



How can the gap between Stakeholder Analysis and Agent-Based Modelling be bridged by modelling stakeholder and user behaviour to investigate the maintenance alternatives of an anthropogenic sandy shore?

**Case study: the artificial lagoon area at the
Hondsbossche Dunes at Camperduin (NL)**

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Preface and acknowledgements

My name is Laura Alblas and in front of you lies the final report of my Master's thesis that is the result of an investigation into how stakeholder behaviour and user behaviour can be modelled to investigate the maintenance alternatives of a beach area. With this thesis, I will also complete the Master's programme Geographic Information Management and Applications (GIMA). I have used all the knowledge and skills that I have gained during the last three years to bring this research to a good result.

The year in which this thesis was written has been educational but sometimes also a tough year for me. Especially during the challenging times of the COVID-19 pandemic, it was sometimes hard to stay motivated. Although I have experienced less productive moments in the past year, I am proud of the result that I have been able to achieve.

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Finally, I would like to thank my responsible professor, Menno-Jan Kraak, for the time and effort he has taken to read my thesis with a fresh perspective.

All that remains for me is to wish you a lot of reading pleasure.

Laura Alblas

Amsterdam, 21 February 2021

Abstract

This thesis research has two main objectives. The first one is generic and is about developing an approach to translating non-numerical outcomes of stakeholder analysis into a numerical simulation model. This has been done by adopting an existing approach that integrates cognitive mapping and Agent-Based Modelling. The development of a System Dynamics Model and an integrated hybrid model is added to this framework. The case study that is used to create this framework is the project around the artificial lagoon at Camperduin (NL). This lagoon has been created in 2015 and the maintenance contract has ended in 2020. Policymakers and stakeholders, among which the municipality of Bergen, are discussing if they will carry on the maintenance or if the lagoon should be removed. To get insight into the opinions of the different stakeholders, a stakeholder analysis is carried out. The outcomes are translated into cognitive maps. Based on the outcomes of the cognitive maps, a System Dynamics Model is created that represents a simplified representation of the dynamics of the system of the project around the lagoon. This System Dynamics Model is finally integrated with an Agent-Based Model which has resulted in an integrated hybrid model. With this integrated hybrid model, policymakers can identify the best practice for the maintenance of the lagoon by experimenting with different values for parameters. The model has shown that it is most beneficial for the municipality to keep on maintaining the lagoon through dredging the trench to ensure a flow of freshwater. This promotes the quality of the lagoon which will attract more visitors. More visitors generate a flow of money for the municipality with which they can cover the maintenance costs.

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1. Introduction

1.1. Context

Many people worldwide live in and around coastal areas because these areas offer a lot of benefits such as recreational purposes. The benefits that coastal lagoons provide are important for enhancing human wellbeing and thus the presence of the coastal lagoons is receiving more recognition from decision-makers that are responsible for protecting these unique areas. In 2015, a reinforcement of the former Hondsbossche and Pettemer Zeewering took place to meet safety standards in case of a storm. Within the design of the Hondsbossche Dunes, new locations became available for nature and recreation along the Dutch Coast. One of the new chances was the construction of an artificial lagoon south of the row of dunes that make up the Hondsbossche Dunes. Five years later, it has already turned out that the presence of the lagoon delivers an improvement of the beach and the surrounding area, so proper maintenance of the artificial lagoon is needed. This research will examine the best practice maintenance strategy by combining stakeholder analysis and numerical Agent-Based Modelling.

This research focuses on including human-elements in spatial modelling by linking a qualitative method like stakeholder analysis to a quantitative formal modelling method like Agent-Based Modelling. This research is built upon a case study of the management of the artificial coastal lagoon at the Hondsbossche Dunes at Camperduin.

Modelling socio-ecological interactions between humans and ecosystem to examine their implications for suitable management strategies of socio-ecological systems is not widely studied yet. Non-numerical human processes on macro-level and numerical human processes on micro-level are often studied separately. This research aims to bridge the gap between the macro-level outcomes of non-numerical stakeholder analysis and numerical modelling on micro-level.

1.2. Case Study: The Hondsbossche Dunes

The area studied in this research is The Hondsbossche Dunes (HD), located at the former Hondsbossche and Pettemer Sea Defence (HPSD). The HPSD was built in 1880 and was a hydraulic engineering structure that consisted of a concrete dyke with breakwaters. The dyke ran from Camperduin to Petten and was around 8 kilometres long. Along the dyke, there were no sandy beaches because the asphalt continued into the sea. This is illustrated in figure 1, where you can see the lack of sandy beaches at the former dyke and in figure 2, where you can see the former concrete dyke with its breakwaters.



Figure 1: Hondsbossche and Pettemer Sea Defence (Meer, 2014).



Figure 2: Hondsbossche and Pettemer Sea Defence (Rijkswaterstaat, 2020).

The Reinforcement Plan

In 2003, Rijkswaterstaat (the Dutch Ministry of Infrastructure and Water Management) assigned various places along the Dutch North Sea coast as ‘Weak Links’. The HPSD was identified as one of the weak links - because it no longer met the applicable safety standard. The Hollands Noorderkwartier Water Board was seeking an innovative way to prepare the Dutch coast at this location for a rise of the sea-level as an effect of climate change (Arcadis, 2019). There were two options for the reinforcement plan of the HPSD. The first was to maintain the sea defence and heightening the existing dyke construction. The second option was implementing the ‘Nature-Based Solution’ (NBS) principle by which the HPSD would be transformed from a concrete, robust and artificial dyke into a natural solution to protect the weak spot at the North-Sea Coast. The latter option was preferred and therefore, a system that linked

the beaches and dunes with each other was constructed. However, the old dyke is still there, but it has become superfluous because of the newly-laid out row of dunes in front of the dyke. This reinforcement plan is visualized in figure 3.

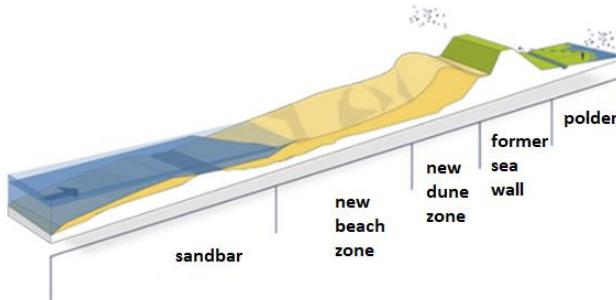


Figure 3: Design of the Reinforcement Plan of the Hondsbossche Dunes (Arcadis, 2019).

The plans on the reinforcement of the Hondsbossche and Pettemer sea Defense are carried out by the joint venture of two maritime companies Van Oord and Boskalis. They are responsible for the maintenance of the coastline until 2035 (20 years from 2015). The Van Oord-Boskalis joint venture has made a design that consists of a soft, flat and shallow foreshore, a sandy beach and artificial dunes. The most important task of these dunes is flood defence. Besides the purpose of flood defence, this design is also focused on the improvement of the spatial quality of the area.

Thus, the coastal reinforcement plan for the HPSD focused on the attainment of the following two objectives (Hollands Noorderkwartier Water Board, 2013):

1. Strengthening the coastal sections so that they meet the safety requirements.
2. Maintaining, strengthening and improving spatial quality.

The two objectives listed above complement each other. The aim to improve the spatial quality can, therefore, provide directions for how a technical solution is worked out. By addressing the issue of spatial quality simultaneously with the coastal reinforcement, opportunities for recreation, tourism, nature and the local economy are being exploited (Ministerie van Verkeer en Waterstaat et al., 2002). Agreements on the ambitions regarding the spatial quality of the area are described in the program 'Kust op Kracht' (Taal, 2020).

It is important to state that the former name of the dyke is the Hondsbossche and Pettemer Sea Defense and after the reinforcement, the resulting area has been renamed Hondsbossche Dunes. From this moment on, the latter name will also be used in this report to describe the area.

The Lagoon

Since the improvement of the spatial quality of the area is one of the objectives of the reinforcement plan, new elements are implemented to add value to the area. One of these implementations is the creation of an artificial lagoon. According to Taal (2020), "This is unique in the Netherlands and -

certainly, with the arrival of the new play ship (for children) - it is a real attraction for the area. The lagoon is suitable for various activities and contributes to spatial quality.”.

Figure 4 shows an aerial view of the Hondsbossche Dunes at Camperduin with the beach lagoon in the middle.



Figure 4: Aerial view of the Hondsbossche Dunes with the beach lagoon at Camperduin in the middle (Krijger, 2018).

1.3. Problem statement

The artificial lagoon was created at the Hondsbossche Dunes as part of the redesign of this area. The development of the lagoon does not affect safety restrictions positively or negatively, but it adds scenic and economic value to the area because it attracts visitors that guarantee a flow of money for the area (Arens et al., 2019). So, the lagoon is considered an economic driver for the area, the municipality and the entrepreneurs in the area.

As stated before, the maintenance contract of the Hondsbossche Dunes runs until 2035. This means that twenty years after the completion of the project, the ZSNH will be responsible for the management and maintenance. Since the lagoon is solely constructed because of its added value for the spatial quality of the area and not for its contribution to water safety, the contract for maintenance and management for the lagoon is different. This contract runs for five years after completion, to be ended in October 2020. Anticipating this, various involved parties, such as Rijkswaterstaat and De BUCH (an umbrella organization of the municipalities Bergen, Uitgeest, Castricum en Heiloo) are investigating whether they should take over the maintenance tasks from ZSNH and carry on dredging the lagoon to keep it open or if they should do nothing and let nature take its course in the lagoon. If no maintenance activities (e.g. dredging) are carried out by the municipality anymore, the lagoon will slowly disappear due to incoming sand carried by the tides (Bodde et al., 2019). Another option is that the pit of the lagoon will be actively closed by shoving the sand of the dunes that lie in front of the lagoon into the pit of the lagoon.

If the involved parties decide to keep the lagoon open, there are also different maintenance alternatives. For example, the lagoon can be dredged at different frequencies. This can be done once a year, but also once every two years or even less.

This active human management of the lagoon requires the stakeholders to employ a common idea about the lagoon to develop and apply an effective management strategy for the area

To explore the best management strategy of the area, it is important to explore and investigate the impact of the different maintenance strategies on the stakeholders. According to Elsawah et al. (2015), it is important to grasp and integrate human elements like these interests, objectives and decisions into decision making and modelling in complex socio-ecological systems (SES). This is important because of three reasons:

1. The activities and choices of people affect the use of natural resources. To be able to change this resource use and behaviour, policymakers need to fully understand how the resources are being influenced by humans.
2. Decision-making processes are always affected by the theories that individuals and groups have about how the real world functions or should function (Argyris and Schön, 1987, Moxnes 1998). In the end, this can result in long-term overexploitation and the downfall of economic and ecological systems.
3. Modelling needs to have a relationship with the real world to be understandable to non-experts and to increase the possibility to adapt to the model's results.

There is still a lack of scientific frameworks to integrate qualitative and quantitative methods. According to Mehryar (2019), for modelling socio-ecological systems, such as the management of an artificial lagoon, both qualitative and quantitative evidence is needed because they complement each other. Quantitative and qualitative data and tools are still being used separate, depending on the aim of the research. Therefore, the problem statement of this research is the lack of integration of both qualitative and quantitative methods to improve the decision-making process.

The socio-ecological system that will be used as a case study for this research, is the project around the artificial lagoon at Camperduin. The different maintenance strategies will be examined by using a numerical model, to see what alternative will be most beneficial for the municipality in terms of economic profit.

The method resulting from this research will provide an answer to the question of how stakeholder and user behaviour can be modelled to investigate the maintenance alternatives of a beach area. The final model can be used by the different stakeholders, decision-makers and policymakers as a communication instrument to test the best practice of the different maintenance alternatives.

1.4. Research objectives

As stated before, the main objective of this research is to find a method to bridge the gap between stakeholder analysis and agent-based modelling (ABM). This will be done by modelling stakeholder and user behaviour to investigate the maintenance alternative of an anthropogenic sandy shore

The research question that arises from this main objective is as follows:

"How can the gap between Stakeholder Analysis and Agent-Based-Modelling be bridged by modelling

stakeholder and user behaviour to investigate the maintenance alternatives of an anthropogenic sandy shore?"

To answer this research question, the lagoon area at the Hondsbossche Dunes at Camperduin will be used as a case study.

To be able to answer the main question, a few sub-questions are formulated. These sub-questions are as follows:

1. What are the different stakeholders that are involved in the project of the lagoon at Camperduin and what is their role?
2. How can the outputs from the stakeholder analysis be formalized into a method applicable to agent-based modelling?
3. How can stakeholder analysis and integrated modelling be combined?
4. What will be the best practice for the maintenance of the area around the lagoon at Camperduin?

1.5. The scientific and societal relevance

Scientific relevance

There is a knowledge gap in the previous researches between stakeholder analysis and Agent-Based Modelling. There seems to be a need to include human elements such as perceptions, decisions and actions into decision making and modelling in socio-ecological systems, such as the beach lagoon at Camperduin. This research aims to contribute by developing a method to translate the outcomes of a stakeholder analysis to the development of a numeric Agent-Based Model. The method that will be developed in this research can help to integrate the qualitative elements (viewpoints, ideas and knowledge of stakeholders) into qualitative simulation models.

It is important to bridge this gap because it supports gaining insight into decision-making processes in socio-ecological systems. By linking a sequence of methods starting with qualitative methods and ending with quantitative methods, the gap between stakeholder analysis and Agent-Based Modelling can be bridged.

Societal relevance

To develop a method for bridging the gap between stakeholder analysis and Agent-Based Modelling, a real-world complex socio-ecological system is chosen that serves as a case study.

For this research, the project around the lagoon at the Hondsbossche Dunes is used. There was a debate going on between different stakeholders about what the best management alternative for the lagoon area would be. The different stakeholders all have different benefits that are influenced by the choice of management alternative.

To connect the qualitative, human elements of the stakeholder analysis to the quantitative, spatial elements of the ABM, it becomes clear what the best maintenance alternative will be for the municipality. Therefore, the resulting model can be used as a way to communicate different strategies for maintaining the anthropogenic sandy shore. That is considered societal relevance.

1.6. Reading guide

Chapter two contains the theoretical framework. This chapter provides a literature review on four topics. The first topic is about coastal lagoons, their characteristics, management of coastal lagoons and in particular about the artificial lagoon at the Hondsbossche Dunes. The second part of the theoretical framework is about participatory modelling and covers a literature review on stakeholder analysis and cognitive maps. The third part is about modelling and covers a literature review on System Dynamics Modelling, Agent-Based Modelling and Hybrid Modelling. The last part covers the theoretical background of the ICTAM-method.

Chapter three contains the methodology used in this research. One main methodology has been used that serves as a guideline for the entire research; the ICTAM method of Elsawah et al. (2015). Within this methodology, other methods are used, which will also be explained in chapter three.

Chapter 4 contains the data used for this research and which served as input for the developed models. Also, this chapter explains how maps are made using GIS that also serve as input for these models.

Chapter 5 contains the results of the research based on the analysis of the different aspects of the research. First, the results of the stakeholder analysis are explained. Then, the results of the development of the models are illustrated by explaining the conceptual development and the implementation of the models. The last section of chapter 5 covers the results of the experiments that are carried out with both the System Dynamics Model and the Integrated Hybrid Model.

Chapter 6 contains the conclusion in which the main and sub-research questions are answered. In chapter 7 the limitations of the research are explained in detail and recommendations for future research are made.

Finally, you will find the transcripts of the interviews conducted in the appendix.

2. Theoretical framework

The theoretical framework is divided up into four general parts. Section 2.1., Coastal Lagoons, is about the characteristics of coastal lagoons, human activities in and around coastal lagoons and in particular about the coastal lagoon at the Hondsbossche Dunes.

Section 2.2., Participatory Modelling, provides the literature review on stakeholder analysis and the development of cognitive maps.

Section 2.3., Models, provides the literature review on System Dynamics Models, Agent-Based Modelling and the Hybrid Integration of System Dynamics Models and Agent-Based Models.

Section 2.4., ICTAM-method, provides the step-by-step guide of the framework that integrates qualitative data and quantitative data.

2.1. Coastal Lagoons

2.1.1. Characteristics of Coastal Lagoons

Among the coastal ecosystems, lagoons have a wide range of geographical and environmental variety (Panda et al., 2015). According to Pérez-Ruzafa et al. (2014), coastal lagoons are transitional habitats between continental and marine environments. They are affected by the influence of marine systems and are separated from the sea by a barrier that has at least one inlet. These inlets enable a restricted exchange of freshwater and organisms between the sea and the lagoon (Kjerfve, 1989).

The behaviour of these inland water bodies are affected by, among other things, tide and waves. They are highly attractive for aquacultural projects but, as a result of this, coastal lagoons are stressed by anthropogenic inputs and human activities.

The closure of a lagoon happens when the channel to the sea silts up (Slinger, 2016). Silting up of a lagoon is an effect of low water depth in the channel of the lagoon and, as a result of this, the lagoon doesn't get water refreshment. This can be solved by intermittently opening the inlet of a lagoon so that the lagoon will be refreshed. Opening the lagoon happens by dredging the sediment in the inlet.

The volume of the lagoon is a function of the surface area and the water depth. The amount of water that gets in and out of the lagoon between high tide and low tide is described as the tidal prism. The amount of sediment supply in the coastal lagoon is largely determined by the size of the channel.

Duong (et al., 2016) identifies three different types of inlets/channels:

1. Permanently open, locational stable inlets
2. Permanently open, alongshore migration inlets
3. Seasonally/intermittently open, locational stable inlets.

The characteristics of a lagoon differ depending on its location to the sea, and the number of inlets that allow water refreshment in the system (Gökçe and Tosunoğlu, 2016). Coastal lagoons can be subdivided into three lagoon types: (1) choked, (2) restricted and (3) leaky systems. This is visualized in figure 5. Based on this, the lagoon at the Hondsbossche and Pettemer Sea Defence can be categorized as a lagoon with a 'choked system'.

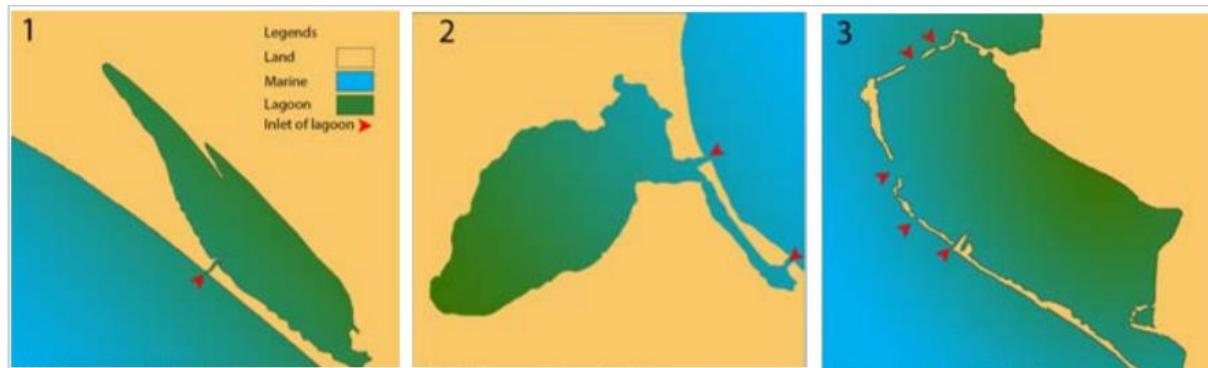


Figure 5. Three different lagoon systems: 1. choked, 2. restricted lagoon, 3. leaky system lagoon (Gökçe and Tosunoğlu, 2016).

2.1.2. Management of Coastal Lagoons

Coastal lagoons usually need active human involvement to control and protect them, to enable the inhabitants of the surrounding area to benefit from the economic, environmental and recreational profits they deliver (Ballarini et al., 2021). If a lagoon is not able to lose sediment in the form of silt or sand, dredging can be a solution. According to Cataudella et al. (2015), the lifespan of coastal lagoons is related to human efforts to manoeuvre their morphology by dredging and other operations. Therefore, coastal lagoons are nowadays the result of a strong interplay between natural dynamics and human actions.

The idea of opening the channels to a lagoon to increase water exchange and renovation in a lagoon has gradually convinced managers and the public as being a potential solution to keep a lagoon open (García-Oliva et al., 2018). Artificial openings of a coastal lagoon are created to drain the lagoon and prevent or reduce flooding of property (Elwany et al., 2003). However, dredging operations can be very expensive and can make up the biggest part of the total maintenance costs (Cataudella et al., 2015). Therefore, dredging activities are usually minimized to dredging the channel instead of dredging the lagoon as a whole. In addition to this, dredging affects the structure of sediments and it deposits the species that live under the seabed.

2.1.3. The Lagoon at the Hondsbossche Dunes at Camperduin

The coastal lagoon at Camperduin is referred to as a Small Tidal Inlet (STI), according to the categorization of Duong (et al., 2016). The surface area of an STI is smaller than 50 km², a maximum width of 500 meters and a depth of fewer than 10 meters (Wittebrood et al., 2018).

As with most lagoons, this dune row separates the lagoon from the coast. The slope and top of the dunes are only covered by plants at the seaside.

Based on the theories about lagoons from Gökçe and Tosunoğlu (2016) that were previously mentioned in the literature chapter, we can conclude that the lagoon at the Hondsbossche Dunes is a lagoon with a choked system and with a seasonally/intermittently open, locationally stable inlet.

The lagoon flows full at high tide and empties at low tide. This provides a unique stretch of beach, close to beach bars and, for example, suitable for families with small children (Jonkman et al., 2015). The beach lagoon is also the ideal location to do various water sport activities, such as supping, windsurfing or wave surfing. The base for the water sports facilities club 'De Jongens uit Schoorl' is located at the edge of this lake. This club organizes numerous recreational activities on this lagoon. Their base includes various public facilities such as showers, changing rooms and attributes for the water sports (ESRI, 2019). The circulation of water is dominated by the tidal flows, which guarantees a natural water exchange, and by water refreshment inputs coming from artificial inlets.

The lagoon in Camperduin has proven to be an attractive added value in recent years. The lagoon is part of the spatial quality and offers additional recreational opportunities. This is beneficial because the local economy of Camperduin and the umbrella municipality of Bergen is highly dependent on recreation and tourism. Maintaining the lagoon means preserving the recreational and tourist attraction of Camperduin and the preservation of the spatial quality. However, the lagoon only brings added value to the area if the preconditions of water quality are sufficient.

The lagoon is connected to the sea by a channel. In this way, water is supplied and discharged. Soon after opening in 2015, it turned out that the lagoon cannot sustain itself because the channel to the lagoon is quickly silting up. As a result, the lagoon does not refresh. This has a direct influence on water quality.

If necessary, the sandbank created by sedimentation will also be (partly) excavated at the beginning of the channel in the lagoon. The sand is deposited and levelled between the high and low water lines. The maintenance tasks of the ZSNH mainly contain dredging the channel from the lagoon to the North Sea before the start of the summer season. These dredging moments are preventive. In addition to the scheduled seasonal maintenance, the channel is being dredged when the water safety of the lagoon is below a certain level, as shown in table 1 (Jacobs, 2019).

Table 1 shows the dates on which the channel has been dredged, including the reasons why ZSNH decided to dredge the channel. There could be two reasons why the channel is being dredged: because the channel is not open anymore because it is silted up, or because the water quality is poor. In the table, when the motivation of dredging is 'unclear', the contractor did not have a clear reason in the report why the trench should be dug open (Jacobs, 2019).

Date of Dredging	Motivation of Dredging
07-04-2016	Start recreational season
12-06-2017 and 13-06-2017	Start recreational season (channel has been open in the winter, therefore earlier dredging wasn't needed)
28-06-2017 and 29-06-2017	Low water quality
09-04-2018	Start recreational season
10-07-2018 and 11-07-2018	Unclear
30-07-2018	Low water quality
24-04-2019	Start recreational season
05-07-2019	Unclear

Table 1: previous dredging moments of the lagoon including the motivation of dredging (Jacobs, 2019).

Sedimentation of the lagoon takes place all year round. Especially as a result of spraying and during the flooding of the lagoon via the tidal channel. Flora and fauna do not influence the level of sedimentation. Sedimentation does, however, affect flora and thus fauna. Sedimentation changes the contents of the lagoon and thus the water depth, water temperature and salinity. This in turn has consequences for the formation of algae and bacteria, which in turn leads to the attraction or otherwise of certain animals.

The municipality of Bergen has analyzed the users of the lagoon employing a survey. This survey was meant to investigate the opinion of these people on the lagoon. The survey was conducted in March 2020 and has been filled in by 2,691 people (Gemeente Bergen, 2020a).

