag 2.	Ga naar vraag 4.	-
2.	**Effect op Natuur Netwerk**	**Ja**	**Nee**	**Gegevens**
	Blijkt uit een effectbeoordeling van het project op het Natuur Netwerk dat het project tot aantasting van de wezenlijke kenmerken en waarden van het Natuur Netwerk leidt?	Project **voldoet niet**.	Ga naar vraag 3.	Effectbeoordeling project op Natuur Netwerk.
3.	**Beschermde soorten**	**Ja**	**Nee**	**Gegevens**
	Kan het project soorten aantasten die op grond van de Flora- en faunawet beschermd zijn?	Ga naar vraag 4.	Project **voldoet**.	-
4.	**Effect flora en fauna**	**Ja**	**Nee**	**Gegevens**
	Blijkt uit onderzoek dat het project geen beschermde soorten aantast?	Project **voldoet**.	Ga naar vraag 5.	Flora- en faunaonderzoek
5.	**Maatregelen Ff-wet**	**Ja**	**Nee**	**Gegevens**
	Blijkt uit onderzoek dat maatregelen mogelijk zijn om aantasting van beschermde soorten te voorkomen?	Project **voldoet onder voorwaarden**.	Ga naar vraag 6	Maatregelenonderzoek Flora- en faunawet.
6.	**Ontheffing Ff-wet**	**Ja**	**Nee**	**Gegevens**
	Is ontheffing van de Flora- en faunawet verleend?	Project **voldoet**.	Project **voldoet niet**.	Ontheffing Flora- en faunawet.

Figure 15: Example of decision-tree for ecology. (Grontmij Nederland B.V., 2015a)

An SEA was published in March 2013 to describe the effects of the SV. In their interview the consultants explained that the SEA process was not integrated in the spatial planning process. It became clear rather late that the SV required an environmental assessment. The SEA had to be completed within 4 months and suffered from this time constraint. The NCEA requested additional information about some specific environmental aspects (mostly nitrogen deposition). An additional SEA report was published 3 months later in June 2013. By this time, the municipality was already working hard on the zoning plan. The same SEA report, including the additional information, was used to serve as an environmental assessment of the zoning plan, since the content of the SV and zoning plan were so similar:

"It does not fit the content of this land-use plan and the concept of organic development to perform a detailed assessment of possible environmental effects before the establishment of the plan. This responsibility is directed to initiators. These are responsible to prove their plan fits aspired developments, based on some restrictions, the development principles, and decision-trees. The decision-trees are objectively designed and can be changed following policy changes in the municipality." (Grontmij Nederland B.V., 2015b, p. 30)

The zoning plan was accepted in September 2016. An executive organisation directs initiatives in the area. An area director evaluates initiatives and decides whether they fit the aspired quality. After approval, initiators are responsible to fulfil planning procedures, including for example archaeological and ecological research, the license application, and the implementation of public services like roads, electricity, water and green. The area director uses a discussion forum and an interactive planning map to keep overview of the process in a transparent way. This forum is at the same time an important information sharing platform for initiators. Only when a permit is applied to, will be assessed whether this fits the norms and what the effects are using decision-trees. The decision-trees function as an instrument for initiators to see whether research is necessary.

The NCEA published an advice for the SV in 2013 and for the land-use plan in 2015, which were both negative as essential information was missing.

Final advice for SV 2013: The SEA report shows essential shortcomings. The proposed activities of the plan are unclear with respect to their bandwidth. Consequently, the maximal environmental impact of the proposed activities is unclear, and it is unclear whether and how a monitoring and evaluation program will be set up. The NCEA advises to write a complementary SEA including worst case scenarios of the proposed activity, worst case scenarios for every individual aspect and a monitoring and evaluation program. This assessment can include a description of environmental risks for every aspect, sensitivities in the area and bottlenecks for development, and additional mitigation measures to prevent significant effects. Important aspects to focus on are traffic intensity, air quality, noise pollution, external safety, nitrogen deposition, water and soil quality, archaeology and cultural history and sustainability.

Final advice for land-use plan 2015: The SEA does not contain all essential information to fully include environmental values in the decision about the land-use plan. Essential shortcomings are missing information about a monitoring and evaluation program, and a description of the impact of nitrogen deposition on Natura 2000 locations. The monitoring program should include critical boundaries of aspects, cumulative effects and the achievement of ambitions, and possible mitigation measures to lower significant environmental impact. Effects of nitrogen deposition should focus on dairy farms and traffic generating activities. Adaptations were made to the land-use plan and the definitive plan was established in 2016. The NCEA did not advise on the latest developments, that included a monitoring program and additional research for nitrogen deposition.