First of all, the survey shows that the majority of the people surveyed are in favour of keeping the lagoon open (figure 6). This was probed by the question: "Are you for or against keeping the lagoon open?" on which 2.471 people responded. This implies that the majority is satisfied with the lagoon.

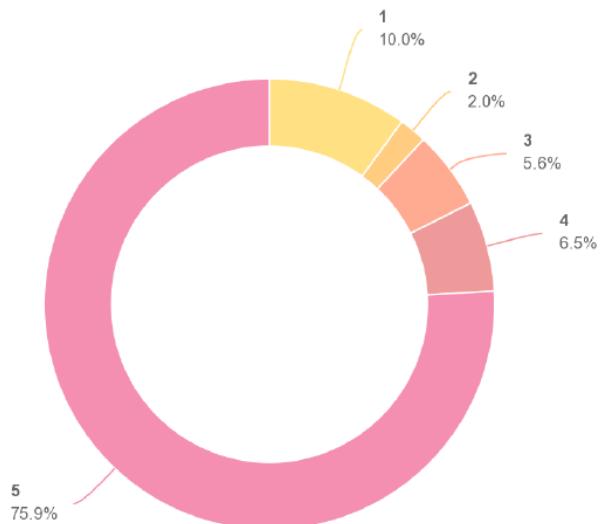


Figure 6: Results on the question: "Are you for or against keeping the lagoon open?" (on a scale from 1 to 5 where 1 is against and 5 is pro) (Gemeente Bergen, 2020a).

Another part of the survey investigated the opinion on ways to make the lagoon more attractive for the users. Eighteen point four per cent (18,4%) voted for extra possibilities for children's activities, 17,5% voted for extra benches, 15,9% voted for more watersport possibilities, 14,1% voted for extra sports facilities in general, 13,6% voted for more spots with shade and 10,7% opted for extra playground equipment. The remaining 10 % came up with other ideas for making the lagoon more attractive (Gemeente Bergen, 2020a).

2.2. Participatory Modelling

2.2.1. Stakeholder Analysis

Public involvement is becoming more and more important in environmental policy, as policymakers acknowledge the need to recognize the persons that are affected by the decisions in a project and actions they take, and the people that can influence their outcome, i.e. the stakeholders (Freeman, 1994).

Profiling stakeholders is an important part of stakeholder analysis. Often, the identification and selection of stakeholders are being done in an *ad hoc* manner. The risk of this approach is that important groups are being disregarded and neglected. Stakeholders can affect the way a project is carried out. On the other hand, stakeholders can be affected by the way a project is carried out. Therefore, it is crucial to analyze the involved stakeholders of a project in a proper way (Yang, 2014).

Reed (et al., 2009) defines stakeholder analysis as a process that comprises three principles. First, they argue that stakeholder analysis defines aspects of a social and natural phenomenon affected by a decision or actions. Second, stakeholder analysis identifies individuals, groups and organizations that are influenced by or can influence those parts of this social and natural phenomenon. At last, the purpose of stakeholder analysis is prioritizing these individuals, groups and organizations for involvement in the decision-making process (Reed et al., 2009)

In general, there are two ways of defining stakeholders. The first way is called empiricism and is – as the name suggests – based on former practices of people that were involved in a project. This method implies that parties have been involved in a certain project before. If this is not the case, the second method of identifying stakeholders will be suitable. This method is called rationalism and it contains including most of the potential stakeholders and formulating the relationship situations between the various stakeholders (Yang, 2014).

As part of the rationalism method, Reed (et al., 2009) proposes a stakeholder analysis typology. This methodology consists of three steps for recognizing stakeholders, classifying these stakeholders and exploring relationships between these stakeholders. These steps result in different stakeholder analysis methods. A schematic representation of these theoretical rationales, typologies and methods for stakeholder analysis is given in figure 7.

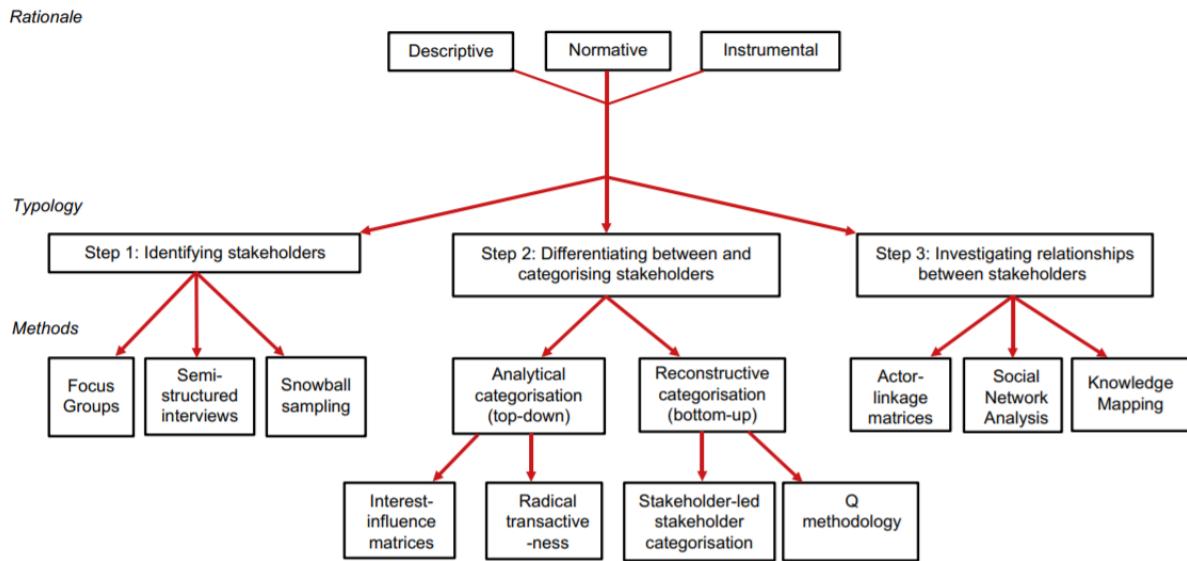


Figure 7: Schematic representation of rationale, typology and methods for stakeholder analysis (Reed et al., 2009)

As shown in figure 8, approaches to stakeholder analysis can be classified in different ways. These are a descriptive approach, a normative approach and an instrumental approach. Using a normative approach, stakeholder analysis is applied to justify the decisions that are made through the involvement of key stakeholders. Instrumental stakeholder analysis is a more pragmatic way of researching stakeholders to understand and influence stakeholders in different ways. A descriptive approach can be considered a precursor to the normative and instrumental approach since it is rarely used isolated because it merely describes the relationship between a stakeholder and the phenomenon under investigation. The most substantial distinction is the one between the normative and the instrumental approach (Donaldson and Preston, 1995, as cited in Reed et al., 2009).

These rationales are mainly used to justify the theoretical foundation for stakeholder analysis. The normative and instrumental approach is practised by using various methods that are used for the identification of stakeholders, differentiating between and categorizing stakeholders and investigating relationships between stakeholders. These methods can be applied with or without the active participation of the stakeholders. In case the researcher already has a lot of documented intimate information, stakeholder analysis can be conducted without the active participation of the stakeholders. When it is unclear which issues are most relevant for the research, active participation may be desirable.

As shown in figure 8, the first typology step for the application of a stakeholder analysis is identifying the stakeholders. The methods that are used to practice this step are focus groups, semi-structured interviews and snowball sampling. Profiling stakeholders is an interactive process, during which the number of stakeholders increases as the process continues (Reed et al., 2009). Each stakeholder that is included in the analysis has a share in the researched phenomenon. Nevertheless, it is difficult to find the most important stakeholders if the phenomenon is not clear. The problem that arises from this is that the stakeholders are identified in a top-down manner in which the researcher/analyst demonstrates their interests and biases, that might not suit the interests of the stakeholders.

The second step for the application of a stakeholder analysis is differentiating between and categorizing stakeholders. This step can be used to improve the stakeholder analysis. Two general approaches exist as a method to describe and categorize stakeholders. The first approach is a top-down approach and is called ‘analytical categorization’. This includes a set of methods in which categorization of involved stakeholders is performed by the researcher(s). Using this method, the stakeholder categorization is based on their observations of the situation that is being researched. One of the disadvantages of such analytical categorization is that less powerful groups are neglected because it tends to only identify the usual suspects (Reed et al., 2009). The second approach is a bottom-up approach and is called ‘reconstructive categorization’. Using this approach, categorizations and parameters are defined in consultation with the stakeholders so that the stakeholder profiling reflects their stakes more thoroughly.

The development of *power versus interest grid* is a method that is being used under the ‘analytical categorization’ approach. This *power versus interest grid* is being introduced by Eden and Ackermann (1998) and shown in figure 8. In the article by Reed (et al., 2009), this is called an interest-influence matrix. In such a matrix or grid, the selected stakeholders are being placed on a two-by-two matrix in which the vertical axis represents the degree of interest of the stakeholder in a project and the horizontal axis represents the degree of power of the stakeholder in the project.

This classification results in four types of stakeholders: **subjects** that have a lot of interest but little power, **key players** that have a lot of interest and a lot of power, **the crowd** that has little power and little interest and at last the **context setters** that have much power but little interest (Bryson, 2004).

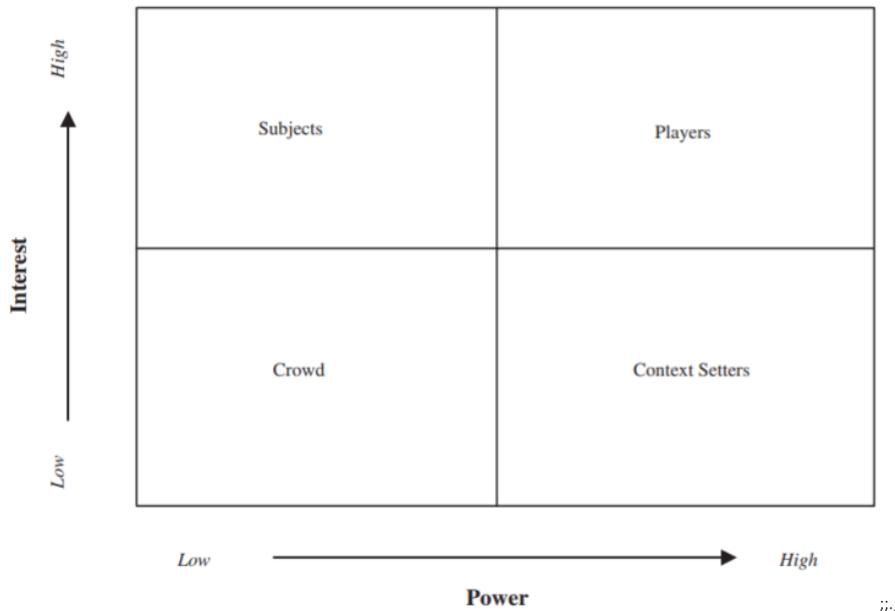


Figure 8: Power Versus Interest Grid (Eden and Ackermann 1998).

2.2.2. Cognitive maps

Cognitive mapping is a participatory modelling method that is used to collect data via experts in SES (socio-ecological system) projects where data is limited. With this data, different interests of stakeholders are investigated to simulate the impact of different interventions on the entire system (Mehryar, 2019). A cognitive map represents how an individual stakeholder considers a specific problem or a system. In other words, such a map is a visual picture of a stakeholder's mental model (Elsawah et al., 2015).

Cognitive maps are a type of models that are developed from qualitative data derived from stakeholder analysis and the perceptions of stakeholders via interviews. Cognitive maps are useful for detecting how variables in a system influence each other. These macro-level variables are for example human interventions, restrictions and use of an area. This results in determining the conditions of each action and the impact of each action on the attributes of the agents and the environment in the ABM.

The term 'cognitive map' is really old and is first introduced by Tolman (1948), but not to describe a problem related to decision making. The first who used this method for decision making was Axelrod (1976). Since then, the method of cognitive mapping is widely used for among others; strategic management, organizational management, marketing purposes and natural resource management. There are a lot of variances between different cognitive mapping approaches. For example, some models contain numerical information such as a given weight between different elements in the model. These weights can be numerical or linguistical, for example ascending from 'very low' to 'very high'. A similarity between all cognitive modelling approaches is that they are networks made up of nodes and arrows. These elements represent chains of argument in the format of means and ends (Elsawah et al., 2015). Ideally, the arguments in a cognitive map are represented as bi-polar statements, such as 'A rather than B'. Various cognitive maps can be combined and better understand by condensing them into one collective map (Elsawah et al., 2015).

2.3. Models

2.3.1. System Dynamics Modelling

Socio-ecological relationships between humans and ecosystems can be explained by making use of System Dynamics Modelling (SDM) (Papachristos, 2019; Martin and Schlüter, 2015).

SDM represent the aggregated system in the form of stocks and flows. Through this approach, the most important part is to illustrate the behaviour of a system. Parts of the behaviour of a system can be for example exponential growth through system-level structures like feedbacks (Martin and Schlüter, 2015).

System Dynamics Models were developed around two important aspects from systems theory Guerrero et al. (2016). Aggregated-level variables influence each other using feedback loops. Besides that, system behaviour is determined by the structure of a system. The dynamic behaviour of a system is usually represented by a set of equations and are analyzed with the tools of SDM. Examples of SDM tools are

stocks, flows and variables. Stocks embody the accumulated form of materials or information. Stocks are generated through inflows and outflows. Stocks are often formulated by integral equations and flows are often formulated by differential equations. The merge of these sets of equations describes the combined dynamics of the system. These conditions change continuously over time and depend on the previous condition of the system Guerrero et al. (2016).

The aim of using an SDM is to describe the stable states of a part of the system and identify how the structure of such a system affects the system behaviour. The way of representing the behaviour of a system is done by making a graphical representation of the main system-level interactions (Martin and Schlüter, 2015).

2.3.1. Agent-Based Models

Agent-based Modeling is a widely used approach for investigating complex adaptive systems, i.e., systems that are characterized by self-organization, emergence and adaptation (Levin, 1998, as cited in Martin & Schlüter, 2015).

The term agent-based modelling (ABM) refers to the use of computational methods to investigate processes and problems viewed as dynamic systems of interacting agents (De Smith et al., 2007). Simulation tools, such as a multi-agent-based modelling approach, can be useful to structure and better comprehend the relations between stakeholders in a project (Henesey et al., 2003). This approach has already been applied to other fields of policymaking and can be practised to assess the stakeholder relations by modelling and simulating the different stakeholders. It helps by making a dispersed model of a real-life system, where the agents perform the processes and tasks. The model becomes a multi-agent system (MAS) when there is more than one agent. This results in more complex problems, for example how the agents communicate with each other and how they work together with each other to achieve goals and accomplish tasks.

Agents operate based on pre-determined groups of rules of behaviour, that are based on ‘if-then’ questions. Agents can have recalls of their current and previous conditions and can be encoded to learn about their environment and the conditions of fellow agents (Nicholls et al., 2017). Gilbert (2008:5) defines agents as “either separate computer programs or, more commonly, distinct parts of a program that are used to represent social actors – individual people, organizations such as firms, or bodies such as nation-states”. The main characteristics of agents in an ABM are autonomy, pro-activity, coordination and communication. Agents are comparable to actors, which are described by Pahl-Wostel (2003) as ‘an individual or an aggregated social entity (collective actor) that can make autonomous decisions and act as a unit –e.g. a company or an association is a collective actor with overall accepted rules for collective choice and can thus be regarded as a single social entity’.

According to De Smith (et al., 2018), the development of an agent-based model starts with making a conceptual model. Basic queries, objectives, elements of the systems and outcomes of the model will be defined in the conceptual model. This conceptual model can be made by identifying and reviewing existing theories concerning the research objective that drive the development of the ABM. This results in the characteristics of the agents and the rules that actuate the behaviour of the agents (Nicholls et al., 2017).

The development of this conceptual model is important to prove that the model is feasible and useful. In this conceptual model, the limitations and scope of the model will also be defined. This is used to validate how the model will be an addition to already existing models in the same field.

The next step of creating an ABM is specifying the attributes of the agents and the rules by which they shall operate and the features of the environment in which the agents operate. If this is done properly, the model can be set up by initializing the simulation according to the predefined rules and behaviours of the agents and the characteristics of the environment. The set-up of the model is followed by executing the model by repeatedly running the simulation (Nicholls et al., 2017).

De Smith (et al., 2018) proposes a classification of agents types and environment types. This classification is as shown in figure 9.

		<i>Agent</i>	
		Designed	Analyzed
<i>Environment</i>	Designed	Model Description: Abstract Purpose/Intent: Discovery of new relationships; Existence proof Verification & Validation Strategy: Theoretical comparison; Replication Appropriate Development Tools: Easy to implement simulation/modeling system	Model Description: Experimental Purpose/Intent: Role-playing games among stakeholders; Laboratory experiments Verification & Validation Strategy: Repetitions; Adequacy of design Appropriate Development Tools: Flexible simulation/modeling systems with well-developed user interfaces
	Analyzed	Model Description: Historical Purpose/Intent: Explanation Verification & Validation Strategy: Qualitative: goodness of fit Appropriate Development Tools: Advanced simulation/modeling systems linked with GIS	Model Description: Empirical Purpose/Intent: Explanation; Projection; Scenario analysis Verification & Validation Strategy: Quantitative: goodness of fit Appropriate Development Tools: Low-level programming languages

Figure 9: Typology of different agent and environment types for an ABM (Berger and Parker, 2001).

According to Couclelis (2001), agents and their environment can either be *designed* or *analyzed*. Designed agents and environments are also called explanatory. In this case, the attributes and behaviours of agents signify circumstances for investigating specific hypotheses about general situations. Analyzed agents and environments are also called predictive and empirically grounded. These agents are meant to simulate real-world objects based on empirical data. Besides that, these agents are also based on assumptions that are accurate alternatives for observed objects and conditions. Not only agents can be either designed or analyzed, but also the environment in an ABM can be classified into one of these two typologies. A designed environment is provided with characteristics that are simplified to focus on specific agent attributes and an analyzed environment illustrates a real-world situation or real-world object (Couclelis, 2001).

The distinction between designed agents and analyzed agents on the one hand and designed environments and analyzed environments on the other hand is visualized in the matrix in figure 10. This matrix is created by De Smith (et al., 2018) and is adapted from Berger and Parker (2001). This overview of the possible agent/environment combinations includes a short description of the model, the purpose and aim of the model, a possible verification and validation strategy and appropriate development tools for the model.

After conceptualizing the model by making decisions for the ABM, the model needs to be formalized. This process of formalization includes a specification that can be translated into a computer program for a computer simulation. According to De Smith (et al., 2018) is of great importance that the model will be complete and coherent. This can be achieved by being detailed and accurate about what the identified theory means related to the object of interest.

2.3.1. Hybrid integration of SDM and ABM

Wallentin and Neuwirth (2017) state that Agent-Based Models and System Dynamics models can be complementary to each other. However, there are some different modelling approaches to integrate these two. Depending on the nature of the system that is being investigated, the choice for a certain integrated modelling approach can be made. Jo et al. (2015) have investigated a public sector investment project. They consider this project as a macro-level system that includes micro-level individuals. To be able to invest in such public investment projects, they combined the macro-level System Dynamics Model with a micro-level Agent-Based Model.

Martin and Schlüter (2015) have developed a framework that combines System Dynamics and Agent-Based Modelling to analyze social-ecological interactions. A schematic overview of this method is presented in figure 10. The steps will be explained below the figure.

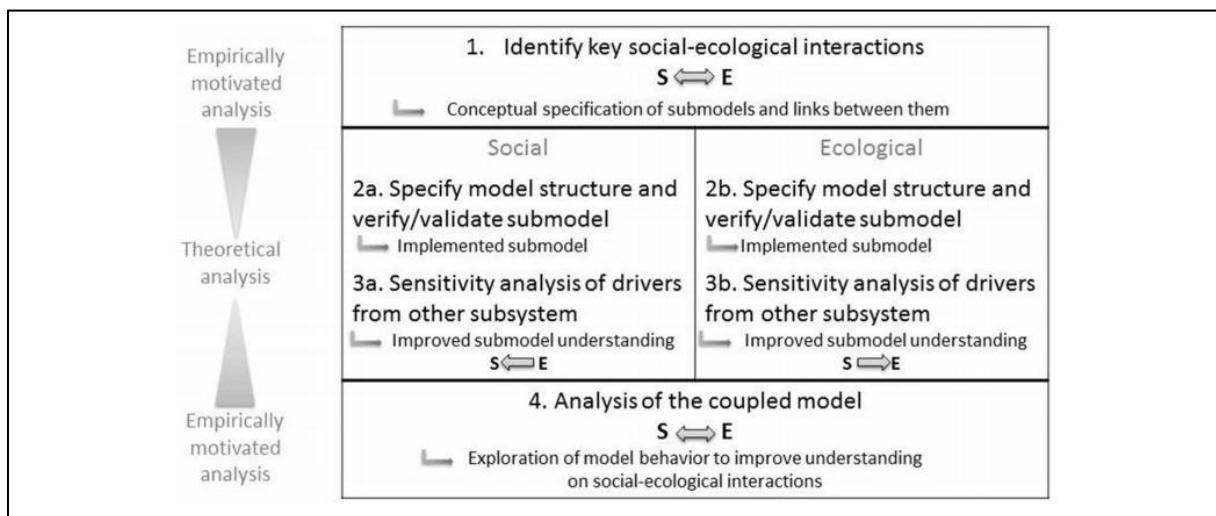


Figure 10: Main steps for developing and analyzing a hybrid model for an SES (socio-ecological system) according to Martin and Schlüter (2015).

The method first starts with conceptually identifying the key socio-ecological interactions between the two sub-models. For the research on the lagoon area, the main interaction between the two models consists of the tourists that are represented by agents in the ABM. As stated before, the output of one

model is used as an input for the other model and vice versa. This is the only connection between the two models.

As stated in the figure, the second and third step of the methodology is for each model separately. This also includes the development of a new model or the adaptation of an existing model. For this research, two completely new models are developed. The specification of the model structure for the SDM is explained in section 3.3.1. and the specification of the model structure for the ABM is explained in section 3.3.2. For both models, sensitivity analysis can be performed to improve the understanding of the model and to calibrate the model. This sensitivity analysis is needed to test if both models can be driven by the output expected from the other sub-model (Martin and Schlüter, 2015).

Step two and three of this approach are performed without integrating feedback between the models. The purpose of these steps is to gain better insight into one-sided effects. Then, through step 4, the coupled model is analysed to get insight into the interaction in the socio-ecological system.

2.4. ICTAM-method

Elsawah et al. (2015) propose a method that intersects Cognitive Mapping and Agent-Based Modelling into a Hybrid Modelling Practice.

This method is called ICTAM, which is an acronym for the key methods used throughout the process: Interviews, Cognitive Mapping, Time-Sequence UML, All-Encompassing Framework and Numerical Agent-Based Models. A schematic overview of the ICTAM methodology is given in figure 11. It is important to mention that the process is cyclic. This means that at any step, the researcher can go back to the previous steps to correct inconsistencies in past data analysis.

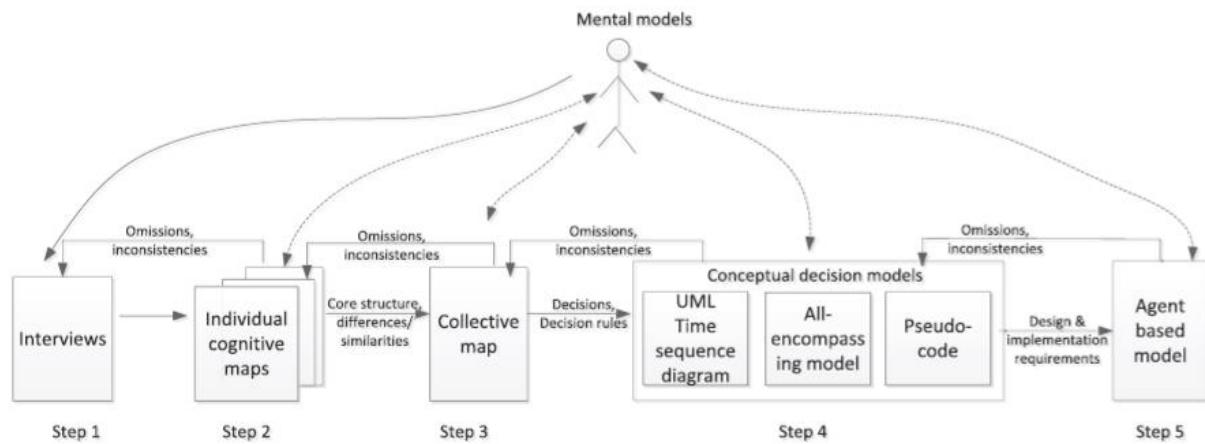


Figure 11: Schematic overview of the ICTAM-methodology (Elsawah et al., 2015).

However the methodology consists of five key methods that are used throughout the process and that comprise the acronym ICTAM, the undertaken steps are different. This is also shown in figure 12. These steps will be explained further below.

2.4.1. Step 1: Interviews

The first step of this method is interviewing the stakeholders. This step aims to understand the personal constructs of stakeholders. Semi-structured interviews are a useful technique for collecting information about how people think, interpret information and make judgements (Elsawah et al., 2015). As preparation for the interview, the researcher sets up a list of open questions. These questions will be used to stimulate the interview rather than to structure lead the interview. The sample of interviewees is selected to explore diversity rather than achieve statistical significance. More literature review about Stakeholder Analysis and semi-structured interviews can be found in section 2.6: Stakeholder Analysis.

2.4.2. Step 2: Individual Cognitive Maps

The second step of the ICTAM-method is making a cognitive map of their opinions and decisions, derived from the interviews. This can be done *online*, where the researcher creates a cognitive map ‘on the go’. This can also be done *offline*, where the researcher creates a map from a transcript of the recorded interviews after the interview is conducted. The project around the lagoon at the Hondsbossche Dunes can be considered a complex socio-ecological system. This is because it contains multiple actors that all employ different strategies and decisions to satisfy their goals and interests. Besides that, it is a multi-scale system, in which the performance of the system is determined by collective outcomes of decisions made by the different stakeholders. Because it can be considered a complex socio-ecological system, cognitive maps can be a useful tool to represent stakeholders in an ABM (Elsawah et al., 2015).

2.4.3. Step 3: Collective Map

Then, as part of step 3, all individual maps are assembled into one collective map. Goals and core concepts are identified. Goals are placed at the top of the collective map and have no outgoing links. Core concepts show a relationship between a cluster of nodes. Core concepts can be recognized in two ways: (1) content-based concepts are core concepts because of the meaning of the concept and its relevance to decision making and (2) structure-based concepts are core concepts because of their relationships to other concepts. In a collective map, there are also *source nodes* that don’t have incoming arrows. These are important in the creation of an ABM because they represent the contextual and internal motivations for the actions of the stakeholders.

2.4.4. Step 4: Conceptual Design Models

The fourth and fifth step of this model is about the transformation from cognitive maps to an ABM. In step four, the collective map is implemented to create a sequence of conceptual decision models. These are transition objects between conceptual and numerical modelling. This step is sub-divided into three sub-steps. The first sub-step comprises the translation of the information from the collective map to develop a structure of the decision-making process of the agents, as presented by a UML. A UML-diagram supports the development and description of an Agent-Based Model. UML is a typical technique for presenting the structure of agents and the flow of processes in a model (Elsawah et al., 2015).

This decision-making process describes information about (1) types of decisions and actions taken (from the core concepts) (2) who makes a decision (the content of the concepts) (3) factors that influence decisions (chain of nodes from source nodes to the core concepts) (4) information feedback (from the feedback analysis) (Elsawah et al., 2015).

The second sub-step of step 4 is to develop a conceptual model to translate all qualitative information into an ABM framework. Through this step (4.2), it will be identified what models and data are required to implement these functions. In the last sub-step of step 4 - step 4.3 – a pseudo-code representation can be created to identify how the defining parts of the conceptual model will be modelled.

2.4.5. Step 5: Agent-Based Modelling

The last step of the Elsawah et al. (2015) proposed method is creating the Agent-Based Model. In most cases, additional information derived from literature reviews, interviews or expert knowledge is needed to define thresholds and functions for the agents and their environment.

More theoretical background on Agent-Based Modelling is provided in section 2.3.1. Agent-Based Models.

3. Methodology

3.1. General methodology

The general methodology of this model is adopted from the ICTAM-methodology as proposed by Elsawah et al. (2015). More theoretical information for this method is described in section 2.4.

The methodology structure of this research will therefore follow the order of the five steps of the methodology as proposed by Elsawah et al. (2015). This research practices the ICTAM-method to translate the individual behaviour of stakeholders into a numeric simulation model to bridge the gap between stakeholder analysis and Agent-Based Modelling.

However, for this research, the steps of the ICTAM-method as developed by Elsawah et al. (2015) are somewhat adjusted. The first step, stakeholder analysis will be performed like Elsawah et al. (2015) proposed. This step is supported by methods of stakeholder analysis from Reed (et al., 2009).

In the second and third step of the ICTAM-method, individual cognitive maps and collective maps are merged into one step. For each stakeholder that is considered important according to the stakeholder analysis, an individual cognitive map is made. The core structures, differences and similarities of these individual cognitive maps are summarized in one collective cognitive map.

The fourth step of the ICTAM-method is the development of the Conceptual Models. The purpose of this step is to develop an all-encompassing framework to transfer all qualitative information to an ABM framework. This is performed by filling in part of the ODD-protocol (Grimm et al., 2010) and developing a time-sequence UML.

As stated before, this research differs from the ICTAM-method because this research has an addition of an extra step between step three and four. Instead of directly creating the spatial Agent-Based Model, a non-spatial System Dynamics Model is developed first. The SDM represents the situation at the lagoon on the macro-level, while the ABM represents the situation at the lagoon on the micro-level. After this, the elements of the two models, System Dynamics Model and Agent-Based Model are merged into one hybrid model. The creation of the two separate models (the SDM and the ABM) is explained in step 3.5. System Dynamics Model. The integrated hybrid model will be explained in step 3.6. Integrated Hybrid Model.

Both the SDM and the Integrated model will be run several times with different values for the variables. In this way, the effects of different maintenance alternatives can be investigated.

A schematic overview of the general methodology for this research is given in figure 12.

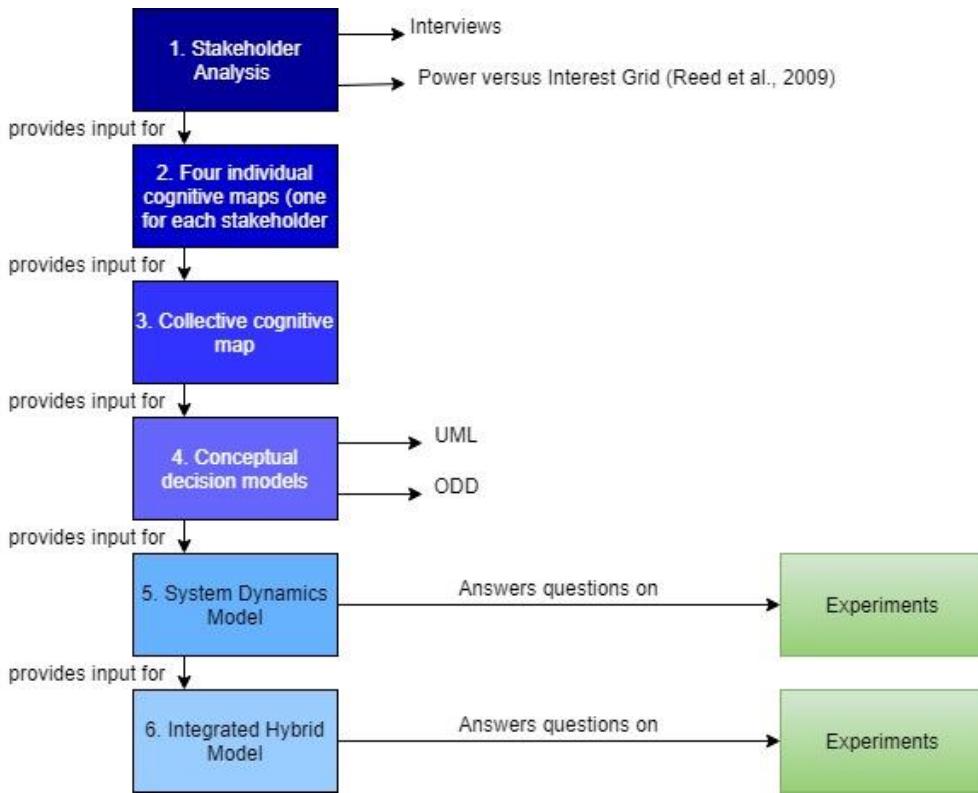


Figure 12: Schematic representation of the methodology (Alblas, 2020).

3.2. Stakeholder Analysis

The first step for the application of a stakeholder analysis is identifying the stakeholders. The project around the lagoon in Camperduin is a project with internal and external actors each with their interests and objectives. According to Reed (et al., 2009), stakeholder analysis can be conducted with or without the active participation of the stakeholders. In the case of this research, in the first instance, the relevant issues to the project were unclear and there was not enough evident documentation of the stakeholders participating in the project. Therefore, active participation of the stakeholders in the stakeholder analysis is needed.

The first practice of observing the socio-ecologic system and its stakeholders is reading articles, policy documents and other readings to figure out what parties play a role in the area. A selection of the items that have been consulted to observe the situations is as follows:

1. Arcadis (2019) Hondsbossche and Pettemerzeewering Coastal Reinforcement Plan. Webpage. Retrieved from http://www.landscape-architects.nl/en/projects/kustversterkingsplan_hondsbossche_pettemerzeewering on 29th November 2019.
2. Bodde, W., Huiskes, R., IJff, S., Kramer, H., Kuiters, L., Lagendijk, G., Leenders, J., Ouwerkerk, S., Scholl, M., Smit, M., Smits, N., Stuurman, R., Valk, B., Van Der, Verheijen, A., Vries, D., De, Wegman, C. (2019) *Innovatieproject Hondsbossche Duinen – Eindrapportage Definitief 0.1*. ECOSHAPE def 0.1 / Wageningen Marine Research Rapport nr.C002/19. Dordrecht: Ecoshape.

3. Hollands Noorderkwartier Water Board (2013) *Zwakke Schakels Noord-Holland Plan voor Mitigerende Natuurmaatregelen en Aanzet tot Integrale Monitoringsmaatregelen*. Heerhugowaard: Hollands Noorderkwartier Water Board.
4. De Jongens uit Schoorl (2020) Lagune Paviljoen – het strandpaviljoen voor watersporten en groepsuitjes. <https://dijus.nl/lagune-paviljoen/647/> (retrieved 10th March 2020).
5. Jacobs, J. (2019). *Prediction of the closure of an artificial lagoon at the Dutch Coast: A case study on the lagoon at the Hondsbossche Dunes*. Master Thesis in Civil Engineering. Delft: TU Delft.
6. Jonker, S. IJ., and Janssen, G. M. (2007). *Strandlopers - Inventarisatie van strandgebruik aan de Noordzeekust en de relatie met natuurwetgeving*. Rapport RIKZ2007.001. Rijkswaterstaat.
7. Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Rijksinstituut voor Kust en Zee (2002) *Naar Integraal Kustbeleid: Beleidsagenda voor de Kust*. Den Haag: RWS, RIKS.
8. Wittebrood, M., de Vries, S., Goessen, P., & Aarninkhof, S. (2018). Aeolian sediment transport at a man-made dune system; building with nature at the hondsbossche dunes. *Coastal Engineering Proceedings*, (36), 83-83.

From observing the situation by reading articles and policy documents, the most important stakeholders arose. Then, these stakeholders were interviewed to gain insight into their interests and level of power. The interviews were semi-structured, with open-ended and freestyle questions. During the unstructured conversations, new stakeholders were presented by the interlocutors. So, also the snowball sampling technique is used to identify the stakeholders.

The second step of stakeholder profiling according to the approach of Reed (et al., 2009) is differentiating between and categorizing stakeholders. The so-called top-down and analytical categorization approach is being used for this research. This includes a set of methods in which categorization of involved stakeholders is performed by the researcher(s). Through this method, the stakeholder categorization is based on the analyst's observations of the situation that is being researched.

The proposed method is used to categorize the identified stakeholders in the power versus interest grid as introduced by Eden and Ackerman (1998). The advantage of this method is that the method makes it possible to prioritize stakeholders for inclusion and clarifies the power dynamics.

These methods can involve a large number of stakeholders, the difficulty of engaging meaningfully with them means that in many cases, not everyone identified as a stakeholder can be involved in all aspects of the process. To avoid this, the top-down approach of categorizing stakeholders has been chosen for this research.

The results of this step are described in section 5.1.1. Stakeholder Profiling.

3.3. Cognitive Maps

Step two of the ICTAM-method – individual maps - is considered the second part of this research. Developing cognitive maps can improve the outcomes of modelling efforts compared to approaches involving modellers alone (Gray et al., 2015a). The theoretical background of this method is introduced in section 2.2.2. of the theoretical framework, cognitive maps.

The first step of creating cognitive maps (CM) is conducting interviews to define the main structure of the to be created cognitive map. The results of the interviews will be translated into cognitive maps. For the development of the cognitive maps, the methodology of Elsawah et al. (2015) is being used. An example of a cognitive map of a participant in the research of Elsawah et ah. (2015) is given in figure 13.

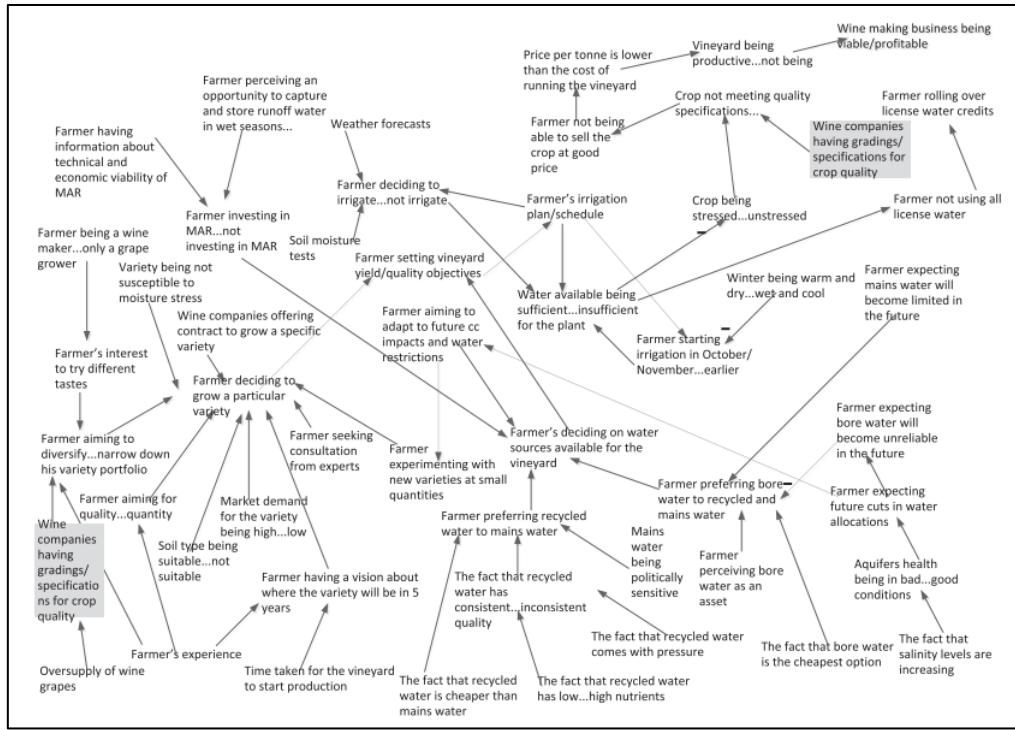


Figure 13: An example of a participant's cognitive map of the research of Elsawah et al. (2015)

For this research, the cognitive maps are developed in an *offline* manner, where the maps were developed from the transcripts of the recorded interviews (Elsawah et al., 2015). The output of the stakeholder analysis and the given summary of each stakeholder is used as a starting point for mapping. The transcripts from the interviews have been studied on several topics; goals, activities, decisions, issues of concern, external drivers and suggested management options. However, the cognitive maps are not only based on knowledge obtained from the interviews. Knowledge obtained by secondary literature, governmental reports and scientific literature is also included in the CM.

As stated before, cognitive modelling approaches can include numerical information and given weights between the elements, but not every approach makes use of these aspects. For this research, the method as used by Elsawah et al. (2015) is reproduced. Since they do not make use of numerical information, the models for this research are also limited to a network of nodes and arrows. The results of these maps are shown in section 5.1.2. Individual Cognitive Maps. The core structures, differences and similarities that arise from the individual cognitive maps are summarized in one collective cognitive map. The results of this are provided in chapter 5.1.3. Collective Cognitive Map.

3.4. Conceptual Design Models

In step three, the collective map from the previous step will be translated into a sequence of conceptual decision models. These conceptual models are the intermediate step between conceptual and numerical modelling. They are used to create more implementation-based delineations of the decision-making process. As stated before, the system at the lagoon at the Hondsbossche Dunes will first be represented on the macro-level through the development of a System Dynamics Model. After that, the system will be represented on a micro-level through the development of an Agent-Based Model. To be able to do experiments and answer the research question(s), the two models will be integrated into one hybrid model.

3.5. System Dynamics Model

As part of this research, the output of the previous steps will be used to create a System Dynamics Model (SDM). As stated before, this step is not included in the ICTAM-method as proposed by Elsawah et al. (2015) but will be included as an extra step in this research. This step is necessary to translate the non-numerical quantitative outputs from the stakeholder analysis to a numerical, spatial model, such as an ABM. The intermediate step is a non-spatial System Dynamics Model. The purpose of this step is to capture the interactions between the stakeholders and the system. The theoretical foundation for this step is provided in section 2.3.1. System Dynamic.

The System Dynamics Model represents the socio-economic system of the artificial lagoon at Camperduin on a macro-level where the dynamics between the visiting tourists, the profit for the municipality and the quality of the lagoon are computed. The quality of the lagoon is a driver for the visiting tourists, if the quality is low, lesser tourists will visit the area. This affects the incoming money flow for the municipality. Dredging the lagoon will improve the quality because it ensures a flow of freshwater from the North Sea. If the water quality is sufficient, more tourists will visit the area and this generates a money flow for the municipality. However, dredging also costs money. All these elements are related to each other. The way one element affects another element will be examined by using the System Dynamics Model. The model has been run at different times with different values for variables to examine the results of the different maintenance strategies. The elaboration of this is given in section 5.2.1. Model Development – System Dynamics Model.

The SDM is developed using the modelling program Netlogo 6.0.4 (Wilensky, 2018). According to the NetLogo User Manual, NetLogo is a programmable modelling environment for simulating natural and social phenomena. This form of computer-based modelling is suited for complex systems developing over time (Wilensky, 2018). The elaboration of this step will be provided in section 5.4.

3.6. Integrated Hybrid Model

The System Dynamics Model that is developed in this research simulates the internal process of the socio-ecologic system of the lagoon at Camperduin, while the interaction between agents is modelled via an agent-based approach. In the hybrid integrated model, the process of individual agents is modelled and the ABM models show how the agents interact with each other and with the environment.

The tourists that visit the beach are considered the agents. The agents enter the area of the lagoon at Camperduin and their satisfaction with the location is computed. The number of satisfied tourists determines how many tourists will re-visit the beach again. The specific details of the agents/tourist will be given in chapter 5. The results of the different maintenance strategies will again be examined by this model.

For the integration of the two models, the methodology of developing a hybrid model as proposed by Martin and Schlüter (2015) will be used. A schematic overview of this methodology is given in figure 13 of chapter 2.3.1. of the theoretical framework section.

4. Data

4.1. Visitors

According to a study by Jonker and Janssen (2007), approximately 100.000 people visit the beach of Camperduin annually. On average, this is $(100.000 / 365) = 274$ people a day.

However, it can also be assumed that there are more visitors in summer than in winter. Therefore, a calculation has been made based on other data to define a factor that indicates how many visitors there are per season. The data that has been used is derived from Centraal Bureau Voor de Statistiek (CBS) and contains information about the average number of day trips in the Netherlands that included sunbathing and swimming, categorized by season

The data from Jonker and Janssen (2007) is data from 2004 when the beach area in Camperduin had not undergone the reinforcement yet. It can be assumed that more people visit the beach each day/year due to the improvements in the area since 2015. However, this data was not available. The number of 274 tourists that visit the beach each day is the most recent number of beach visitors and therefore it has been chosen to stick to this number.

The factor that indicates the number of day trips per season based on the annual average number of day trips is calculated by dividing the average number of day trips per season by the average number of day trips annually.

The results are shown in Table 2.

	The average number of day trips (* 1.000)	Calculated seasonal factor
Annual	113	0
Winter	80	0.7
Spring	127	1.1
Summer	160	1.4
Autumn	85	0.8

Table 2: Average daytrips in the Netherlands, categorized by season (Centraal Bureau voor de Statistiek, 2016).

This data can be used to make an indication of the average number of visitors at the beach of Camperduin per season. As stated before, Jonker and Janssen (2007) claim that 100.000 people visit the beach of Camperduin annually. Taking into account the differences in visitors per season by using the calculated factor has resulted in an average number of visitors per season. This information is given in table 3.

An average number of visitors per day without taking differences in seasons into account.			The average number of visitors with taking the differences in season into account.
Winter	274		192
Spring	274		301
Summer	274		384
Autumn	274		219

Table 3: Average number of visitors at the beach of Camperduin per day, categorized by season (Jonker and Janssen, 2007 and Alblas, 2020).

4.2. Estimated costs

To estimate the profit for the municipality for the different maintenance strategies, it is needed to get insight into the costs for the municipality. These costs are twofold: the municipality has to pay for the lifeguard station to keep the area safe and the municipality has to pay for the dredging activity if it takes place. The explanation of the two cost items is given in this section.

Figure 14 below shows that there are five lifeguard stations in the area of the municipality of Bergen. All lifeguard stations together have an estimated cost of € 30.000,- a year (Gemeente Bergen, 2016). On average, one lifeguard station costs € 6.000,- a year



Figure 14: Overview of the lifeguard stations in the municipality of Bergen (Gemeente Bergen, 2020b).

The costs of the maintenance of the lagoon are estimated by Rijkswaterstaat. The total estimated costs for the maintenance of the lagoon are € 54.168,- per year. This includes estimated costs for digging the tidal channel (€ 11.198,-), maintaining size and water depth (€ 19.375,-) and sampling water quality (€ 23.595,-). This is shown by a document named 'Estimate maintenance costs lagoon', derived via personal communication with Rijkswaterstaat.

These costs will be shared by the municipality of Bergen and the entrepreneurs in the area. The entrepreneurs have pledged to contribute €10.000,- per year. So, the municipality has to pay the remaining amount, namely €44.186,- per year.

4.3. Estimated benefits

The stakeholder analysis and the interviews showed that many economic benefits derive from the presence of the lagoon in Camperduin. However, these benefits are mostly indirect and can not easily be measured in exact amounts of money. Therefore, it has been decided to focus on the revenues that will directly be derived from the tourists that visit the beach at Camperduin.

No doubt, the municipality will economically benefit more from the tourists visiting the area than only the revenues derived from the tourist tax. For example, it is assumed that tourists also buy food and other goods at the local stores. The municipality also benefits indirectly from these expenses, but it is impossible to determine these incomes. Therefore, it has been decided to only include direct incomes, namely the tourist tax.

According to an analysis of bungalowparkoverzicht.nl (2020), the tourist tax in the municipality of Bergen amounted to €1.85,- per person per night in 2020. This amount of money is directly paid to the municipality.

According to Arcadis (2013), it was expected that only a part of the visitors at the beach of Camperduin will stay overnight. They assume that most recreants will leave the area at the end of the day. They are considered day-recreants. That means that they will also pay no tourist tax. For this research, it is decided to state that 50% of the visiting tourists pay the tax to the municipality.

4.4. Creation of spatial dataset with GIS

4.4.1. Landuse map

The base for the spatial dataset is derived from AHN (Actueel Hoogtebestand Nederland). The AHN is the digital elevation dataset for the whole of the Netherlands. It contains detailed and precise elevation data with an average of eight elevation measurements per square meters (AHN, 2020). For this research, the most recent version of the AHN dataset – AHN3 – is used. This is downloaded as open-source data in GeoTIFF format as a 0.5-meter raster DTM (Digital Terrain Model).

The whole AHN dataset covers a large area and for this research, only a spatial dataset of the area around the lagoon is needed. Therefore, a new, empty polygon is created that only covers the lagoon and the area around it. The area around the lagoon, derived from the AHN dataset is clipped from this empty polygon by using the ‘Clip (data management) tool’ in ArcMap 10.6.1. The output is a raster dataset of the area around the lagoon where each pixel is assigned with a value that indicates the elevation. The resulting raster file is shown in figure 15.



Figure 15: Cutout from the AHN3 dataset that covers the area around the lagoon at Camperduin (Alblas, 2020).

Since the file will be only used in NetLogo as a simulation of the real world, it was not necessary to assign similar coordinates of the real-world area to the file.