8.2.4 Greenport Venlo

Greenport Venlo is an area between the municipalities of Venlo, Horst aan de Maas and Peel aan de Maas. It is located in the Province of Limburg, close to the border with Germany. Situated in the area are businesses for agrologistics, horticulture and (intensive) livestock farming. A large part is used for agriculture and has a relatively dispersed character. Greenport Venlo is one of six Greenport in the Netherlands. A Greenport is a cluster of horticultural businesses, including farms, auctions, sales organisations, trading companies, exporters, suppliers, and knowledge institutes. Concentrating these businesses enables cooperation and knowledge exchange.

To further exploit the economic opportunities in the area, and to diminish dispersion in the landscape, the area is to be developed sustainably from 14.000 to 27.000 jobs up to 2022. Business parks are expanded with the settlement of new companies that are active in agribusiness, logistics, and knowledge institutes. A high-quality landscape surrounds the business parks. The development is inspired by the concept of Cradle2Cradle, an economic philosophy focusing on (re)development, implementation, management, and transformation (Development Company Greenport Venlo, 2012, p. 9). Up to 2040 the area will transform approximately 2.000 hectares of existing agricultural land to newly developed business parks, infrastructure, and nature (Table 15).

	Current situation	Autonomous development	New development	Total
Business parks	775 ha	670 ha	610 ha	2.055 ha
Infrastructure	300 ha	40 ha	5 ha	345 ha
Nature	1.175 ha	-	630 ha	1.805 ha
Agriculture	3.150 ha	-710 ha	-1.245 ha	1.195 ha

Table 15: The proposed transformation of Greenport Venlo (Development Company Greenport Venlo, 2012)

The Structure Vision [SV] was created in 2012 by the Development Company Greenport Venlo [DCGV]. DCGV is the development company responsible for the implementation of the Structure Vision. The municipalities Horst aan de

Maas, Peel en Maas and Venlo, and the Province of Gelderland, are shareholders of DCGV (Development Company Greenport Venlo, 2012). The fact that DCGV coordinates spatial development in the area, does not mean that governmental authorities have no role to play: they are still responsible to grant permits for initiatives.

The SV was based on earlier stages of development, including a Masterplan and a Provincial plan, for which an SEA was performed (Figure 16). This led to the design of a conceptual SV, for which a new SEA was performed that studied the environmental effects and possible mitigation measures of the plan. This means the SEA and planning process were not as integrated compared to Waalweelde West, where the procedures started simultaneously. The SEA resulted in a preferred alternative, that was also assessed concerning its effects and led to the final SV. SEA was used to find the preferred alternative and to identify issues that require attention in the following planning procedures (land-use plans and permits).

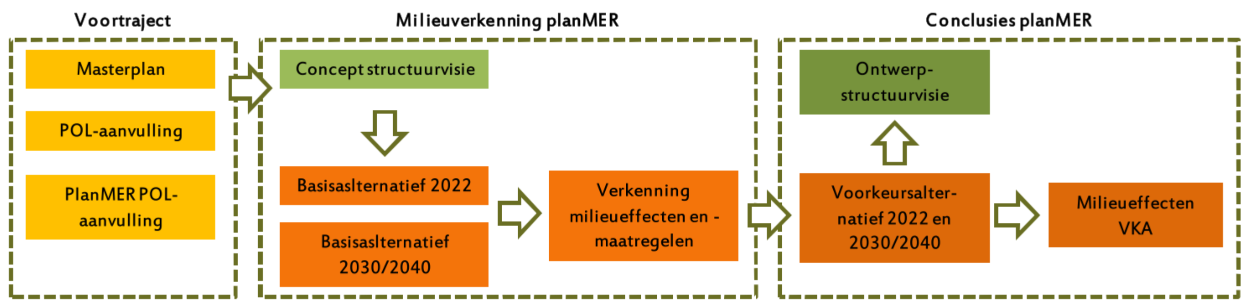

Figure 16: Planning process Greenport Venlo. Source: SV 2012

The SV is an overarching framework for further developments in the area and so the SEA is also the overarching instrument for further research. The SEA also includes a health effect screening to explore possibilities to improve a healthy living environment in the area around Greenport Venlo.

The NCEA was involved in multiple occasions, including an advice on the scoping document, an interim advice, and a final advice.

Scoping document: Because this SEA serves as an overarching framework for future assessments of land-use plans, it needs to include environmental information on different levels of detail. When developments are uncertain, it is sufficient to assess uncertainty bandwidths, effects of large-scale developments, environmental limits within which development is possible and evaluation criteria for future planning procedures. SEA therefore needs to include 1) the probability that effects can occur (best-case and worst-case), 2) the role of uncertainty in significant differences between alternatives, and 3) in what way real effects will be monitored, evaluated, and treated after decision-making if goals are not met.