The AHN3 DTM is intended as a ground-level dataset, where all points classified as ‘ground level’ have been resampled to a grid-based on a squared IDW (inverse distance weighting) method. Points classified in a different class (such as water) are not used in the resampling. Therefore, the lagoon (water) could not be assigned as a water body in the AHN.

However, for this research, it is important to determine the location of the lagoon and the surrounding beach. For this step, the clip from AHN3 has been reclassified with the ‘Reclassify (Spatial Analyst)’ tool in ArcMap. This classification is manually carried out with three new classes. Identifying the pixels of the grid learns that the highest point is around 30 meter. The highest point is assigned as ‘dune area’. The dune area starts at 3 meters. All values below 3.5 meter are assigned as beach area around the lagoon. The new, reclassified values of the spatial dataset are as given in table 4. The resulting map with the three classes is shown in figure 16.

Finally, this raster is converted to a file in ASCII-format to be able to load it into the NetLogo environment.

Old values	New values	Meaning of values
0.55 - 5	1	Beach
5 - 23.3	2	Dunes (not allowed for tourists to perch)
NoData	3	Lagoon

Table 4: Values of reclassification of AHN3 (Alblas, 2020).



Figure 16: Cutout from the AHN3 after reclassification in three classes where blue = lagoon, pale yellow = beach area and dark yellow = dunes (Alblas, 2020).

4.4.2. Location map

It is the intention to only locate the tourists in the NetLogo environment at the beach area around the lagoon. That is because it is being assumed that the tourists that perch at the other part of the beach, will recreate in the North Sea rather than in the lagoon. These tourists should not be included in the simulation model because they are not considered visitors of the lagoon but visitors of the North Sea. Therefore, a second spatial dataset needs to be imported into NetLogo that determines where the turtles can perch.

A new empty polygon is created that only covers the beach area around the lagoon. This polygon determines where the tourists will be located. With the 'Extract by Mask (Spatial Analyst) tool, a cut-out from the classified raster is made. This cut out does only contain the middle of the raster, with the lagoon and the beach area around it. This results in a Boolean raster with two values: 0 (lagoon) and 1 (beach area around the lagoon). The resulting map is shown in figure 17, where the green area is assigned as the area where the tourists can locate themselves. The cutout from AHN3 is used as background to show where this area is located relative to the lagoon.

This raster file is also converted to a file in ASCII-format so that it can also be loaded into the NetLogo environment.

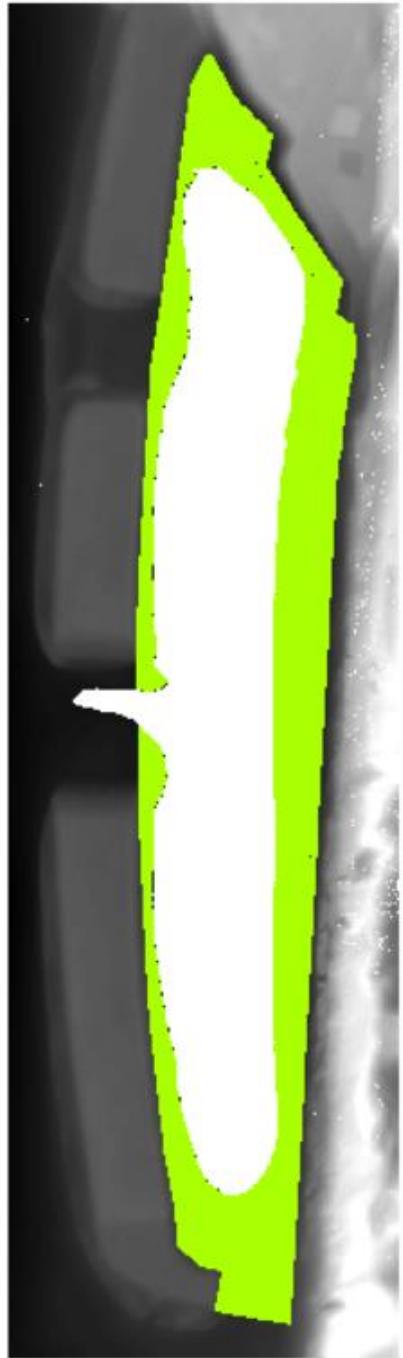


Figure 17: Beach area where the tourists can locate themselves depicted in green (Alblas, 2020).

4.4.3. Optimal location map

It is being assumed that the tourists that recreate around the lagoon are looking for the most optimal location. The most optimal location is the location that is close to the lagoon, close to the sports facilities club (DJUS) and close to the entrance. To determine where the most optimal location is, a new raster file is created where the value of every pixel indicates how close the location is to the three destinations.

First, three new shapefiles are created in GIS. The first shapefile is a polygon shapefile of the location of the lagoon, the second shapefile is a point shapefile of the location of the sports facilities and the third shapefile is a point shapefile with the location of the entrance of the beach. The three shapefiles with their three features with the AHN3 as background are shown in figure 18. The area depicted in blue is the lagoon, the magenta dot represents the sports facilities club and the green dot represents the entrance.

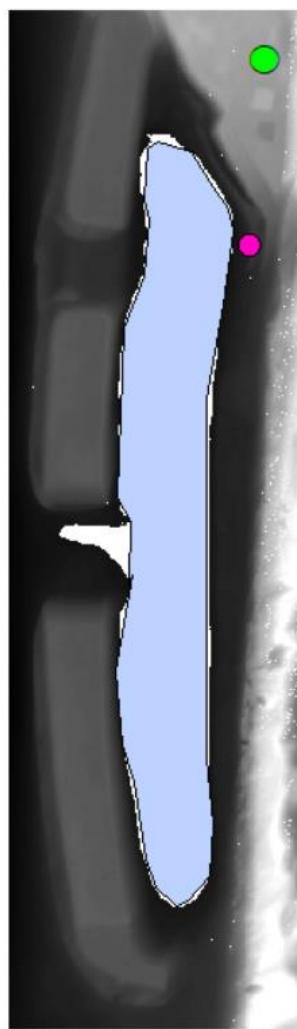


Figure 18: Location of the three elements, blue = lagoon, magenta = sports facilities club and green = entrance (Alblas, 2021).

The Euclidean distance from each cell to one of the elements is calculated with the ‘Euclidean distance (Spatial Analyst)’ tool in ArcMap. This resulted in three raster files, one where the value of every cell indicates the distance to the lagoon, one where the value of every cell indicates the distance to the sports facilities club and one where the value of every cell indicates the distance to the entrance. The resulting raster files are as given below in the figures 19a, 19b and 19c.



Figure 19. Euclidean distance to the lagoon (19a), sports facilities club (19b) and entrance (19c) (Alblas, 2021).

To determine for each cell the most optimal location, a new raster is created where the values of the Euclidean distance to each source are added to each other. This resulted in a new raster where the lower the value of a cell, the more optimal the location at the beach is in terms of proximity to the lagoon, the sports facilities club and the entrance. This resulting raster file is reclassified with the ‘Reclassify (Spatial Analyst) tool in ArcMap to divide the beach into three parts: the part with the most optimal location, the part with a lesser optimal location and the part with the lowest optimal locations. The resulting map is shown in figure 20, where the lighter the blue, the more optimal the location is.

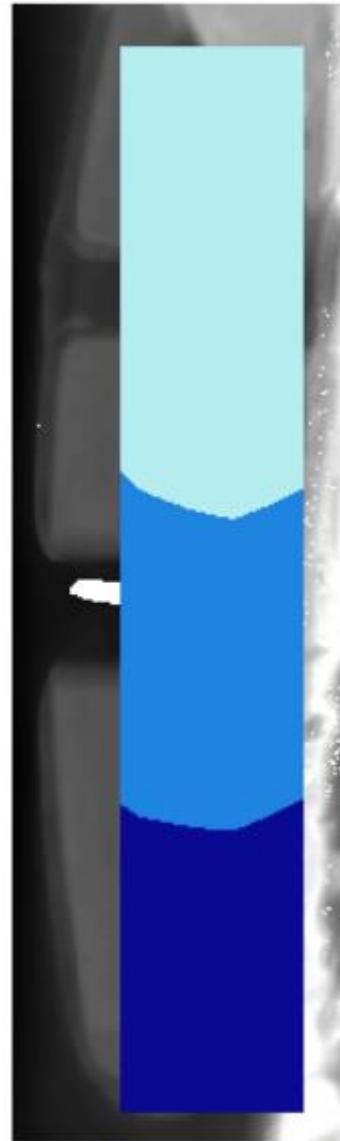


Figure 20: Division of the beach area around the lagoon in areas of optimal location regarding the proximity to the lagoon, the water sports facilities and the entrance (Alblas, 2021).

5. Results

5.1. Stakeholder Analysis

5.1.1. Stakeholder profiling

As stated in the literature section, profiling stakeholders is an iterative process, during which the number of stakeholders increases as the process endures. At first, these stakeholders have globally been identified by reading online documents about the project. For this research, unstructured conversations with a few stakeholders have been held. This started with an informal and unstructured conversation with Petra Goessen and Lars Fortuijn (employees at the Hollands Noorderkwartier Water Board), Willem Taal (employee De BUCH) and Gerrit van Terwisga (employee at Rijkswaterstaat). After defining the most important stakeholders, more structured interviews have been held with the most relevant stakeholders.

This has resulted in the identification of the following four stakeholders and stakeholder groups:

- Municipality of Bergen (N-H).
- Hollands Noorderkwartier Water Board (HHNK)
- Rijkswaterstaat (Dutch Ministry of Infrastructure and Water Management)
- De Jongens uit Schoorl (Water Sports Facilities)

As described in the theoretical framework and methodology section, the second step of stakeholder profiling is differentiating between and categorizing the stakeholders. The information that emerged from the semi-structured interviews with the stakeholders is used as input for this step of the Stakeholder Analysis approach. Based on this, the interests and power of the various stakeholders will be detected and visualized in a *power versus interest grid* as introduced by Eden and Ackerman (1998).

The main interests and characteristics of the different stakeholders will be summarized below.

1. Rijkswaterstaat (Dutch Ministry of Infrastructure and Water Management) – Harold Hansen

Rijkswaterstaat can be considered ***the crowd***. RWS was the initiator of the project of the reinforcement of the Hondsbossche and Pettemer Zeewering, and thus the construction of the lagoon. The main task of Rijkswaterstaat is maintaining water safety for the Netherlands. They are in favour of keeping the lagoon because they see it as an added value for the area. However, the lagoon does not contribute to water safety so in that respect, it does not matter to RWS if the lagoon will be open or not. Therefore, RWS does not have a lot of interest. They don't have to pay money for the maintenance of the lagoon so they don't have much power either.

2. Hollands Noorderkwartier Water Board (HHNK) – Petra Goessen

Hollands Noorderkwartier Water Board can also be considered ***the crowd***. The main task of HHNK is maintaining water safety for the Netherlands. They are in favour of keeping the lagoon because they

see it as an added value for the area. However, the lagoon does not contribute to water safety so in that respect, it does not matter to HHNK if the lagoon will be open or not. Therefore, HHNK does not have a lot of interest in the project. However, the interview with Petra Goessen (an employee of HHNK) has shown that in general, HHNK is in favour of keeping the lagoon open.

They don't have to pay money for the maintenance of the lagoon so they don't have much power either. The role they play in the project around the lagoon is advisory.

3. Municipality of Bergen (N-H) – Willem Taal

The municipality of Bergen is in favour of keeping the lagoon open because they see the lagoon as a valuable addition to the area. It attracts a lot of visitors which, in their turn, generate a lot of money for the local government. Besides that, the image of the area and the surrounding towns such as Camperduin, Groet and Schoorl will be positively affected by the presence of the lagoon. When the contract of the maintenance of the lagoon with the constructor (Van Oord/Boskalis) ends, the municipality has the responsibility for the lagoon. They have to perform the maintenance themselves, or they have to outsource these tasks again. Whatever the decision will be, if the lagoon remains open, the municipality has to pay for the costs. The municipality decides if the lagoon remains open or not. That makes that they have a lot of power in this project, but also a lot of interest because for the municipality it is of great importance that the area around the lagoon is astutely valued by the visitors. According to the *power versus interest grid* as introduced by Eden and Ackermann (1998), they are the **players** in this project.

4. De Jongens uit Schoorl (DJUS) – Richard Minkema

The water sports facilities club 'De Jongens uit Schoorl' (DJUS) can also be considered a **player** in the project. Their interest in the project is high because their business model relies on the lagoon. They organize events that are based in the area at the lagoon rather than the area at the North Sea. The lagoon attracts a lot of visitors and thus money for this club. Besides that, the power of DJUS is high because if it will be decided that the lagoon will remain open, the DJUS will cover a part of the maintenance costs, together with the municipality.

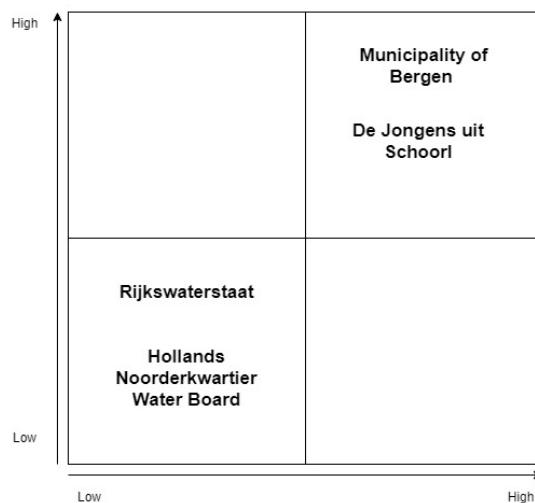


Figure 21: Classification of stakeholders in a power versus interest grid (adapted from Eden and Ackerman, 1998).

5.1.2. Individual Cognitive Maps

For each of the four categorized stakeholders, an individual cognitive map is developed. The first stakeholder is Rijkswaterstaat. As stated before, the main task of Rijkswaterstaat is maintaining water safety. Since the lagoon does not contribute to water safety, it does not matter for RWS if the lagoon will be open or not. However, they are still in favour of keeping the lagoon open since they think it is an added value. But they don't have an interest in terms of profit or benefits. The actions and decisions of RWS are visualized in the individual cognitive map of RWS. The pluses and minuses indicate if the elements influence each other negatively or positively.

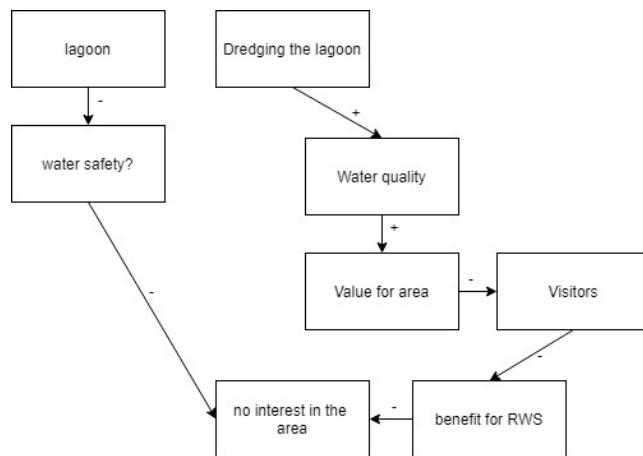


Figure 22: Individual Cognitive Map for Rijkswaterstaat (Alblas, 2020).

The characteristics of the second stakeholder, the HHNK are the same as the characteristics of RWS. They are in favour of keeping the lagoon open because they see the benefit but the maintenance strategy that will be carried out will not affect them. The individual cognitive map for HHNK is shown in figure 23.

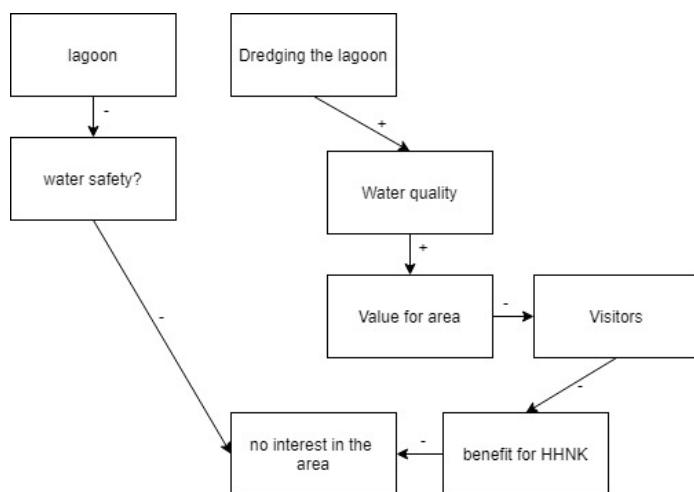


Figure 23: Individual Cognitive Map for Hollands Noorderkwartier Water Board (Alblas, 2020).

According to the results of the stakeholder analysis, the municipality of Bergen is the most important stakeholder in the examined socio-ecologic project. They have to pay for the maintenance costs, but they also benefit from the money that will be generated by the flow of visitors that the lagoon will attract. Their actions, decisions and how they are related to each other are summarized in their cognitive map that is provided in figure 24.

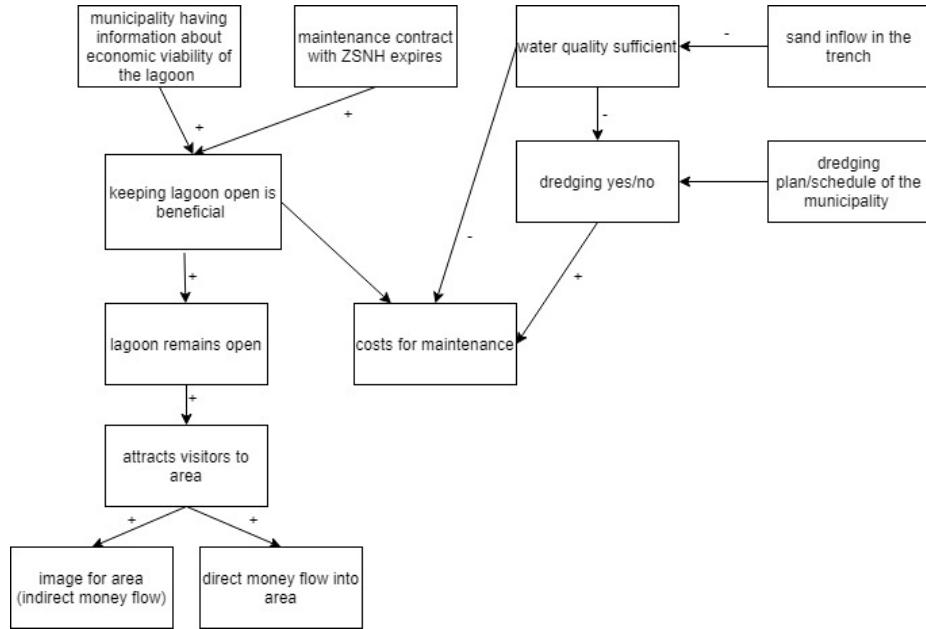


Figure 24: Individual Cognitive Map for the Municipality of Bergen (Alblas, 2020).

The last stakeholder is the entrepreneurs of the area, represented by De Jongens uit Schoorl (DJUS). They have a high interest in the socio-economic system because they benefit from the visitor flow that will be attracted by the presence of the lagoon. However, they will not pay the total amount of costs for dredging and they also do not make the final decision about the maintenance strategy. They have pledged to contribute €10.000,- to the dredging costs. They will not pay this if the maintenance strategy for the lagoon is not beneficial. Their actions, decisions and how they are related to each other are summarized in their cognitive map that is provided in figure 25.

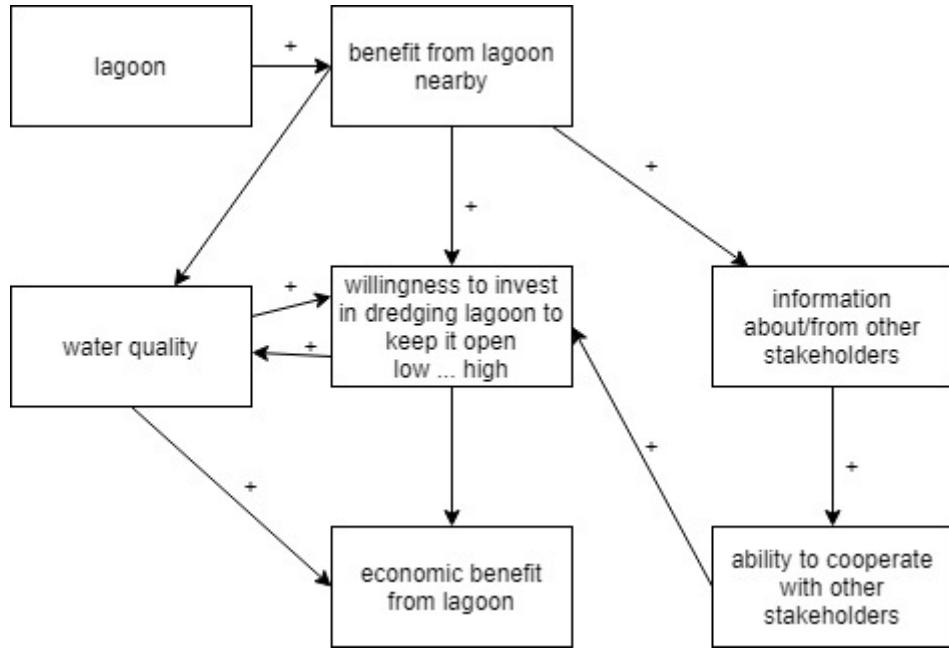


Figure 25: Individual Cognitive Map for DJUS (Alblas, 2020).

5.1.3. Collective Cognitive Map

All individual cognitive maps are assembled into one collective map where similar goals and core concepts are identified. These elements show relationships between a cluster of nodes. The elements at the top depicted in green are the collective goals for the stakeholders. The resulting collective cognitive map is shown in figure 26.

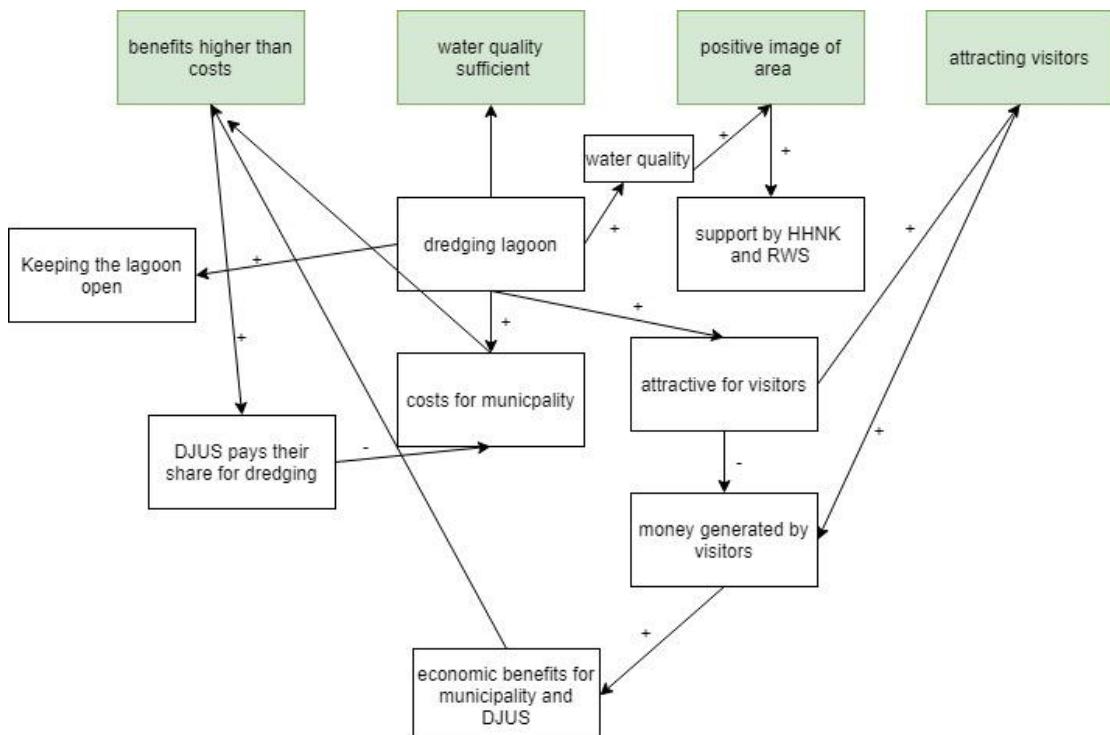


Figure 26: Collective cognitive map for all stakeholders (Alblas, 2020).

5.2. Model Development (Conceptual and Implementation)

5.2.1. System Dynamics Model

The components of the System Dynamics Model are based on the outcomes from the previous steps. An overview of the diagram of the SDM is given in figure 27. The dynamics of the different components will be explained below.

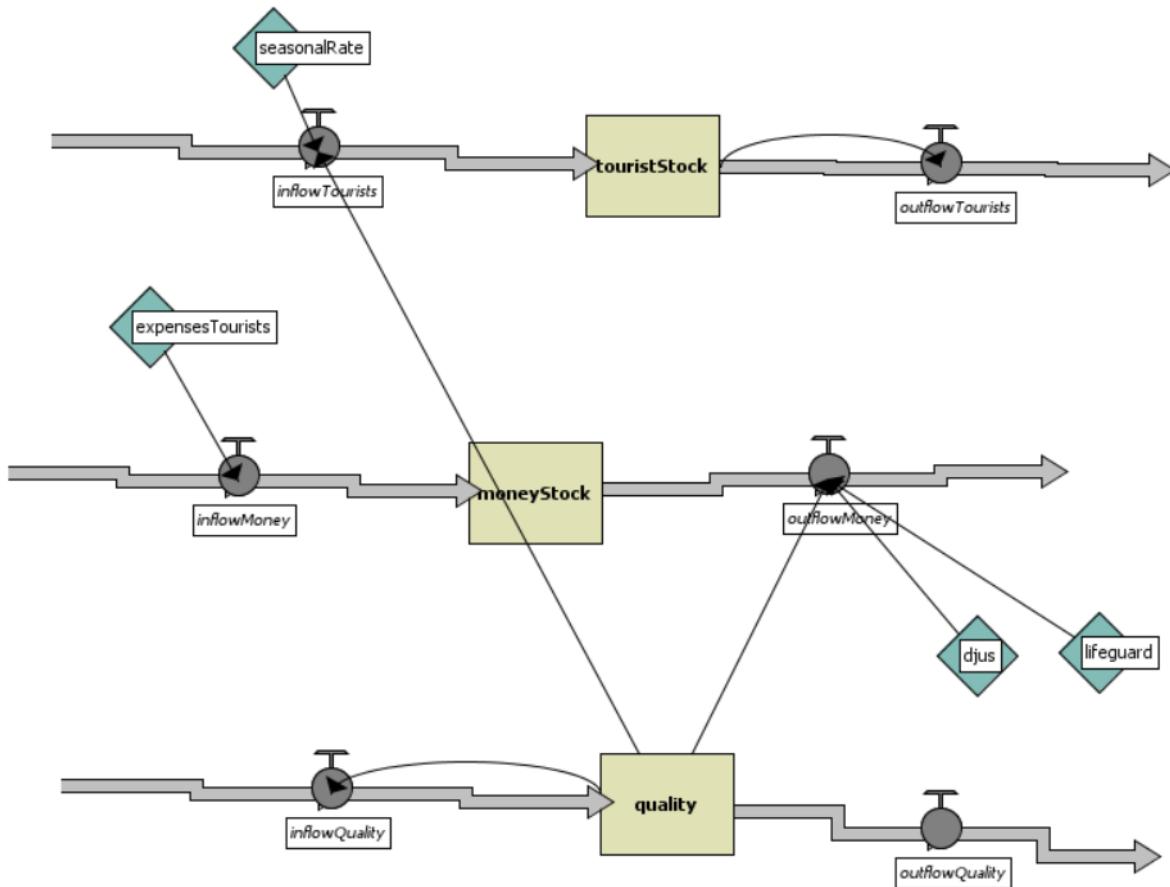


Figure 27: Diagram of the System Dynamics Model (Alblas, 2020).

At first, there is a stock of tourists called *touristStock*. This stock is affected by *inflowTourists* and *outflowTourists*. These flows are not static. Initially, the inflow of tourists depending on the season and the quality of the lagoon. The interviews show that the (water)quality of the lagoon is an important factor for visitors to stay away from the lagoon. It is being assumed that the lower the quality, the lesser tourists will visit the beach area because it is not attractive anymore. Besides that, it has been proven that in high season, more tourists visit the beach than in low season. The *seasonalRate* is defined as a formula of the calculated seasonal factors and a cosines function to generate a natural flow of tourists over the seasons. The data that has been used to calculate the *seasonalRate* is given in section 4.1. Visitors.

The outflow of tourists is the same as the absolute number of tourists that visit the beach on a day, being assumed that every tourist leaves the beach at the end of the day.

The expenses of the tourists are also not a static amount of money. The stakeholders have claimed that the presence of the lagoon generates an inflow of money for the municipality, but they couldn't give an exact amount or even an estimation because most revenues are indirect and thus not measurable. The only revenue that is measurable and direct is the tourist tax. The tourist tax per person per night is €1.85. Justification for this data is given in section 4.3. Estimated benefits. However, not all tourists will stay overnight and thus pay tourist tax. For this research, it is decided that half of the tourists will pay the tourist tax to the municipality. This variable is given as a percentage of the total beach visitors.

Besides that, Arcadis (2013), has estimated an increase of 25% in tourist-recreational expenditure due to the reinforcement of the Hondsbossche Dunes. The construction of the lagoon is also part of this project, so the *inflowMoney* is multiplied by 1.25.

At a certain moment, the water quality is considered too low. This is the moment that the municipality should decide that the lagoon should be dredged to ensure refreshment of water through a water flow from the sea. The total estimated costs for the maintenance of the lagoon are € 54.168,- per year. The costs for dredging are not the only costs, the municipality also has costs for the lifeguard station at the beach. The costs for the lifeguards for the whole municipality are € 30.000,- per year. There are 5 lifeguard stations in the whole municipality, which means that on average, each station costs € 6.000,- a year. This is translated into a daily cost, by dividing € 6.000,- by 365. Each tick, the daily costs for the lifeguard station flows out.

In the SDM, the *outflowMoney* is also related to *qualityDecrease*. On average, the lagoon is dredged once a year. This means that in one year, the water quality goes from 100% (perfect quality) to 0% (low quality). When the lagoon is being dredged, depends on the value of the variable *dredging-every-x-years*. This is a flexible variable and can be defined using a slider in the interface of the model. For example, a value of 1 for this variable means that the lagoon will be dredged once every year. A value of 2 for this variable, means that the lagoon will be dredged once every two years. This also affects the *outflowMoney*. The costs for dredging will only go out if the lagoon is being dredged. However, the entrepreneurs in the area (in this research represented by DJUS) have pledged to pay € 10.000,- per year when the lagoon is being dredged. For the sake of carrying out experiments, this is considered a Boolean variable. If the DJUS decide to pay their share, the slider in the interface called *djus-pays?* can be set *on*, otherwise, the slider can be set *off*. This determines if the municipality has to pay € 10.000,- per year extra or not.

Finally, there is also a *quality* stock. This is affected by the *inflowQuality* and the *outflowQuality*. Table 1 (section 2.5) shows that on average, there is a dredging moment due to low water quality once a year. This means that in one year, the water quality of the lagoon comes below an acceptable threshold. For this model, it has been decided that in one year, the water quality goes from 100% (right after the lagoon is dredged) to 0% (when the lagoon needs to be dredged). The *inflowQuality* takes place when the lagoon is being dredged, depending on the frequency of dredging that can be set by the slider in the interface.

Then, the *outflowQuality* is the percentage of quality that flows out of the lagoon per day. This is also related to the *quality decrease*. The quality that is assumed to flow out in one year is being divided by 365 to define the outflow of quality per day.

The *quality* is not cumulative but represents a percentage between 0 and 100. A quality of 100% represents the perfect quality of the lagoon and a lower percentage represents a lesser quality level of the lagoon. The graph of the quality of the lagoon shows that the quality doesn't start at 100 (assuming perfect quality) but a bit lower because the lagoon is dredged at the beginning of the recreational season (March) and the model starts 3 months later, in high season (June). The quality flows out until the municipality dredges the channel and the quality is brought back to 100%.

All expressions of the elements of the System Dynamics Model are given in table 5.

Element	Expression
seasonalRate	COS(ticks) * 0.35 + 1.05
inflowTourists	initial-number-tourists * seasonalRate * (quality / 100)
outflowTourists	touristStock
touristStock	Initial-number-tourists
expensesTourists	(1.85 * touristStock * 0.5) * 1.25
inflowMoney	expensesTourists
moneyStock	0
outflowMoney	ifelse-value(ticks mod (365 * dredging-every-x-years) = 0 AND ticks != 0) [44168 + lifeguard + djus] [lifeguard]
lifeguard	6000 / 365
djus	ifelse-value(djus-pays?) [0] [10000]
inflowQuality	ifelse-value(ticks mod (365 * dredging-every-x-years) = 0 AND ticks != 0) [100 - quality] [0]
Quality	75
outflowQuality	100 / 365

Table 5: Elements of the System Dynamics Model and their expression (Alblas, 2020).

The interface of the system dynamics model in NetLogo is shown in figure 28.

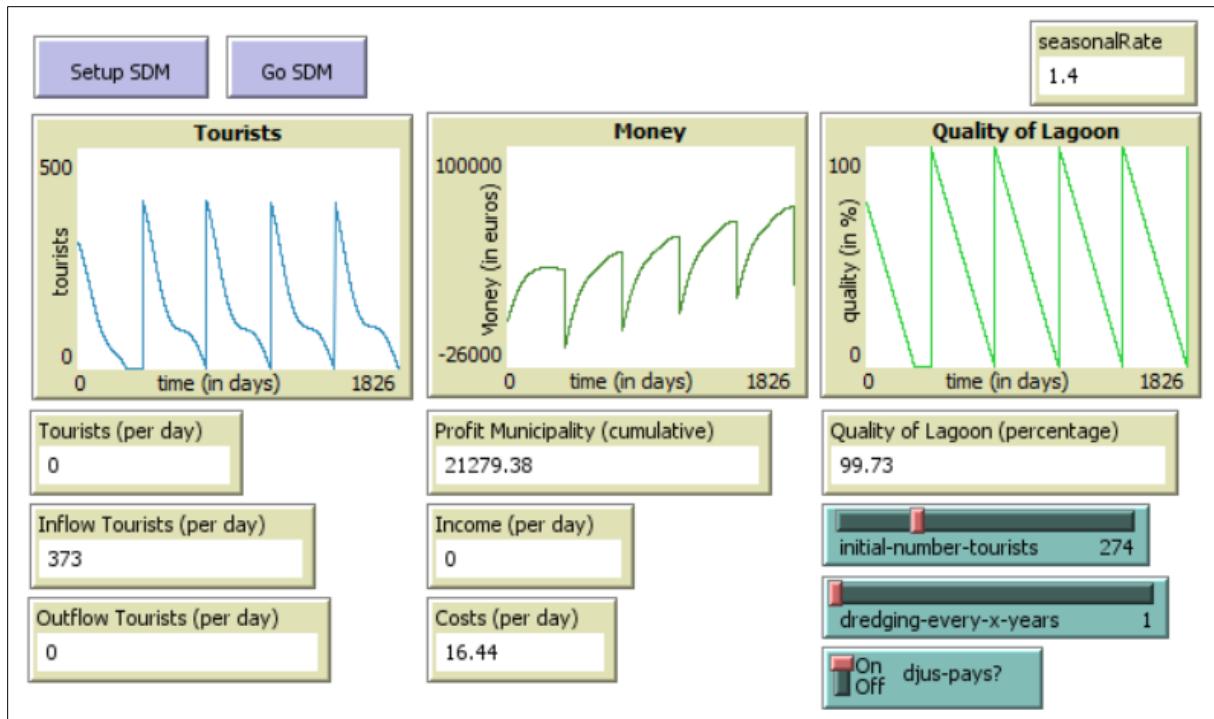


Figure 28: Interface of the System Dynamics Model (Alblas, 2020).

The interface has three plots; one for each stock. The graph of the plot 'Tourists' shows the number of tourists at the beach each day. The graph of the plot 'Money' shows the cumulative amount of money for the municipality and the graph of the plot 'Quality of the Lagoon' shows the quality of the lagoon per day in percentage. There are also some monitors, that show the value of the flows or variables for each tick/day. There are two sliders, with the slider called 'initial-number-tourists' the number of tourists that visit the beach the first tick can be adjusted. The slider 'dredging-every-x-years' determines the frequency of dredging. If the entrepreneurs of the area (represented by de DJUS) pay their share in the dredging costs or not can be adjusted by the switch called 'djus-pays'. This is for the sake of carrying out experiments with different variables.

The model is activated by the button called 'Setup SDM' that calls the procedures 'system-dynamics-setup' and 'system-dynamics-do-plot' of the System Dynamics code.

The model runs by pressing the button 'Go SDM'. This is automatically repeated 1826 times, to see what the outcome of the model will be after 5 years. The characteristics of the experiments and the results are given in section 5.3.1. Experiments – System Dynamics Model.

The graph that represents the tourist show a decrease in visiting tourists simultaneously with a decrease in quality. The graph of money still goes up but shows a decreasing rise. The graph of quality shows an abrupt rise at the moment that the lagoon is dredged, the quality goes back to 100%. The dredging moment is also shown by the graph of the money, where the graph has an abrupt decline. The same moment is shown in the tourist graph when the number of visiting tourist goes up. This is because more people visit the lagoon area if the quality is back at 100%.

5.2.2. Agent-Based Model

The behaviour of the tourists at the beach is modelled by the spatial Agent-Based Model. The structure of the agents and the flow of processes is presented in the UML-diagram of figure 29.

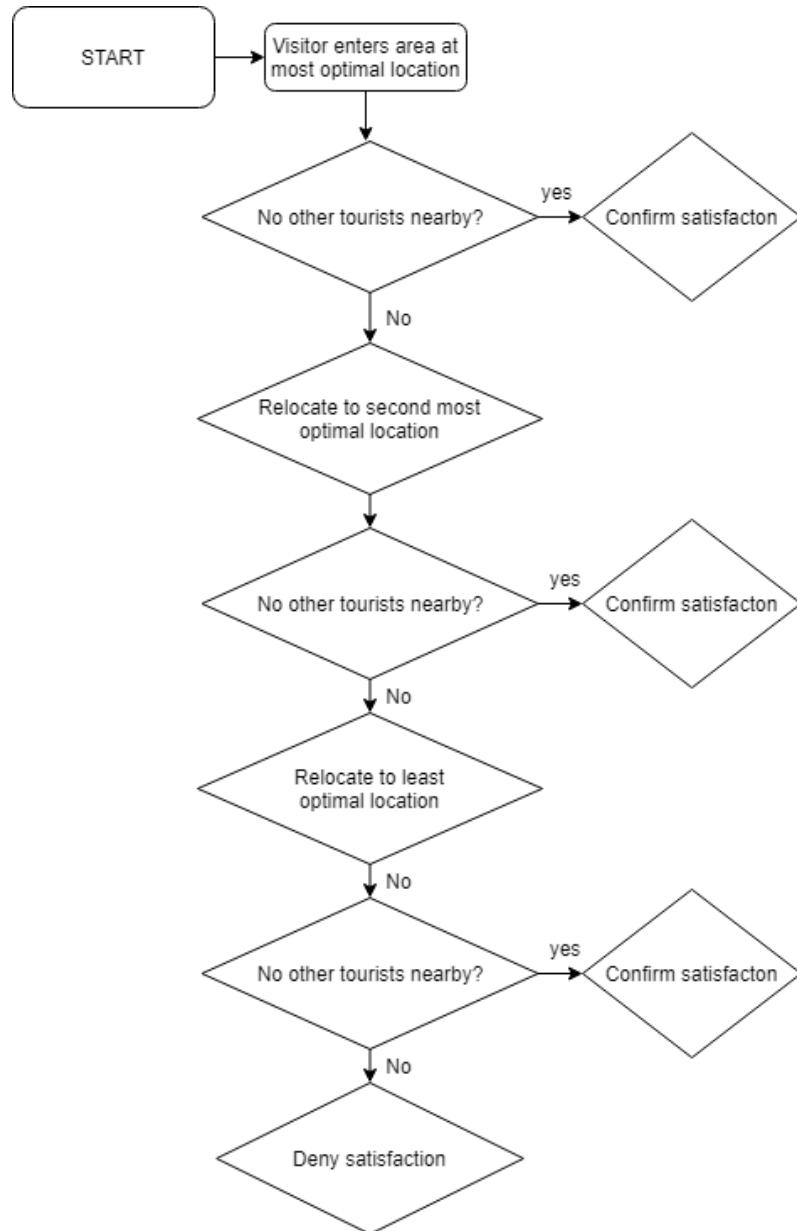


Figure 29: UML Time-Sequence Diagram (Alblas, 2020)

For this research, there is no detailed information on the ABM because the separate ABM is a simplified model. Thus, only the first component of the ODD protocol (Overview) will be explained.

Purpose

This model simulates agents as visitors at an artificial lagoon at the Hondsbossche Dunes at Camperduin (NL). This simulation will be used to determine the effects of beach visitors in terms of crowdedness at the beach. The non-spatial elements of the System Dynamics Model will be integrated with spatial elements of an Agent-Based Model to create a hybrid, integrated model. The ABM simulate how tourists enter the beach and find a location and generate satisfaction with the location. The satisfaction is determined by the crowdedness. If a tourist enters the beach and the nearest other tourist is considered too close, they will not be satisfied. The level of satisfaction determines if the visitors will return to the lagoon area the next day. Each tick represents one day.

Entities, state variables and scales

The agents in this model represent the visitors of the beach area around the lagoon at the Hondsbossche Dunes at Camperduin. The total amount of visitors varies over the year since the beach attracts more visitors in the high season than in the low season. The initial number of visitors that will be sprouted on the beach is 274. This number is derived from the research of Jonker and Janssen (2007). It is assumed that this number differs per season. So, the number 274 is multiplied by 0,7 in low season, and in high season, this average number is multiplied by 1.4. The calculations for this are justified in section 4.1. The initial-number of tourists that is sprouted is represented by a stock of the SD model: touristStock.

The attribute of the agents is satisfaction, in the model called '*satisfied?*'. This satisfaction is calculated by checking the distance from a tourist to the closest neighbouring tourist. This is measured in pixels since every tourist is sprouted on an empty patch. The size of a patch is 0.5 meter. It has been decided to set the minimum distance to other tourists at 8. This is translated into 4 meters.

The agents are distributed across a simplified representation of the area around the lagoon at the Hondsbossche Dunes. This representation consists of a total of 553 x 1925 cells. Each cell represents 0.5 squared meters. Of course, the lagoon itself is represented in the middle of the representation. In the model, this is represented by a blue plane. Besides that, the area around the lagoon is represented as a beach area where the visitors can perch. This is represented in the model by a pale yellow colour. The remaining cells are categorized as dunes, where visitors are not allowed to recreate. This is represented in the model by a dark yellow colour.

The development of the input spatial data layer, in which every cell is assigned with a value (1) lagoon, 2) beach or 3) dunes, is made in GIS. The steps that were undertaken to create this layer are explained in section 4.4: Creation of spatial datasets with GIS.

The environment as represented in the ABM without the agents being present is shown in figure 30.

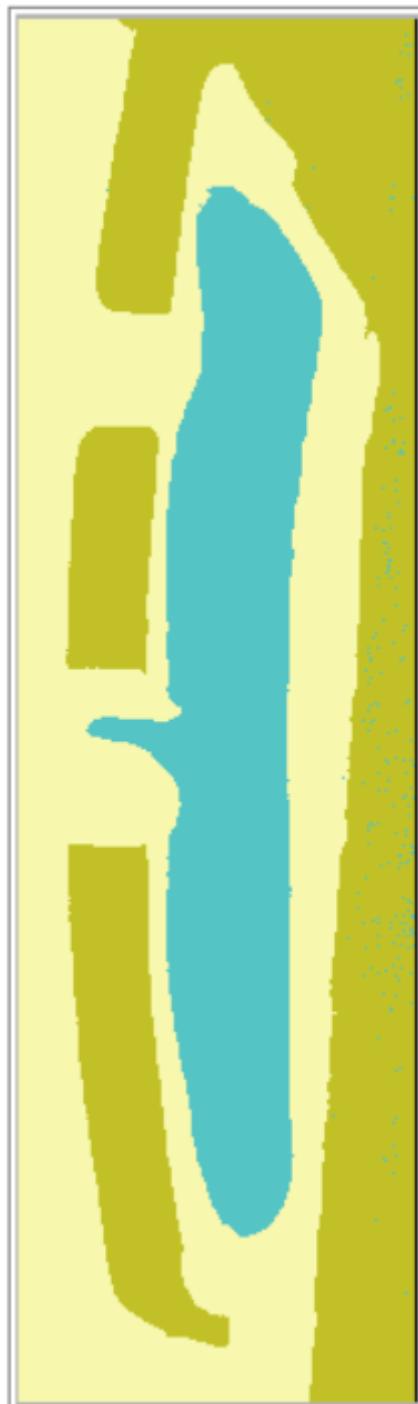


Figure 30. Environment as used in the ABM where blue = lagoon, pale yellow = beach and dark yellow = dunes (Alblas, 2020).

Process overview and scheduling

According to the distinction of Couclelis (2001) of agents and their environment, the agents and environment of the case of the lagoon at the Hondsbossche Dunes have analyzed agents. The behaviour and attributes are empirically grounded and are intended to simulate a real-world object.

The objectives of the stakeholders in the real-world will be translated into the objectives and goals of the agents in the simulation. Is it being assumed that visitors can only locate themselves on a patch that is assigned as 'beach'. These are the patches that are not assigned as 'lagoon' or 'dunes'. However, there are also patches with the value 'beach' that are not close to the lagoon. Agents can only locate themselves on patches that have both value 'beach' and are close to the lagoon. Agents that are located on the beach far away from the lagoon are not included in this research because they are not identified as visitors of the lagoon area. Therefore, another spatial dataset is added to the NetLogo code that determines where the tourists are allowed to locate themselves. This spatial dataset is not visible but every patch has a value of NaN or 1. The tourists can only be located at patches with value for 'location' of 1.

Also, it is being assumed that tourists have a preference for a location near the three elements; the lagoon, the sports facilities club and the entrance. Another spatial dataset is added that assigns a value of 'optimal_distance' of 1, 2 or 3. A value of 'optimal_distance' of 1 means that these patches have the most optimal location regarding the distance to the three mentioned elements, a value of 'optimal_distance' of 2 means these patches have the second most optimal location regarding the distance to the three elements and a value of 'optimal_distance' of 3 means that these patches have the least optimal location regarding the distance to the three elements.

The agents will first locate themselves at the patches with the most optimal location, if they are not satisfied because it is too crowded, they will relocate themselves to a patch with the second most optimal location and if they are also not satisfied there because it is too crowded they will relocate themselves to a patch with the least optimal location. If the agent stays dissatisfied with the third location, the agent will stay dissatisfied and will not return the other day. So, dissatisfied agents will relocate themselves maximal two times to be satisfied.

An agent is not satisfied if they are close to another agent. Each tick, the so-called *satisfaction* for each agent is updated, based on if the agent is satisfied with their place concerning the presence of other turtles in their personal space. The amount of turtles that are satisfied in one tick, is being used as input for the next day/next tick.

If an agent is not satisfied with their place, their satisfaction (as defined in *turtles-own* as *satisfied?*) is confirmed. Then, it is calculated how many agents are satisfied based on the proximity of other agents. This amount of agents is translated into a percentage that is updated in each tick and is defined in *globals* as *p-satisfied*. The number of agents that are satisfied return in the next tick, assuming that they were satisfied and they will return the next day. Each tick, all agents are cleared since it is being assumed that the beach is empty at night.

5.2.3. Integrated Hybrid Model

The only interaction between both models is the amount of tourist at the beach at one day, defined in both the SDM and the ABM. It is being assumed that this is on the one hand affected by the type of season, in the winter lesser people visit the beach than in summer. On the other hand, this is affected by the quality of the lagoon; a low-quality level means lesser people recreating at the lagoon area. These variables are staged in the SDM. It is also being assumed that the amount of tourists at the beach depends on their level of satisfaction that is in turn determined by the number of other tourists around one tourist. This is a spatial element and therefore staged in the ABM. The interaction between the two models is represented in figure 19. The bold arrow shows how the connection between the two models is being made.

The ABM is represented in the left box by a flow chart and the SDM is represented in the right box by a causal-loop diagram. The pluses and minuses in the right box represent if the elements of the System Dynamics Model influence each other positively or negatively.

The integrated hybrid model starts by sprouting the initial number of tourists of 274 based on the 'touristStock'. Initially, the tourists are only sprouted on patches with the most optimal location regarding the distance to the lagoon, the sports facilities club and the entrance. The tourists that are not satisfied with their location relocate themselves to the patches with the second most optimal location and the satisfied tourists stay where they are. The tourists that are still not satisfied with patches with the second most optimal location, relocate to a more quiet place on patches with the least optimal location. Then, the percentage of satisfied tourists is calculated. This percentage is sent back to the 'touristStock', where this is multiplied by the initial-number-tourist, the percentage of quality and the seasonalRate. This results in a new number of 'touristStock'. The new number of 'touristStock' is sprouted as new agents the next tick. Again, the agents are first sprouted on patches with 'optimal_distance' of 1, etcetera.