Interim advice: the NCEA found that not all essential information was included to fully integrate environmental effects in decision-making. Information is missing about effects of nitrogen deposition, effectiveness of mitigation measures, the reference situation, and cumulation of effects on health. In addition, the NCEA states that information on nitrogen deposition is essential for acceptation of the plan. The other aspects can be additionally included yet pose no legal risk.

Final advice: An additional assessment was performed and included in the SEA report, together with the Appropriate Assessment and the Health Effect Screening. The NCEA advised on this last addition as well, and concluded that essential information was still missing. This is the same information as was discussed above for the interim advice. The NCEA argues that calculations for nitrogen deposition need to be included.

8.2.5 Eemsmond Delfzijl

Eemsmond Delfzijl is situated in the north of the Netherlands in the Province of Groningen. The planning area includes the harbour Eemshaven, the harbour Oosterhorn and some adjacent areas. Chemical industries are situated around the harbour of Oosterhorn. Around the harbour of Eemshaven a cluster of energy industries evolved, and a Google datacentre was built. Wind farms near both harbours include a total of 143 wind turbines. The area is well connected to the rest of the Netherlands and to the European market due to shipping lanes, cable connections, railways, and highways. Ecologically valuable areas surround the region: the Waddenzee, Eems-Dollard estuary, and the (uninhabited) islands Rottumerplaat and Rottumeroog. The Dutch Nature law protects these areas. The Waddenzee and Eems-Dollard estuary are Natura 2000 and UNESCO world heritage locations. Apart from the economic activities and ecological value, the region includes several villages that are close to the industrial areas and windfarms and therefore experience nuisance of odour, light and noise pollution. Economic growth is expected in the Eemsmond region, with special regard to sustainable energy, industrial development and accessibility. A Structure Vision (SV) is established in 2017 to guide regional developments and serve as an overarching framework for future projects. The SV includes 15 of such large spatial projects: industrial areas, wind farms, a railway, a heliport, cable connections and a dike reinforcement (Figure 17). The SV was designed by a cooperation of the Province of Groningen, municipality Delfzijl, municipality Eemsmond and Groningen Seaports (the manager of both harbours and industrial areas). Several goals are set in the Structure Vision, which are (in order of importance):

- Room for sustainable energy
- Creating an attractive business climate
- Prevention of environmental pollution
- Flood protection
- Increasing biodiversity
- Protecting landscape and cultural heritage
- Creating an attractive recreational climate (Provincie Groningen, 2017)