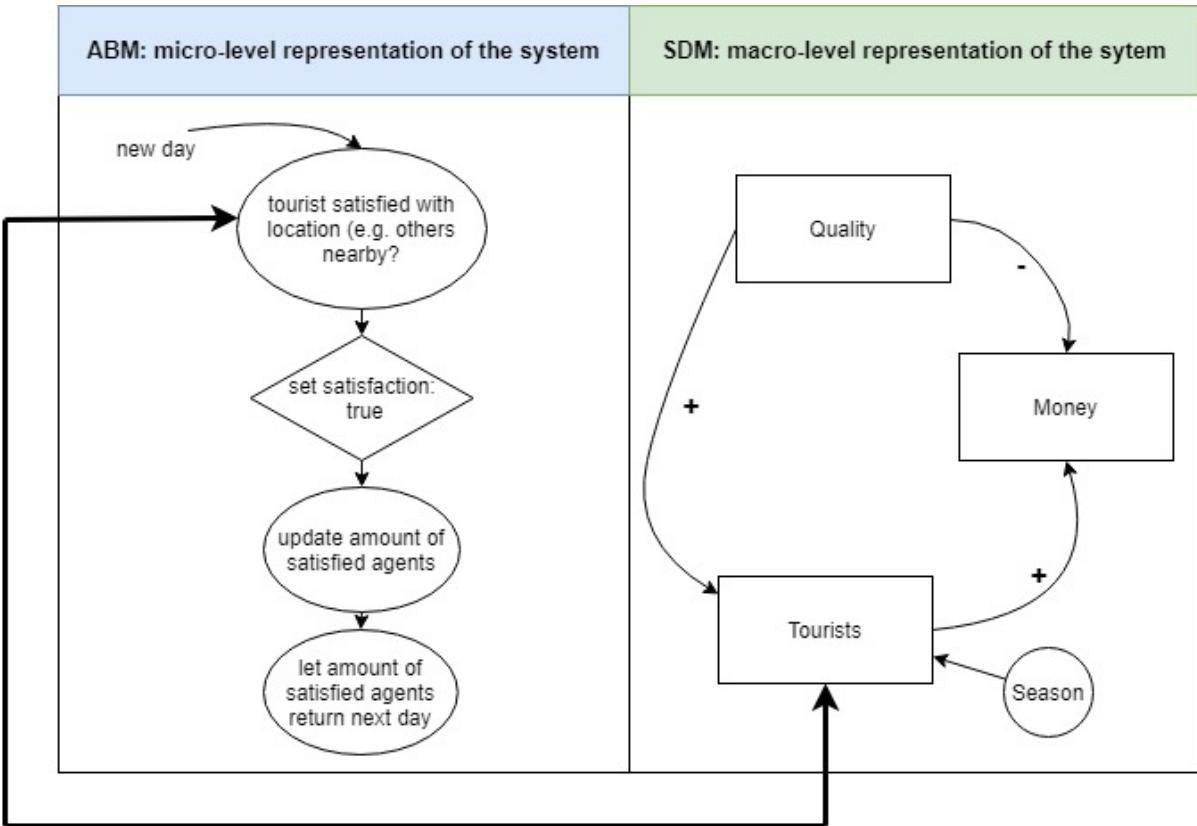


Figure 31: Conceptual graph of the Integrated Hybrid Model (Alblas, 2020).

The resulted interface of the integrated hybrid model is presented in figure 32.



Figure 32: Interface of the integrated hybrid model in NetLogo (Alblas, 2020).

The interface of the integrated hybrid model is the same as the interface of the System Dynamics Model, except for the spatial dataset that represents the area around the lagoon.

For this research, the changing amount of tourists in the area in the ABM (defined by their satisfaction) will affect the dynamics in the SDM. This will change the *touristStock* in the SDM since only the satisfied tourist will return. Vice versa, the changing *touristStock* will affect the distributed amount of tourists/agents in the area in the ABM. The change of *touristStock* in the SDM each day is also affected by the *seasonalRate* and the quality of the lagoon; defined as *quality*.

5.3. Experiments

5.3.1. System Dynamics Model

The outcomes of the experiments of the separate System Dynamics Model will be explained in this chapter. As stated before, the difference between the SDM and the Integrated Hybrid Model is that the Integrated Hybrid Model has a spatial element, the satisfaction of the tourists that are based on the proximity of other tourists. This spatial component is not included in the System Dynamics Model. In the separate SDM, the behaviour of the tourists is only determined by the seasonal rate and the quality of the lagoon.

The model starts in summer, this can be deduced from the starting value of the seasonalRate. The highest seasonalRate per year is 1.4, this is in summer when most people visit the beach. For the justification of this data, see section 4.1. This can also be deducted from the value of quality. The interviews and data have shown that in the past, the lagoon is being dredged at the beginning of the recreational season, e.g. in March/April. Assuming that the model will start running in high season, e.g. in June, the quality of the lagoon is already a bit decreased after 3 months.

Several experiments are carried out with the model to compare the effects of different maintenance strategies. Table 1 of the Theoretical Framework shows that the trench of the lagoon is being dredged once a year anyway. Besides that, the municipality has already decided that they will keep on maintaining the lagoon, so that indicates that dredging the channel once a year is beneficial anyway.

However, it will be investigated if it is also possible for the municipality to dredge the channel once every two years, once every three years, once every four years or once every five years. It is decided to run the model in total for five years, and 1825 ticks/days.

The difference maintenance strategies that are translated into experiments are as follows:

1. Dredging the channel once a year.
2. Dredging the channel once every two years.
3. Dredging the channel once every three years.
4. Dredging the channel once every four years.
5. Dredging the channel once every five years.

Besides that, there is another element in the different maintenance alternative. In section 4.2. Estimated costs, it is stated that the costs of dredging are €54.186,- per year. The entrepreneurs in the area have pledged to contribute €10.000,- per year. So, the municipality has to pay the remaining amount, namely €44.186,- per year. The model of this research is also used to see if it is still beneficial for the municipality to dredge the trench of the lagoon to keep it open if the entrepreneurs don't pay their share any more. This means that the municipality has to pay the whole amount. The two types of experiments (frequency of dredging and if the entrepreneurs cover a part of the costs) are combined and an overview of the characteristics of the experiments are given in table 6.

Experiment number	Frequency of dredging (once every x years)	Entrepreneurs cover €10.000,- of the costs (yes/no)
1.	1	Yes
2.	2	Yes
3.	3	Yes
4.	4	Yes
5.	5	Yes
6.	1	No
7.	2	No
8.	3	No
9.	4	No
10.	5	No

Table 6: Overview of the experiments carried out with the SDM (Alblas, 2021).

Per experiment, the profit for the municipality is checked. This is the result of the estimated costs for dredging and the benefits (the money that is generated by the tourists). If it is decided to dredge the channel on a lower frequency, the costs of dredging will be lower because in the years the municipality doesn't dredge the channel, they do not incur any costs. However, no dredging also means a decrease quality of the lagoon which in its turn results in a decrease in tourists. This means that there is no money flow generated by the tourists because they don't visit the area anymore because of its bad quality. Regarding the profit for the municipality after five years of keeping the lagoon open, the different maintenance strategies have their advantages and their disadvantages. These experiments are carried out to see which maintenance alternative is most beneficial.

The results of the experiments are given in table 7 and figure 33. The row that is highlighted in green in the table indicates the maintenance alternative that is most beneficial for the municipality according to the outcomes of the model. This is when the lagoon is dredged once every two years and when the entrepreneurs do pay their share of €10.000,- of the costs for dredging.

Experiment number	Frequency of dredging (once every x years)	Entrepreneurs cover €10.000,- of the costs (yes/no)	Profit for the municipality after five years (in €)
1.	1	Yes	21.279,38
2.	2	Yes	34.966,90
3.	3	Yes	20.250,99
4.	4	Yes	19.731,00
5.	5	Yes	- 38.620,20
6.	1	No	- 28.720,62
7.	2	No	14.966,90
8.	3	No	10.250,99
9.	4	No	9.731
10.	5	No	- 48.620,20

Table 7: Overview of the results of the experiments carried out with the SDM (Alblas, 2021).

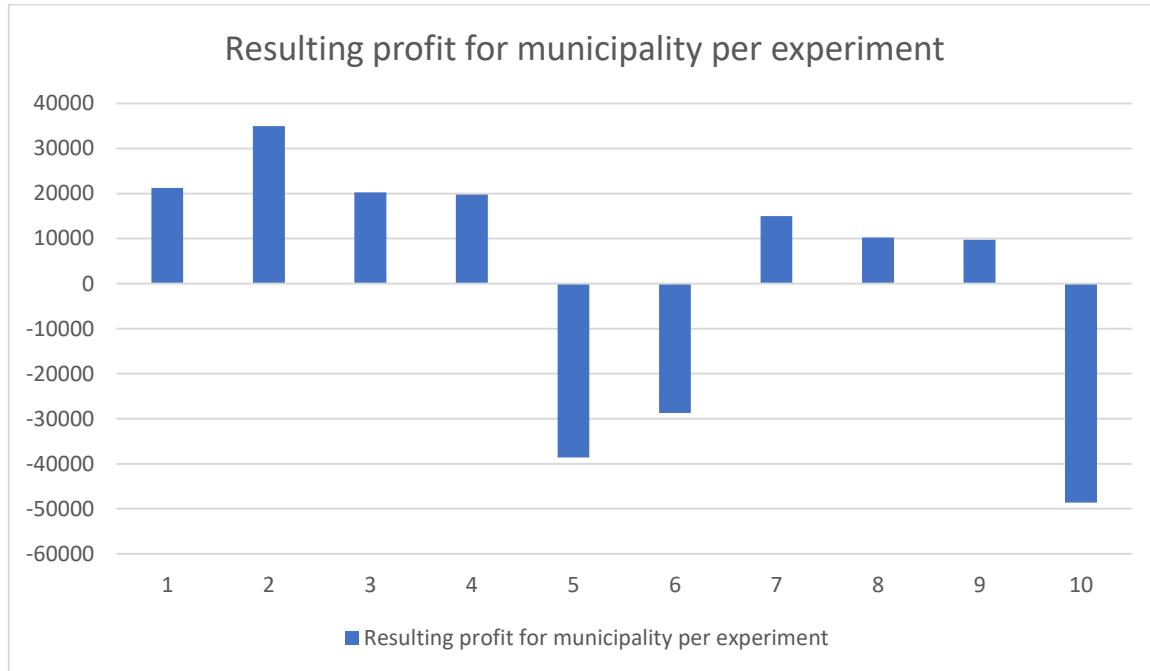


Figure 33: Histogram of resulting profit for municipality per experiment carried out with the System Dynamics Model (Alblas, 2021).

According to the outcomes System Dynamics Model, the most beneficial maintenance alternative after five years is to dredge the channel once every two years to ensure a freshwater flow and to keep the quality sufficient. The costs for dredging the lagoon are only paid once every two years. Besides that, the model has proven that it is important that the entrepreneurs keep paying their share. If they don't pay their share, the municipality will make a loss instead of profit.

The graphs and the plots are provided in appendix II: Resulting plots and graphs System Dynamics Model.

5.3.2. Integrated Hybrid Model

The same selection of experiments as carried out with the separate System Dynamics Model is carried out with the Integrated Hybrid Model. As stated before, the latter model has an extra spatial element that checks if the tourists are satisfied or not based on the proximity of other tourists. If the beach is too crowded, the tourists are not satisfied and will not return to the area. The explanation of the experiments is given in the previous section, 5.3.1. Experiments – System Dynamics Model.

The results of the experiments are given in table 8 and figure 34. The row that is highlighted in green in the table indicates the maintenance alternative that is most beneficial for the municipality according to the outcomes of the model. This is when the lagoon is dredged once every two years and when the entrepreneurs do pay their share of €10.000,- of the costs for dredging.

Experiment number	Frequency of dredging (once every x years)	Entrepreneurs cover €10.000,- of the costs (yes/no)	Profit for the municipality after five years (in €)
1.	1	Yes	13.910,56
2.	2	Yes	31.012,26
3.	3	Yes	18.034,72
4.	4	Yes	17672,15
5.	5	Yes	- 39.041,46
6.	1	No	- 36243,59
7.	2	No	11.080,01
8.	3	No	8.033,27
9.	4	No	7.674,71
10.	5	No	- 49.136,45

Table 8: Overview of the results of the experiments carried out with the Integrated Hybrid Model (Alblas, 2021).

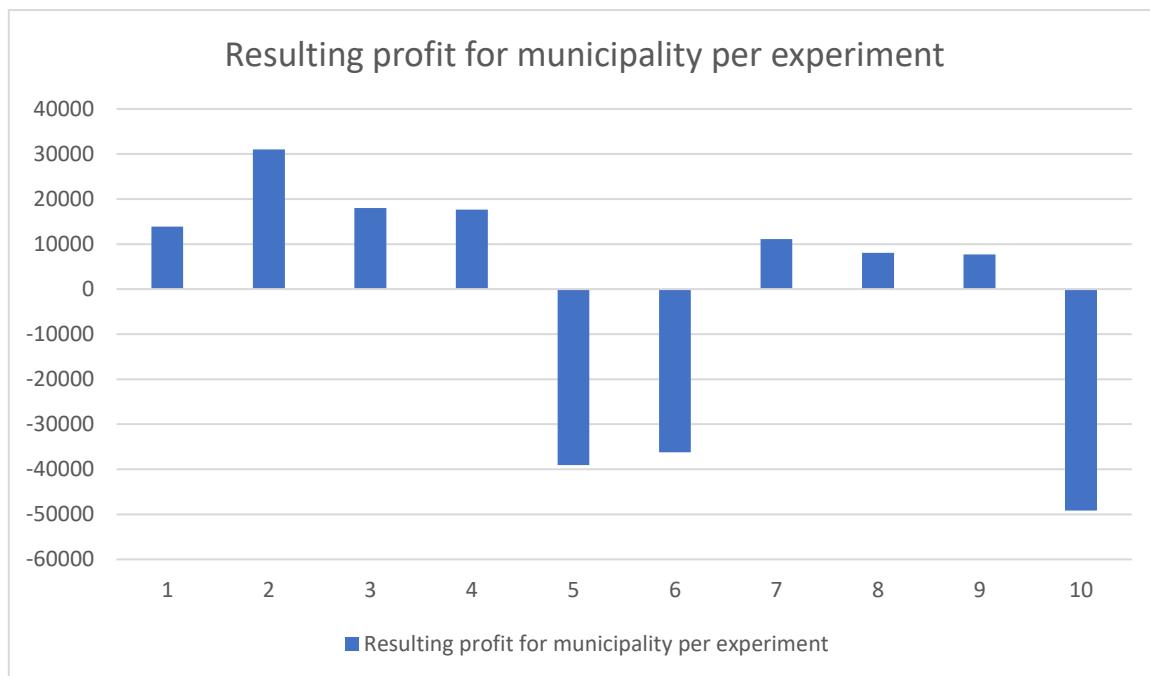


Figure 34: Histogram of resulting profit for municipality per experiment carried out with the Integrated Hybrid Model (Alblas, 2021).

According to the results of the Integrated Hybrid Model, the maintenance alternative where the municipality dredges the channel of the lagoon once every two years and the entrepreneurs pay their share of €10.000,-. This is in line with the results of the experiments of the System Dynamics Model. To see the differences in output between the two models, the outcomes of both models are plotted in a combined histogram. This histogram is shown in figure 35. The blue bars represent the outcomes of the System Dynamics Model and the orange bars represent the outcomes of the Integrated Hybrid Models. Both bars represent the profit that is made by the municipality after five years for the ten different experiments.

For both models, the same trends are shown. Maintenance strategy 5, 6 and 10 give a negative profit. The generated revenues from visiting tourists do not cover the costs of dredging. This is because the lagoon is dredged so little, that the quality is insufficient for a very long time. An insufficient water quality means that no tourists visit the beach because it is not attractive. This also means that there is no money coming in for the municipality. These maintenance strategies are not beneficial. It is also remarkable to see that the sixth maintenance strategy, where the municipality dredges the channel once every year, is not beneficial if the entrepreneurs don't pay their share of the costs. This means that the municipality needs the entrepreneurs to share the costs for dredging to let the presence of the lagoon be beneficial.

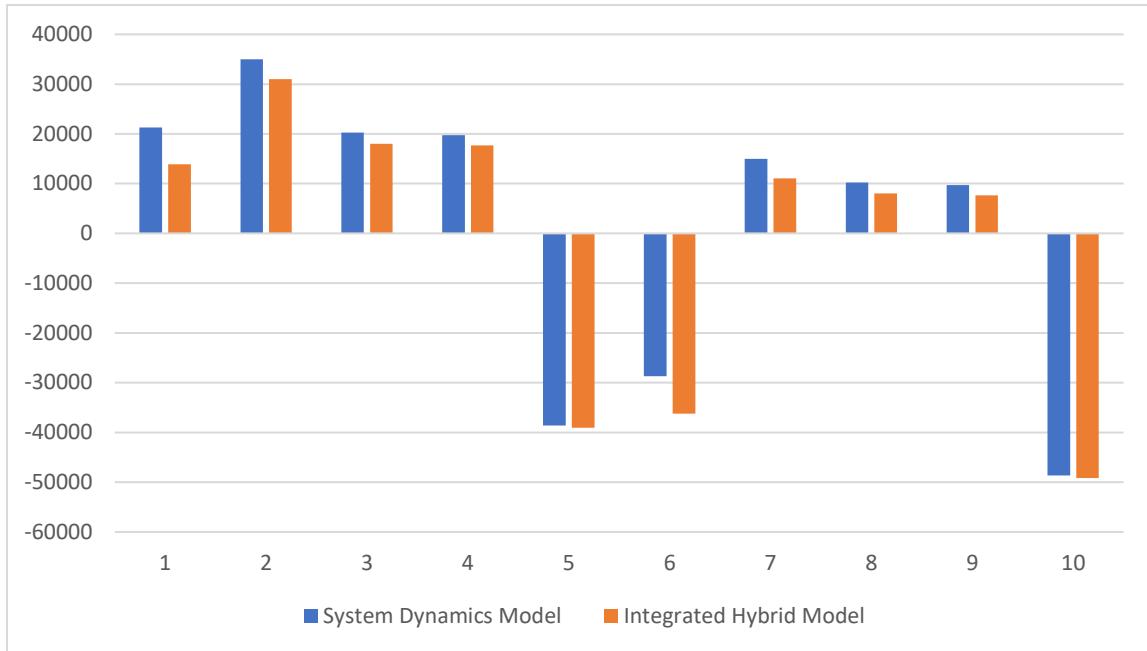


Figure 35: Histogram of resulting profit for municipality per experiment carried out with the System Dynamics Model (blue) and the Integrated Hybrid Model (orange) (Alblas, 2021).

The Integrated Hybrid Model is also used to see where and how the tourists are distributed over the area. As stated before, in the model the beach area is divided into three areas: the first area has the most optimal location considering the distance to the lagoon, the sports facilities club and the entrance, the second area has the second most optimal locations considering the distance to these three elements and the southernmost area has the least optimal location. A tourist relocates themselves maximal two times to another area if it is not satisfied with their first or second location.

The Integrated Hybrid Model is run again with the values belonging to the second experiment that seemed to be most beneficial. The position of the agents is captured in an output ASCII file. This output file is loaded into ArcMap to see the position of each agent in every tick. Besides that, the model has run again with the same conditions but then the position of the unsatisfied agents is captured in an output ASCII file. This is done to study the movements of the agents and to see if there is an area in which the agents moved the most. The output file represents the total number of agents that have been at each patch over the whole simulation run of 1825 ticks.

The resulting map shows the total number of agents that have been at each patch of this area shown in figure 36. This can be considered a heatmap of the movement of the agents.



Figure 36: Heatmap of the agent's movement of the beach area around the lagoon for experiment 2 (Alblas, 2021).

The movements of the **dissatisfied** agents are also captured in an ASCII file that is loaded into ArcMap. This has been done to investigate if there is an area at the beach where a lot of tourists become dissatisfied because of the crowdedness. The heatmap of the movements of only the **unsatisfied** agents is provided in figure 37.

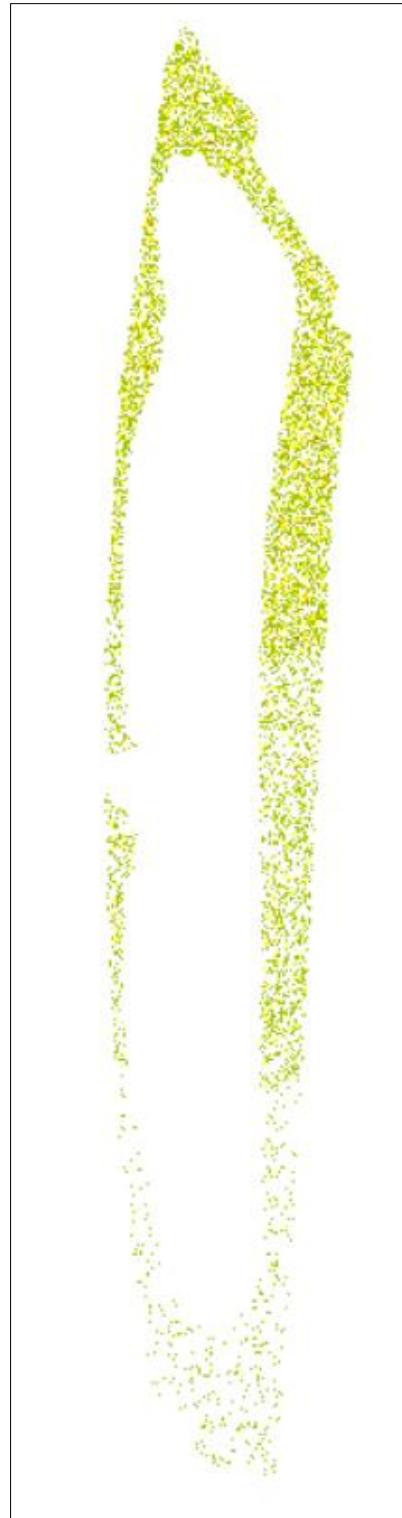


Figure 37: Heatmap of the **dissatisfied** agent's movement of the beach area around the lagoon for experiment 2 (Alblas, 2021).

The heatmap of the movement of all the agents (figure 36) doesn't show a cluster of agents. This is because the agents are equally sprouted across the first area and they move to the second area when they are not satisfied there because it is too crowded. This is shown in the figure. The first area has the most movements, the second area has lesser movements and the third area has the least movements. This shows that most tourists are already satisfied with their first location. For only some agents, the first zone of the beach is too crowded and they move to a part of the beach further away.

The heatmap of the movements of only the dissatisfied agents shows that most agents become dissatisfied at the first location. If all the agents locate themselves there, where the lagoon, the entrance and the water sports facilities are the closest, it becomes too crowded and some agents decide to move to a part of the beach that is further away. The second part has lesser movements of dissatisfied agents. The third part has the least movements of dissatisfied agents. This implies, that with an initial number of tourists that are sprouted the first day, most tourists can find a spot at the beach around the lagoon where they will be satisfied in terms of crowdedness.

6. Conclusion

In this chapter, the research questions, as defined in chapter 1. 4, will be answered.

What are the different stakeholders that are involved in the project of the lagoon at Camperduin and what is their role?

For this research, four different stakeholders are identified. The stakeholders are: Municipality of Bergen (N-H), Hollands Noorderkwartier Water Board (HHNK), Rijkswaterstaat (Dutch Ministry of Infrastructure and Water Management - RWS), De Jongens uit Schoorl (Water Sports Facilities - DJUS).

The extensive stakeholder analysis has shown that RWS and HHNK do not play a crucial role in the project of the lagoon at Camperduin. They were involved in the starting phase of the construction of the lagoon and the planning process. Now, when the lagoon is there, they are not involved anymore except for having an advisory role because of their knowledge about water management.

The DJUS is identified as a crucial stakeholder. They are based in the lagoon area and they organize activities in and around the lagoon. They state that the presence of the lagoon generates a lot of money for them because the lagoon attracts visitors and the visitors generate an incoming money flow for the DJUS. That is why they are willing to pay €10.000 per year for the maintenance of the lagoon. The municipality will pay the remaining amount.

The municipality is therefore also a crucial stakeholder. They make the final decision on if they want to maintain the lagoon or not. The municipality is also the party that makes money out of the presence of the lagoon. On the other hand, the municipality has to pay for maintenance. These issues can be considered using the model created in this research.

How can the outputs from the stakeholder analysis be formalized into a method applicable to Agent-Based Modelling?

The main objective of this research is to create a framework that can be applied in a situation where the outcomes of a stakeholder analysis should be converted into numerical modelling.

The ICTAM-method has proven to be a good approach. Through this approach, the outcomes of stakeholder analysis (including qualitative interviews) are first being translated into cognitive maps. The statements from the interviews are represented by elements, goals and arrows. The connection of the different elements shows the contextual and internal motivations for the actions of the stakeholders. As the last step, different individual maps can be combined into one collective map.

The next step of the ICTAM-method is the development of the ABM, starting by making a UML-diagram, and a pseudo code. However, this is still a big step to go from a cognitive, non-numerical and qualitative map to a numerical and quantitative Agent-Based Model. Therefore, for this research, it has been decided to create a System Dynamics Model first. It is a small step to go from a cognitive map to an SDM because they have a lot of similarities. Like cognitive maps, an SDM is also represented

by nodes and arrows and the different elements influence each other. So, when the ICTAM-method is being applied, it is a good suggestion to add one step in between, the creation of an SDM model.

Then, it should be defined which parts of the cognitive map are not represented in the SDM yet. Usually, spatial elements – like in this research; the distance to other agents – can't be included in the SDM because the SDM only represents the dynamics in a system on a macro-level. The elements that are not represented in the model yet, should be modelled in the ABM. The ABM and the SDM should be connected to the elements that they have both in common, in this research the number of tourists.

Both models can be run several times for the sake of carrying out experiments. The values of variables can be adjusted to examine the outcomes of different decisions and management strategies.

Finally, the outcomes of the numerical model can optionally be given as feedback to the stakeholders. They can use the model as a way to communicate and to see what strategy will be the best practice according to the model.

How can an integrated model be used to develop different maintenance strategies?

The integrated hybrid model can be applied to other situations where a decision-maker (in this case; the municipality and the sports activities club) considers different strategies for maintaining a beach area. The values of some variables are different in each case study, but this model has made it possible to adjust these values to the values that are suitable for a particular case. That makes it a generic model. The only thing that should be changed when the model is applied to another situation or another area is the spatial data because that is case-specific.

The model can be run several times with different input for the parameters. Decision-makers and policymakers can use the model to see what will happen if they decide on a particular maintenance strategy. Through this, the model will be used as a means of communication.

What will be the best practice for the maintenance of the area around the lagoon at Camperduin?

The best practice for the area around the lagoon at Camperduin will be explained based on the experiments carried out with the model.

Accepting the fact that only the direct revenues for the municipality are taken into account, the most beneficial maintenance strategy for the municipality is the strategy where the trench of the lagoon is dredged once every two years, and when the entrepreneurs contribute to the costs of dredging. Other maintenance strategies are also beneficial, which means that the annual costs for the maintenance are lower than the yields of the visiting tourists. However, the profit for the municipality after five years is the highest in the scenario when the trench is dredged once in two years. Then, the municipality has to make the costs for dredging twice, but it also ensures that the water quality will be sufficient most of the time so that the area still will be attractive for visitors that generate an incoming flow of money. It is better to dredge the channel once a year and to spend some money. These expenditures can be seen as an investment because a good quality attracts a lot of tourists.

The outcomes of the model also show that the majority of the tourists succeed in finding a spot where they are satisfied regarding the crowdedness. This can be a spot close to the facilities, the lagoon and the entrance, but when it's busy at the beach, the tourists have to walk a bit further to find a spot that is not too crowded.

7. Discussion

In this chapter, the limitations and further recommendations of this research will be examined. However this research has shown interesting results that can be applied in some cases of beach use and maintenance alternatives, some limitations need to be highlighted to be able to do further research on this topic.

7.1. Limitations of research

The first recommendation for the future is that cognitive maps can also be validated by sharing them with the stakeholders that were interviewed to get feedback on the cognitive maps, the outputs and the System Dynamics Model and the Agent-Based Model. This can be done by scheduling a follow-up interview. Due to time restrictions and limitations, this has not been done yet. However, the model and the framework developed in this research can still be conducted by the stakeholders/decision-makers to see how their plans in terms of maintenance activities will be affected by the different factors. Validating the outcomes by scheduling a follow-up interview will complete the participatory cycle.

Besides that, the satisfaction of the tourists that are calculated in the Integrated Hybrid Model is not validated yet. It is being assumed that the minimum distance to others should be 4 meters, that is translated into 8 patches of 0.5 meter in the model. The model has been run several times to see what the distance to other tourists is on average. The number of 4 meters is derived from this, but can be different in reality. Calibrating the value of this variable will rule out any uncertainties.

Finally, the area around the lagoon on which recreation can take place differs during the year because of the tides and other natural and physical factors. The spatial data that is used for this research is derived from AHN3, but the date on which these images are created is unknown. It is possible that at another moment, a bigger or smaller part of the beach is passable because of tidal circumstances. This is not taken into account in this research.

7.2. Missing data

Both models that are created – the System Dynamics Model and the Agent-Based Model – are too simplified. Many aspects can affect the dynamics that are not being taken into account. So, not every element in the system of the beach area is covered. This is because of a lack of data and information about these aspects. For example, there are many ways in which beach users/tourist generate money, but a limited amount of data on this subject was available. The same goes for a different type of users. The literature review and the outcomes from the interviews show that there are many different types of beach users in the area around the lagoon at Camperduin. These different types of beach users can

be categorized into a few different user groups. However, there was no data available on how the users were distributed among the different user groups. Therefore, the decision has been made to consider all the users as one homogenous group of users without any differences between the different users/tourists. This results in a distorted representation of reality. In further research or further use of the framework and model, the tourists in the model can be categorized into different user groups with different behavioural characteristics.

The lack of data on beach use is partly caused by the fact that a beach is a public area. Visitors are free to use the beach without anyone knowing. If a tourist visits the beach by car, they need to park their car somewhere near the beach. At the beach of Camperduin, there is a parking lot that is exploited by a private party. Contact has been made with this private party to retrieve data about the use of the parking lot to estimate the number of visitors but they responded with the answer that this data can't be used publicly. There is also a large number of visitors that come to the beach by bike or on foot and these visitors are not monitored. The data on the average number of visitors that are now being applied originates from a report by Jonker and Janssen (2007). This is the most recent data on the number of beach visitors that was found. This report presents the average number of beach visitors (274) at the beach of Camperduin. This number is applied for this study as a base number of tourists to compute the seasonalRate, but is also not considered representative because the research of Jonker and Janssen (2007) originates from 2004, even before the construction of the lagoon. The expectations are that the average number of tourists at the beach is now, sixteen years later, different.

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Appendix I: Interviews

Harold Hansen

Representative Rijkswaterstaat (RWS)

Harold Hansen:

Met Harold Hansen, goedemiddag.

Interviewer:

Hi goedemiddag, u spreekt met Laura Alblas. Ik zou even bellen voor een kort interview over mijn masterscriptie.

HH: Yes, klopt.

IN: Heeft u van uw collega Gerrit gehoord waar ik mee bezig ben of zal ik dat nog even uitleggen?

HH: Nee, ik had het van de mail een beetje doorgelezen maar ik zou het toch fijn vinden om nog even uitgelegd te krijgen waar het onderzoek en het interview precies over gaat.

IN: Ja. Zelf doe ik de studie GIMA, dat is een masterstudie die zich richt op GIS. Ik schrijf nu mijn scriptie en ik doe onderzoek naar de lagune die vijf jaar geleden is aangelegd bij Camperduin als onderdeel van het versterkingsproject van de Hondsbossche Duinen. Het is niet echt een hydrologisch onderzoek want dat was iets te technisch voor mij omdat ik toch meer bezig ben met GIS. Het is meer een onderzoek met een sociale insteek waarvoor ik een model ga maken waarin alle stakeholders die bij het project rondom de lagune betrokken zijn worden gerepresenteerd als de agents in een Agent Based Model.

HH: Oké. Wat bedoel je met agents in een Agent Based Model?

IN: Een Agent Based Model is een model waarin een situatie in de echte wereld gerepresenteerd wordt en op basis waarvan de uitkomsten een voorspelling kunnen geven over de ontwikkeling in de toekomst.

HH: Oké, Oké. En doe je dat onderzoek voor jezelf of doe je dat binnen een organisatie?

IN: Ja dat doe ik voor mezelf.

HH: Oké, Oké. Dus het is niet een soort afstudeerstage.

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Interviewer: Wie bent u en wat is uw rol binnen Rijkswaterstaat?

HH: Ik ben betrokken bij de Hondsbossche Duinen, dus ook bij de lagune. Het Hoogheemraadschap heeft het spul natuurlijk aangelegd. We hebben afgesproken uiteindelijk in die tijd dat wij vanuit Rijkswaterstaat en Kustlijnzorg onderhoudsvragen gaan aansturen. Dat is een landelijk team dat dat doet. Omgevingsmanagement doen wij regionaal. In dit geval Rijkswaterstaat regio West-Nederland Noord. Daar ben ik omgevingsmanager, onder andere voor alles rondom de kust. Dat is mijn betrokkenheid bij dit project.

Interviewer: Oké. Ik ben nu een stakeholderanalyse aan het uitvoeren die uiteindelijk dient als de input voor het model om erachter te komen wat de verschillende stakeholders in het gebied drijft en hoe ze zich bewegen en hoe dat vertaald kan worden naar het gedrag van de *agents* in het model. Het de bedoeling dat U Rijkswaterstaat als stakeholdergroep representeert.

HH: Dus ik hoef het niet te hebben over de externe stakeholders die ik heb daar? Dit gaat echt over de rol van Rijkswaterstaat en de mensen die daar werken in het project?

Interviewer: Ja, precies. Nou ja, wat bedoelt u met de stakeholders die u daar heeft?

HH: Nou ja, je moet je voorstellen. Binnen RWS zijn er natuurlijk allerlei betrokkenen die bij dit project betrokken zijn. Maar buiten bij de lagune zelf, laat ik het zo maar zeggen, daar heb je strandondernemers, paviljoenhouders met een recreatief belang. Je hebt de gemeente met een recreatief belang. Dat soort partijen bedoel ik, de strandbadgasten, dat soort partijen. Dus als daar ontwikkelingen zijn of wij moeten een strandsuppletie doen dan zijn dat wel allemaal partijen waar ik mee moet dealen. Dat bedoel ik met externen. Maar ook met het Hoogheemraadschap.

Interviewer: Ja precies, ik heb straks ook een interview met iemand van het Hoogheemraadschap en morgen met Richard Minkema van De Jongens uit Schoorl. Dus die heb ik zelf al onderscheiden als verschillende stakeholders.

HH: En wie spreekt je bij het Hoogheemraadschap?

Interviewer: Petra Goessen.

HH: En een belangrijke stakeholder is ook de gemeente Bergen, Willem Taal.

Interviewer: Ja, daarmee heb ik over twee weken een afspraak staan.

HH: Oké, hoe ben je daar allemaal achter gekomen? Via Gerrit (van Terwisga)?

Interviewer: Ik ben eerst bij Petra Goessen al langs geweest, dat is al een maand geleden. Via haar ben ik ook bij Willem Taal terecht gekomen en bij Gerrit (Van Terwisga). Dat is een beetje via-via gaan rollen.

HH: Mooi, dan heb je de goede mensen aan boord. Dan zal ik me nu beperken tot de RWS kant van het verhaal.

Interviewer: Ja, dat is goed. Ik heb ook nog een praktische vraag: "Heeft u er bezwaar tegen als ik dit opneem?"

HH: Nee, hoor. Dat is prima.

Interviewer: Oké. Dan zal ik beginnen met de vragen. Uw functie bij Rijkswaterstaat is dus omgevingsmanager.

HH: Ja, dat klopt.

Interviewer: Kunt u iets vertellen over de rol van Rijkswaterstaat bij de aanleg van de lagune?

HH: Ja. Toen werkte ik er zelf nog niet maar ik weet dat wel van een collega. Het Hoogheemraadschap had een projectteam dat het contract op de markt heeft gezet, de aanbesteding heeft gedaan. Een collega van mij die is in een aantal overleggen betrokken geweest bij de totstandkoming van het contract. Dat was geen bepalende rol. Er is meegelezen. Dat was niet een bepaalde rol, maar wel een adviserende rol, een meeles- en redactieele rol om te komen tot het contract.

Interviewer: Oké.

HH: Maar in de aanbesteding hebben wij niet mee beoordeeld.

Interviewer: En waarom is dat eigenlijk niet?

HH: Dat weet ik eigenlijk niet, waarom dat niet was. Je had bij het Hoogheemraadschap het aanbestedingsteam. Dat was het projectteam dat de aanbesteding en het contract deed. En je hebt bij het Hoogheemraadschap ook gewoon de beheerafdeling die ook niet direct bij de beoordeling betrokken waren maar wel meelazen.

Interviewer: Jullie hadden dus vooral een adviserende rol. De rol die vooral doorslaggevend was, was dat meer bij de gemeente?

HH: Nee, de doorslaggevende rol lag vooral bij de opdrachtgevers, dus de managers van het Hoogheemraadschap zelf. Dus daar in de lijn, projectmanager en de verantwoordingslijn richting het Hoogheemraadschap intern werden de besluiten uiteindelijk genomen.

Interviewer: Oké, en dat is de rol bij de aanleg. Hoe is de rol van het Rijkswaterstaat bij het onderhoud van de lagune de afgelopen vijf jaar. Is dat anders?

HH: Ja dat is wezenlijk anders geweest. Bij de start van het project is afgesproken, omdat Rijkswaterstaat ervaring heeft met suppleties en kustlijnzorg, dat in de onderhoudsfase

Rijkswaterstaat de aansturing van de aannemer overneemt en dat doet namens Rijkswaterstaat en het Hoogheemraadschap samen. Dat betekent dat het team van Gerrit (van Terwisga) die stuurt de aannemer aan. Die stuurt het onderhoudscontract aan. Daar zijn wij *leading* in. Omdat wij dat mede namens het Hoogheemraadschap doen, hebben we wel driehoeksoverleggen met het Rijkswaterstaat, de aannemer en het Hoogheemraadschap. En operationele overleggen. Ook bestuurlijk en ambtelijk hebben wij besluitvormende overleggen, samen met het Hoogheemraadschap en Rijkswaterstaat. Maar wij hebben in de dagelijkse aansturing van de aannemer een leidende rol gekregen. Een andere rol in deze fase is natuurlijk niet richting de aannemer maar dat is de rol van omgevingsmanager, stakeholdermanager en publiekscommunicatie. Dat is wat er in mijn portefeuille zit.

Interviewer: Publiekscommunicatie dat is bijvoorbeeld naar de omwonenden toe en de bezoekers van de lagune?

HH: Ja, de bezoekers en omwonenden. Dat soort dingen. Dus stel dat wij daar een zandsuppletie moeten doen, dan komt er een persbericht en misschien kiezen we er wel voor als een lokale omroep dat wil dat we een interview geven voor radio of tv.

Interviewer: Hebben de omwonenden en bezoekers dan een grote invloed op het vraagstuk rondom het openhouden van de lagune?

HH: Nee, wel qua imago maar geen invloed in de zin van bepalend. De gemeente heeft gezegd: 'Wij willen de lagune openhouden'. Dus wij hebben gezegd: 'Wij denken maximaal met jullie mee'. Wij delen ook onze ervaring van de eerste vijf jaar onderhoud met jullie. Dat gaat om kosten, frequentie van opengraven van de geul, hoe zijn we omgegaan met waterkwaliteit meten, allemaal dat soort dingen. De gemeente maakt dan een bestuursovereenkomst waarin het Hoogheemraadschap, zij en Staatsbosbeheer het onderhoud ondertekenen. Stel nou dat dat traject ergens zou stranden en dat het toch niet doorgaat, dan gaan schuiven wij de lagune dicht. Dat bepalen wij, zo staat het in het contract en zo is het afgesproken. Het was eigenlijk een 'cadeautje van de aannemer', zo moet je het zien. Maar als wij dat doen, de lagune heeft natuurlijk een enorme publieke waarde gekregen voor watersporters, zwemmers, surfers, kinderen die pootje baden, er is een speelschip bij gekomen. De Jongens uit Schoorl hebben een activiteitenpaviljoen neergezet. Dus als wij zeggen: 'Sorry jongens we schuiven hem dicht, want dat hebben we contractueel zo afgesproken'. Dan krijgen wij publicitair wel last. Want dat is moeilijk uit te leggen. En dan kan je heel hard zeggen: 'Zo is het afgesproken, het was een cadeautje.' En we hebben gezegd: 'Wij exploiteren geen recreatiegebieden, wij zijn van waterveiligheid. En als blijkt dat die lagune zichzelf niet in stand houdt, dat hebben wij de eerste vijf jaar geprobeerd en dat blijkt niet te lukken, dan schuiven we hem dicht. Maar ja dat heeft natuurlijk een emotionele waarde die heel moeilijk uit te leggen is. Dus in die zin is de invloed van burgers dat wij negatieve publiciteit en negatieve beeldvorming krijgen.

Interviewer: Dus de omwonenden en burgers hebben wel een groot belang, maar niet een directe invloed?

HH: Nee, dan leggen wij uit waarom we hem toch dichtschuiven en dat is het dan.

Interviewer: Dus als de lagune niet opengehouden wordt, is het dan echt dat het actief dichtgeschoven wordt? Want ik heb ook ergens begrepen dat jullie ‘de natuur zijn gang laten gaan’ met het risico dat hij dichtslibt.

HH: Ja, in het contract staan twee dingen. Of hij mag dichtgeschoven worden, of hij mag verworden tot een zilte zandvlakte. Ik weet niet of je ter plekke bent geweest maar tussen de lagune en de zee liggen voorduinen. Ik denk dat als de lagune dichtgaat, dan wordt het de variant dichtschuiven. Dan schuiven de voorduinen in de lagune. Want als je die zilte zandvlakte door de natuur laat ontstaan dan heb je de kans dat het een vieze drabboel wordt en nat met zacht zand. En ik denk niet dat je hem zo moet willen achterlaten, ook vanuit veiligheidsoogpunt. Ik denk dat het het eerste wordt. Als we er niet uitkomen, wat ik niet verwacht.

Interviewer: De beslissing is al wel genomen om hem actief open te houden toch?

HH: Ja, er is een contractuele plicht dat wij als aannemer de eerste vijf jaar die lagune actief openhouden. Dus ook zo vaak als nodig de geul richting zee open maken zodat het water zich ververst. En ook de lagune op diepte houden. Dat moeten we de eerste vijf jaar van het contract doen. Nou, de eerste vijf jaar die zijn na dit recreatieseizoen hebben we die eerste vijf jaar gehad. Dus in principe in oktober zou de aannemer kunnen zeggen; ik schuif hem dicht. Maar omdat de gemeente met De Jongens uit Schoorl dit initiatief hebben genomen, hebben we gezegd: “We willen wel dit jaar die overeenkomst rond hebben, maar het is voor de aannemer geen bezwaar dat het pas in april dichtgeschoven wordt”. Maar ik ga er van uit dat we er met zijn allen uit komen en dat we na dit recreatieseizoen de gemeente het overneemt.

Interviewer: Hoe staan jullie als Rijkswaterstaat tegenover de lagune? Zien jullie het als een toegevoegde waarde? Wat voor belang hebben jullie erbij?

HH: Eigenlijk nul. Wij zien het als een toegevoegde waarde, absoluut. Want het heeft toegevoegde waarde voor de lokale samenleving daar. Want het trekt mensen, het trekt toeristen, het heeft absoluut toegevoegde waarde. Als je sec kijkt naar waar wij van zijn, zijn wij als Rijkswaterstaat langs de kust alleen maar van waterveiligheid; bescherming tegen de zee. Nou heeft dit contract, bij Petten en bij Camperduin, een droogstrandbreedte-eis om daarmee ook een recreatief belang te dienen. Dus die droogstrandbreedte eis van vijftig meter gaan wij gewoon handhaven. Daarom is het van belang dat de aannemer dat doet omdat wij dat contract gewoon moeten dienen. Maar stel dat de gemeente en ondernemers de lagune alsnog niet willen, dan zeggen wij: “Wij zijn geen exploitanten van recreatiegebieden, dus als niemand anders het wil doen dan volgen wij het contract en gooien we het dicht”. Want de aannemer hoeft het niet meer te doen, dat zijn wij overeengekomen. Dan gaan wij niet als Rijkswaterstaat een nieuw contract met een nieuwe aannemer maken om die lagune open te houden. Nee, want dan zouden wij een recreatiegebied exploiteren en daar zijn wij niet van.

Interviewer: Nee, omdat jullie daar niet direct baat bij hebben.

HH: Nee, zo is dat. En dat is vervelend voor de regio maar dat is wel wat wij doen. Dan handelen wij het contract af en dat betekent dichtschuiven. Maar wij zien wel het belang van de regio en daarom

zeggen wij wel: "Joh, we gaan maximaal meewerken en onze ervaring delen zodat zij ermee kunnen doorgaan".

Interviewer: En is het dan weer aan de andere kant voor jullie dat het bijvoorbeeld geld kost? Dat jullie liever zien dat hij dichtgaat omdat dat bijvoorbeeld goedkoper is?

HH: Nee want de lagune zit in de aanbieding van de aannemer die die gedaan heeft. Dus het budget van het onderhoud hebben wij toch. Dat hebben wij van het schap overgekregen natuurlijk. En dat onderhoudsbudget was voor vijf jaar. Dus als hij open blijft kost het ons niks want dan komt het op het budget van de gemeente en de exploitanten.

Interviewer: Omdat zij het initiatief hebben genomen om hem open te houden?

HH: Ja. Dus je moet je voorstellen dat het hele onderhoud en het openhouden van de lagune gaat door de gemeente en de ondernemers gedaan worden. Dus zij zullen een aannemer daarvoor in de arm nemen. En dat gaat van hun budget af. Dus wij sluiten een overeenkomst met ze. En zij nemen het onderhoud over van hun eigen budget.

Interviewer: En de exploitanten, is dat De Jongens van Schoorl of zijn dat ook de andere strandpaviljoens?

HH: Volgens mij zijn dat De Jongens van Schoorl en Stichting het Speelschip. Ik weet wel dat de exploitanten van Luctor et Emergo meer gaan over de droogstrandbreedte-eis. En als we dan sec praten over de lagune, dan praat ik altijd met Willem Taal, Richard Minkema en Joost Botman. En er zit volgens mij ook altijd iemand bij van Struin. Maar ik heb Richard en Joost als contactpersoon. Maar wie precies bij de ondernemersgroep zit ten aanzien van de lagune om daar financieel aan bij te dragen dat weet ik eerlijk gezegd niet. Maar wij hebben er in die zin wel belang bij dat de gemeente hem overneemt en dat die open blijft omdat dat ook een goed signaal is naar de buitenwereld: "Dit kunnen wij samen bereiken".

Interviewer: Ja, dat zijn niet directe baten die jullie erbij hebben, maar meer qua imago.

HH: Imago ja, maar wij zijn als Rijkswaterstaat ook welwillend: als wij samen met andere overheden en bedrijfsleven meerwaarde kunnen creëren waarbij iedereen zijn deel bijdraagt. Daar zijn wij wel voor.

Interviewer: Maar in principe is het jullie om het even?

HH: Ja, want wij hebben budget voor het onderhoud al beraamd. Daarna kost het ons niks meer.

Interviewer: denken jullie dat het openhouden van de lagune veel geld genereert voor het gebied? Is het een toegevoegde waarde? Qua imago, maar ook op een economische manier?

HH: Nou ja, dat denk ik wel. Ten eerste denk ik omdat de gemeente en de ondernemers anders het gebied niet hebben genomen. Als het paviljoen dicht gaat staat het heel ver van de zee af. Dus ja, ik

het genereert zeker inkomsten. Maar exacte cijfers zou ik niet weten. Daarvoor zou je bij de gemeente of bij Richard Minkema moeten zijn.

Interviewer: Ja. Dan zal ik dat aan een van hen vragen. Ik heb al een excel-bestand met een kostenschatting van Gerrit (van Terwisga) gekregen.

HH: Oh, dat is heel mooi.

Interviewer: Ja, dat is zeker wel nuttig. Ik denk eigenlijk dat ik er wel ben. Het is vooral de bedoeling om een duidelijk overzicht te krijgen van hoe jullie er in staan, wat jullie rol is en wat de baten zijn. Bedankt dat je tijd vrij kon maken.

HH: Oke, ik hoop dat je een duidelijk beeld hebt. Interessant project wat je doet.

Interviewer: Ja, dat vind ik ook. Ik zal laten weten als het zo ver is.