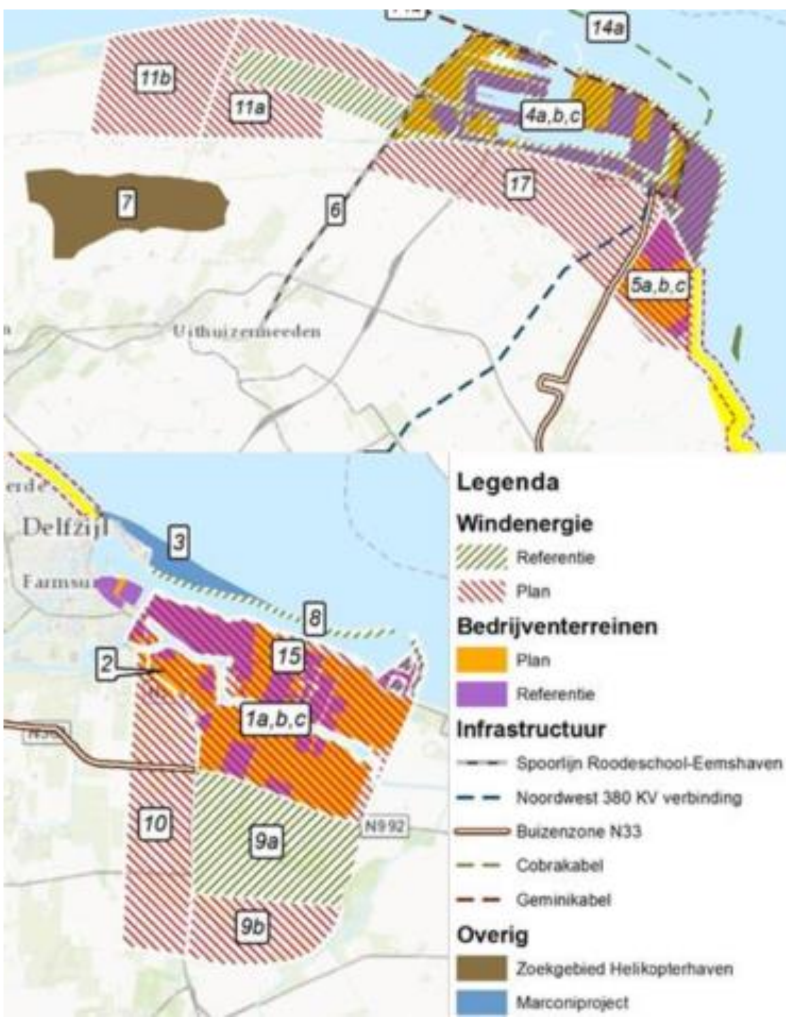

Figure 17: Proposed spatial development in Eemsmond Delfzijl (Arcadis Nederland B.V., 2016)

The Province wishes to facilitate development in the area without compromising environmental values. The SEA therefore uses the environmental capacity, or 'environmental development space' in the region, as a reference point for impact assessment. The overall goal of the SV is to ensure that the 15 individual projects (i.e. windfarms and industrial development) and their cumulative effects will fit within the boundaries of the carrying capacity of the region. That also means to ensure inhabitants are not further bothered by environmental pollution (Provincie Groningen, 2017). To ensure this, location specific policy is necessary that determines the critical limits for environmental pollution. Consequently, limits are established in the SV for:

- Cumulative noise pollution (caused by windfarms and/or industrial activity)
- Noise emission per windfarm
- Cumulative odour pollution as well as the overall norm for noise pollution
- Combinations of windfarms and industrial areas concerning external safety
- Emission of nitrogen and heavy metals

The limits are included in the environmental policy for the Province of Groningen. The responsibility for the strategic implementation of the environmental policy lies with the regional environmental service (*Omgevingsdienst Groningen).* They are responsible for permits, surveillance and enforcement via a monitoring program (Provincie Groningen, 2017, p. 27). Several steps are described that led to the design of the Structure Vision. These include:

1. 'Keuzedocument': In 2015 the Province of Groningen created a document including all policy principles.
2. A scoping document was created in 2015, including an advice of the NCEA.
3. The SEA and Appropriate Assessment have been executed to assess the provincial ambitions regarding their economic and environmental impact. The NCEA published an interim advice in 2016 focussing specifically on effects on safety, noise, odour, and nature.
4. Administrative consultation followed in the end of 2016 to discuss the content and progress of the SEA and planning process, including the NCEA interim advice.
5. A final design for the SV was created and established in February 2017.

The SEA and SV processes were integrated from the start. The assessment of effects of different economic scenarios, design of windfarms and locations for a heliport led to the design of the preferred alternative. Using this approach also made clear how the content of the SV or even provincial policy could be adapted. The SEA then assessed the effects of the preferred alternative, whether this could be realised within the available environmental space and identified mitigation measures and preconditions for developments. Scenarios and variants to frame developments:

- Economic development scenarios 'grey' and 'green': green development focuses on business initiatives in circular economy by closing loops and investments in sustainable energy sources, whilst grey development entails a more traditional focus on fossil fuels.
- Variation in size of wind turbines: wind farms can include wind turbines of 100 meters tall or 150 meters tall, generating respectively 3MW or 7,5MW.
- Location for the heliport: a location is assessed in the west and in the east of the Uithuizerpolder.

Scoping document: in their advice on the scoping document the NCEA recommended to design variants and alternatives of the spatial developments to determine the band width of environmental effects. It was also recommended, amongst other things, to include an analysis of cumulative effects in the region and an Appropriate Assessment to evaluate effects on Natura 2000. It is visible in the SEA that these recommendations were adopted.

Interim advice: the NCEA was requested to advice on the aspects of noise pollution, external safety, odour pollution and nature. The NCEA found that sufficient information was provided for noise pollution and external safety. Odour pollution required additional argumentation on the acceptation of cumulative effects. Nature required additional research into effects of heavy metals, nitrogen deposition and wind farms. Recommendations were adopted.

Final advice: the NCEA found that the report included sufficient environmental information to establish the spatial plan. The commission gave some recommendations for further planning processes, which are to provide an analysis of landscape effects of wind farms, to assess effects of turbidity in the Eems-Dollard estuary, and to keep information accessible for future plans. Effects on the Eems-Dollard estuary were arguably left out of the scope since effects were not expected and turbidity in the estuary is a long-lasting issue for which other action programmes exist.

8.3 Transcripts

Due to confidentiality, transcripts of the interviews are available upon request.