HH: Ja, dat lijkt mij leuk. Fijne dag verder.

Interviewer: Bedankt, hetzelfde.

Interview with Petra Goessen

Representative for Hollands Noorderkwartier Water Board (HHNK)

Petra Goessen: Hallo, met Petra

Interviewer: Hallo, met Laura Alblas. Komt het u goed uit dat ik bel?

PG: Ja, hoor.

Interviewer: Oké, ik heb u twee maanden geleden al gesproken over een focus of invalshoek voor mijn thesis. Uiteindelijk is dat iets veranderd omdat ik erachter ben gekomen omdat onderwerpen met morfologie en hydrologie iets te technisch voor mij zijn omdat ik niet uit dat veld kom. Dus nu is de invalshoek wat sociaal geworden en het idee is nu dat ik de verschillende stakeholders uit het gebied van de lagune bij Camperduin ga modelleren in een Agent Based Model waarbij dus iedere stakeholder gerepresenteerd wordt als een agent. De stakeholders die ik nu gedefinieerd heb zijn jullie – als Hoogheemraadschap –, de aannemer – Van Oord/Boskalis, Rijkswaterstaat, de Gemeente en de gebruikers van de lagune. De stakeholderanalyse wordt uiteindelijk gebruikt als input voor het model. Hierbij represeneert u het Hoogheemraadschap als stakeholdergroep.

PG: En welke gebruikers heb je onderzocht? De gebruikers, zijn dat recreanten of de ondernemers?

Interviewer: Dat zijn de recreanten, want ‘De Jongens uit Schoorl’ van Richard Minkema beschouw ik apart als stakeholdergroep.

Interviewer: Ik weet al best veel uit het vorige gesprek, dus sommige vragen zouden dubbel kunnen zijn. Het is vooral voor het onderzoek noodzakelijk dat het wat gestructureerde en vollediger is. Een praktische vraag om mee te beginnen: “Heb je er bezwaar tegen dat dit gesprek opgenomen wordt?”

PG: Nee, hoor.

Interviewer: Oké, dan zal ik beginnen met de vragen. Kun je mij vertellen wat de rol van het Hoogheemraadschap bij de aanleg van de lagune is?

PG: Wij hadden bij het onderwerp de aannemers gevraagd of zij iets extra's konden doen voor dezelfde euro. In de zin van, ze kunnen het waarschijnlijk allemaal: een bak zand neerleggen. Dus wij hebben ze uitgedaagd wat zij extra zouden kunnen doen voor de regio. Deze aannemer heeft deze lagune bedacht. Dit is een tijdelijke situatie. Daar hebben zij de meeste punten voor gekregen in combinatie met de prijs, voor dit ontwerp. Dit mochten zij toen uitproberen.

Interviewer: Dus hun ontwerp, in combinatie met de kosten heeft uiteindelijk de doorslag gegeven om voor deze aannemer te kiezen?

PG: Ja, precies.

Interviewer: De aannemer nu is Van Oord/Boskalis. Welke aannemers waren nog meer in de race?

PG: Dat weet ik eigenlijk niet eens, dat is een tijdje terug. Ik weet niet eens of ik dat mag zeggen. Het is een openbare aanbesteding geweest. Over het algemeen zijn het altijd dezelfde. Het zijn er maar een paar in Nederland en België die een poging doen.

Interviewer: Oké. Waarom was er behoefte aan iets extra's? Waarom waren de Hondsbossche Duinen niet genoeg?

PG: Je wilt iets onderscheidends hebben voor een aannemer. Je gaat er vanuit dat iedereen hetzelfde werk voor dezelfde prijs kan doen. Waar ga je dan op kiezen? Dan kies je voor kwaliteit. We hebben een opdracht gegeven voor veiligheid en kwaliteit. De veiligheidsopgave – gooï er een bak zand voor – dat kan iedereen voor dezelfde prijs. Maar wat kunnen ze nou extra doen voor de kwaliteit opdracht die er ook ligt? We hebben de kwaliteit opdracht vertaald als ‘zand is mooi voor de natuur en recreatie’. Daarom hebben we hier gekozen voor zand en niet voor een ouderwetse dijk. En dat is voor de veiligheid handig want het is een flexibel systeem. Als de zeespiegelstijging tegenvalt dan gooï je er wat meer zand op en valt het mee dan heb je mazzel want dan heb je minder onderhoud. We vinden dit vanuit veiligheid een hele fijne oplossing. Maar ja, wat kun je dan nog extra doen? Dan kom je al snel uit bij natuur en recreatie en toen is de vraag geweest: ‘verzin daar iets leuks voor’. En daar heeft deze aannemer gezegd: ‘een lagune voor de recreatie en iets verderop wat meer natuur. De lagune is een hotspot voor recreatie.

Interviewer: Oké. En vanuit het Hoogheemraadschap zijn jullie er puur voor de veiligheid. Hebben jullie als Hoogheemraadschap baat bij de lagune dat hij er is? In term van dat het recreatie oplevert en dat het geld genereert, hoe zien jullie dat?

PG: Nee, we willen daar alleen een goede buur in zijn. De belastingbetalen betaalt ons voor waterveiligheid. Ook voor waterkwaliteit maar dan gaat het om waterkwaliteit landinwaarts. Waterkwaliteit van de zee worden wij niet voor betaald om dat te doen. Het enige dat wij kunnen doen is een goede buur zijn voor de gemeente. Ook met de natuurorganisaties en elkaar daarbij helpen en steunen.

Interviewer: Want degene die het meeste baat bij hebben bij de lagune zijn de gemeente en de ondernemers?

PG: Juist, en de bezoekers.

Interviewer: Wat is jullie rol bij het onderhoud van de lagune? De afgelopen vijf jaar en in de toekomst?

PG: Wij hebben eigenlijk meer een soort ‘signaleringsrol’. De aannemer heeft de taak om de lagune open te houden. Wij lopen daar vaker rond dan de aannemer. In het begin is de aannemer daar heel

veel bij aanwezig. Wij roepen ze nu terug: ‘we hebben een melding dat de waterkwaliteit niet goed is’. In die zin hebben wij meer een signalerende, en bijna een controlerende rol. Op het moment dat er iets aan de hand is dan trekken wij aan de bel. In de toekomst hebben wij daar geen rol. Ik ben heel benieuwd hoe dat gaat lopen. Voor de veiligheid ligt het zand er, hoe het zand er ligt en of de waterkwaliteit van de lagune slecht wordt gaan wij niet over. We hebben er wel ideeën over. Wij kunnen vanuit onze expertise wel iets aanbieden of meedenken maar we hebben onze handen op onze rug staan daarin. De gemeente vindt het belangrijk en heeft er geld voor over, maar wij kunnen het niet betalen en wij kunnen het niet maken. Daar betaalt de belastingbetalen geld voor aan de gemeente, en niet aan ons.

Interviewer: Want het geld dat wordt betaald aan jullie is puur bedoeld voor waterveiligheid?

PG: Juist

Interviewer: Dus ik kan jullie rol meer zien als een adviserende rol nu, en dan de aannemer als de uitvoerende rol?

PG: Ja. Zij hebben nu ook de verantwoordelijkheid. Het contract is dat zij dat voldoende openhouden, maar tot oktober dit jaar (2020, red.). Onze buitenman heeft al een aantal keer aan de bel getrokken van: “Gemeente, als je iets wilt moet je dat wel gaan organiseren.” Als de gemeente het belangrijk vindt en de ondernemers ook, dan zou het zijn dat ze daar iets moeten organiseren.

Interviewer: Is er nu al definitief uitsluitsel over wat er vanaf oktober gaat gebeuren?

PG: Nee, nog niet. Wij weten het in ieder geval nog niet. Misschien dat de gemeente al een stap verder is. Wij weten niet anders dan dat het stopt in oktober.

Interviewer: Vanaf oktober stopt het onderhoud voor jullie sowieso?

PG: Ja.

Interviewer: En dan is het aan de gemeente en eventueel de ondernemers of zij het de moeite waard vinden de lagune open te houden? En daar geld in willen investeren.

PG: Ja.

Interviewer: En zou ik de aannemer eventueel nog kunnen zien in een andere rol? Zijn zij puur uitvoerend of hebben zij zelf ook nog invloed in de zin van: handelen zij alleen als er opdracht wordt gegeven of nemen zij ook initiatief?

PG: Zeker niet. Zij verdienen geld met het project, het is een miljoenenproject. Alles dat zij nu extra doen zijn kosten. Dat zien zij niet als baten. Alles dat zij niet hoeven te doen is voor hun beter want dan houden ze meer geld over op het eind.

Interviewer: Hoe moet ik dat zien?

PG: Zij hebben natuurlijk beraamd hoe vaak zij denken dat ze dat moeten doen. Het kost geld om het te onderhouden. Dus als het niet nodig is dan gaan ze dat niet doen. Het contract loopt af in oktober, dan zijn zij weg. Dan zijn zij klaar.

Interviewer: Maar aan de andere kant levert het voor de aannemer ook geld op neem ik aan?

PG: Hoezo?

Interviewer: Nou, ik zie het zo dat ze voor de opdracht betaald krijgen.

PG: Dat klopt, voor de grote opdracht hebben zij betaald gekregen.

Interviewer: Oh, dat is eenmalig binnengehaald?

PG: Waarschijnlijk. In ieder geval, de afspraak is dat zij tot oktober dat moeten doen. Daar hebben zij zelf over nagedacht: ‘Nou dat zal een X aantal keren zijn.’ Dat hebben zij geraamd en dat hebben zij ook gekregen. Dus als zij het een keer extra moeten doen, kost het ze geld. Doen ze het minder, hebben ze wat verdiend. Maar het zijn allemaal ‘peanuts’ vergeleken bij zo’n heel project. Zij denken meer in grotere projecten.

Interviewer: Als ik het aan hen zou vragen, zouden zij neutraal tegenover het behoud van de lagune staan?

PG: Ja. Ze zullen het wel voor de gemeente doen, maar dat gaat de gemeente heel veel geld kosten. Ik zou de gemeente eens willen adviseren: ‘Vraag het eens aan ons – aan de waterschappen’. En betaal diegene en dan helpen we elkaar. Ik denk dat dat goedkoper is. Want zij hebben het materieel al op de werf staan. De aannemer moet van verder komen.

Interviewer: Dus het werk dat de aannemer doet zou het Hoogheemraadschap ook kunnen doen?

PG: Zeker. Alleen dan kom ik weer bij de taakopvatting. Wij worden daar niet voor betaald. Wij mogen dat niet zomaar doen. Als de gemeente vraagt: ‘Help ons daarmee, wij betalen het, wij betalen de onkosten’. Dan denk ik wel dat het waterschap zegt: ‘Dat doen we wel’. Ik kan me wel voorstellen dat dat kan. Maar dat is nog niet zo, het is nog niet onze taak dus dat gaan wij niet doen. Tenzij er andere afspraken komen.

Interviewer: Dat moet vanuit de gemeente komen?

PG: Ja, daar moeten wij bestuurlijke afspraken over maken. De gemeente kan zelf ook de aannemers die wij af en toe inhuren ook inhuren. Maar goed, iets dergelijks is wel te bedenken. Mensen moeten wel zeggen: ‘Dat vinden wij belangrijk en we hebben er wat voor over.’

Interviewer: Oké. Dus op het moment is het vooral de gemeente die een beslissing moet nemen of zij het de investering waard vinden?

PG: Ja. Of de gecombineerde ondernemers.

Interviewer: Zijn jullie nu verder nog betrokken bij het vraagstuk over het wel of niet openhouden van de lagune of is dat ook vooral adviserend?

PG: Ja, adviserend. Daar zijn wij niet bij betrokken.

Interviewer: Dus jullie hebben daar geen doorslaggevende rol meer in?

PG: Nee, niet echt nee.

Interviewer: Het doel van dit interview is vooral om een goed beeld te krijgen van de verschillende stakeholders en de partijen die in dat gebied actief zijn. En de interactie met elkaar en wie welke rol speelt. Maar zoals ik het nu hoor is het dus vooral de ondernemers en de gemeente die een besluit moeten maken.

PG: Ja, of de provincie zou je ook nog kunnen interviewen. Dat is een andere partij.

Interviewer: Want wat is hun rol? Wat is hun invloed?

PG: Zij hebben de opdracht neergelegd aan ons van: 'combineer kwaliteit en veiligheid'. De provincie is bevoegd gezag voor natuur maar ook voor het overkoepelende. De gemeente kijkt alleen binnen hun gemeente maar als iets een uitstraling heeft wat buiten de gemeente is, met de gemeente ernaast, dan heeft de provincie daar ook een idee over. Streekplannen komen bij de provincies vandaan. Bestemmingsplannen bij de gemeente. De grotere lijnen komen bij de provincie vandaan. Dus ik kan me goed voorstellen dat de provincie ook wel een idee over de lagune heeft.

Interviewer: Dat is inderdaad wel een goed punt denk ik omdat het project van de Hondsbossche Duinen wel twee verschillende gemeentes bestrijkt.

PG: Ja, en meerdere wensen. Dus je hebt veiligheid, natuur en recreatie. De lagune aan de zuidkant is Natura2000 gebied. Staatsbosbeheer is daar terreinbeheerder. Die moeten of aan ministerie van LNV rapporteren maar Natura2000-toezicht doet volgens mij de provincie. Of er wel of niet een paviljoen wordt geplaatst, daar vindt de gemeente wat van, daar vindt Rijswaterstaat wat van, het waterschap maar ook de provincie. De provincie is wat meer hoofdlijnen, en de gemeente wat meer detail. Ik zou die zeker ook even benaderen.

Interviewer: Ja, dat is een goed idee. Ik ben inderdaad met veel mensen in gesprek, maar de provincie heb ik nog niet aan gedacht.

PG: Myra Heesakkers is vanuit natuur een goede ingang. Ik kan me voorstellen dat zij bij dit project niet zo betrokken is, maar dan weet zij wel de goede ingang binnen de provincie waar jij het meeste aan hebt.

Interviewer: Ja, daar zal ik even achteraan gaan. Bedankt. En wat denk jij van de bezoekers? Die hebben natuurlijk veel belang omdat de lagune een trekpleister is en een toegevoegde waarde. Maar hebben de bezoekers invloed?

PG: Dat is nou echt een goede vraag voor de gemeente. Hoe zij luisteren naar hun bezoekers. Of dat ze zeggen: 'Dat zijn de ondernemers, die hebben daar omzet van'. Maar de parkeerterreinen hebben ook omzet. Dat is weer de gemeente denk ik. Dat is via de gemeente denk ik een hele goede vraag.

Interviewer: Ik heb volgende week een afspraak met Willem Taal staan, dan zal ik dat even bij hem voorleggen.

PG: Wil je nog met Staatsbosbeheer of Natuurmonumenten praten?

Interviewer: Ja, als zij ook een actieve rol daar hebben, zeker.

PG: Dat hebben ze nu niet, ze zijn daar meer natuurbeheerde. Maar ze zijn wel een goede buurman. Ze kunnen daar ook nog wat van vinden. Dat kan zomaar haaks staan op de rest, dat kan voor jouw onderzoek nog wel leuk zijn. Als de lagune nu blijft zoals hij is, dan is het vrij rustige recreatie, niks mis mee. Heeft de natuur alleen maar mazzel mee, want mensen lopen niet zo ver en blijven lekker daar. Aan de andere kant kun je zeggen: 'We gaan er houseparty's organiseren met lichtvervuiling en lange rijen tot diep in de nacht'. Daar vinden zij wel weer wat van.

Interviewer: Ja, dat het bijvoorbeeld verstoring is voor de flora en de fauna daar.

PG: Ja, voor de broedvogels. Ik kan me voorstellen dat zij daar wel wat van vinden. En als je nou iets *out of the box* denkt en je kijkt naar het water bij IJmuiden aan de zuidkant van het Noordzeekanaal. Dat is spontaan ontstaan, dat is niet aangelegd. Dat water werd op een gegeven moment gebruikt voor recreatie, zeker als het waaiide. De waterkwaliteit werd op een gegeven moment bijzonder slecht omdat er een meeulenkolonie was neergestoken. Die poept veel en het water stroomde niet, dus het werd nogal vies water. Dat heeft op een gegeven moment Natuurmonumenten naar zich toegetrokken. Die hebben daar twee gebieden van gemaakt, de een was puur natuur. Je zou dat ook hier kunnen zeggen van: 'Je gooit de recreanten eruit en het wordt natuur'. Ik heb begrepen van Martien dat niemand van natuurwensen daar aan wilde. Zij hadden iets van: 'Je weet niet hoe het gaat ontwikkelen en dat kost meer dan dat het oplevert, dus doe maar niet'. In die zin zijn zij afwachtend en daarin is het ook meer haalbaar vanuit een ondernemer of de gemeente om het harde geld meteen terug te zien. Als je meer mensen aantrekt die allemaal een ijsje halen, dan heb je al inkomsten. Voor natuur moet je een langere adem hebben. In die zin denk ik dat de pijlen gericht zijn op degenen die er wat aan kunnen verdienen wat betreft recreatie. Maar daar ben ik ook een leek in, dat is niet mijn vak. Dat lijkt mij logischer.

Interviewer: Dat zijn korte termijn opbrengsten.

PG: Ja, maar ik kan me voorstellen dat de natuurman of -vrouw daar misschien ook ideeën over heeft.

Interviewer: Dat is inderdaad wel goed om te weten want ik ben inderdaad op zoek naar voors- en tegens om uiteindelijk te kunnen bepalen of het het meest rendabel is om de lagune open of dicht te houden op basis van de belangen.

PG: Ja, dan zou je eigenlijk ook met iemand kunnen kletsen met iemand van Natuurmonumenten bij IJmuiden.

Interviewer: Oké, bedankt. Ik denk dat de overige vragen toch meer geschikt zijn voor het interview met de ondernemers en de gemeente omdat die meer gericht zijn op de lagune als waarde voor het gebied. Nu neem ik aan dat iedereen het daar wel over eens is dat het een toegevoegde waarde is. Maar de directe belangen liggen meer bij hun. In ieder geval: voor jullie directe belangen is het jullie om het even of de lagune open of dicht is? Als ik dat zo mag zeggen.

PG: Ja. Voor ons zit het pijnpunt voorbij Hargen, bij de Hondsbossche. Bij de zuidkant wil je wat extra zand hebben hoe die wordt neergelegd, dat maakt voor ons niet uit. De lagune mag van ons verdwijnen.

Interviewer: Dat gaat meer om het praktische, de waterveiligheid.

PG: Ja.

Interviewer: Oké, ik denk dat ik dan genoeg informatie heb nu.

PG: Heel goed.

Interviewer: Ik denk dat het duidelijk is wat jullie standpunt is en wat jullie beweegredenen zijn in het gebied.

PG: Ik ben heel benieuwd wat je gaat ophalen bij de anderen.

Interviewer: Ja, het is heel interessant om te ontdekken wat er speelt en ik hoop ook dat er voor mij iets uit gaat komen.

PG: Ja, als je zover bent tegen die tijd ben ik benieuwd naar het resultaat. En als je tussentijds vragen hebt: schroom niet. Ook als je niet verder komt met contactpersonen.

Interviewer: Dat zou heel fijn zijn. Dan laat ik dat weten. Bedankt voor je tijd vandaag.

PG: Heel veel succes, en veel plezier. Het is een leuke klus.

Interviewer: Fijne dag.

PG: Hetzelfde.

Interview with Willem Taal

Representative for Municipality of Bergen

WT: Met Willem Taal.

Interviewer: Goedemorgen, met Laura Alblas.

WT: Oh hai, goedemorgen.

Interviewer: Komt het uit?

WT: Ja, hoor.

Interviewer: Ik zou u nog bellen over het interview dat ik met u af zou nemen voor mijn scriptie.

WT: Ja, over de lagune he?

Interviewer: Ja, dat klopt. Ik had u een tijdje geleden daar al over gesproken alleen toen is gebleken dat de factoren die ik aan het onderzoeken was eigenlijk weinig invloed hadden op de lagune. Dus ik heb de focus van mijn onderzoek een beetje aangepast.

WT: Ja, dat begreep ik uit je mail.

Interviewer: Ja, dus ik ga nu meer met een sociale insteek het onderzoek doen, waarvoor ik ook een stakeholderanalyse ga doen.

WT: Ja.

Interviewer: Daarvoor heb ik stakeholder geïdentificeerd. Een daarvan is de gemeente. Als in: De BUCH (Bergen, Uitgeest, Castricum, Heiloo). Daarvoor bent u de vertegenwoordiger. Allereerst wil ik ook vragen: 'Vindt u het erg als ik dit interview opneem zodat ik het kan uitwerken?'

WT: Nee, hoor.

Interviewer: Ten eerste: Wat is de rol van De BUCH in het algemeen?

WT: De BUCH is een werkorganisatie. Dat betekent dat de ambtelijke organisaties van vier gemeentes – Bergen, Uitgeest, Castricum en Heiloo – zijn samengevoegd. Dat zijn nog steeds vier afzonderlijke gemeentes. Dat waren allemaal vrij kleine gemeentes. Dat was om de vier gemeentes beter ambtelijk te kunnen ondersteunen. Alle nieuwe taken die de gemeentes op zich af hebben gekregen, vooral in het sociaal domein.

Interviewer: Oké. En is dat vooral voor de lagune en de Hondsbossche Duinen of geldt dat voor meerdere projecten?

WT: Nee, want de lagune is een Bergense angelegenheid. De vier gemeentes hebben nog wel eigen begrotingen en eigen beleid op bepaalde onderdelen en de lagune is daar onderdeel van.

Interviewer: Oké, en dat gaat vooral om de gemeente Bergen?

WT: Ja.

Interviewer: Oké. Wat is de rol van de gemeente Bergen bij de aanleg van de lagune vijf jaar geleden?

WT: De lagune is een onderdeel geweest van het project ‘Kust op Kracht’. De Hondsbossche Zeewering was de laatste ‘Zwakke Schakel’, zoals dat heette, in de hele kustverdediging – het Deltaprogramma Kust zoals dat heet. De zeeweringen in Zeeland is daar een voorbeeld van, en zo hebben ze allerlei plekken in de Nederlandse kust onderzocht en bekeken hoe ze die het beste kunnen verstevigen. En de Hondsbossche Zeewering was daar de laatste van. Toen is daar onderzoek gedaan: ‘Hoe kunnen we dat het beste doen?’ Toen is uiteindelijk voor gekozen om daar nieuwe duinen voor de Hondsbossche Zeewering aan te leggen. Vanuit het Rijk en de Provincie kwam toen gelijk de mogelijkheid om ruimtelijke kwaliteit te ontwikkelen. Dus om het gebied economisch en toeristisch te versterken. Zo zijn er allerlei fietspaden aangelegd en wegen verbeterd, en dat soort dingen. Een daarvan was de lagune. Dat was puur om de ruimtelijke kwaliteit een impuls te geven zodat het gebied aantrekkelijker wordt voor toeristen en bezoekers. Snap je dat?

Interviewer: Ja zeker, dat is inderdaad ook wat ik al eerder gelezen heb. Wat was de rol van de gemeente op dat moment?

WT: De planvorming is lang geleden. Dat speelde daarvoor allemaal al. Daar was Rijkswaterstaat bij betrokken, daar was het Hoogheemraadschap bij betrokken, daar was de aannemer bij betrokken, de ondernemers uit Camperduin waren daarbij betrokken, de inwoners waren daarbij betrokken. Dan is er nog niks en dan moet je nadenken over een gebied. Dan wordt er van alles en nog wat geroepen. Toen is de lagune ook door iemand geroepen als iets bijzonders aan de Nederlandse kust. Zo is die daar gekomen.

Interviewer: Oké. En het onderhoud de afgelopen vijf jaar, wat heeft de gemeente daarbij gedaan?

WT: Daar hoefden wij de afgelopen vijf jaar niks voor te doen. Want dat heeft de aannemer gedaan. Het hele gebied, Hondsbossche Duinen, moet voor twintig jaar onderhouden worden door de aannemer. Dus zij moeten ervoor zorgen dat er genoeg zand voor de duinen blijven liggen, dat het gebied er achter veilig is. In het contract staat ook dat de aannemer voor vijf jaar de lagune moet bijhouden. Die vijf jaar loopt nu af. Tot 1 januari 2021. De raad heeft afgelopen donderdag gezegd: ‘Wij vinden het een goed idee’. Dus de gemeente gaat over tot onderhoud en betalen. Zoals het er nu voor staat.

Interviewer: En voor wie waren de kosten van het onderhoud voorheen?

WT: Voor de aannemer.

Interviewer: Op dit moment is dus besloten dat de lagune in stand wordt gehouden en dat het onderhoud overgedragen wordt aan de gemeente. Wie gaat dat dan uitvoeren?

WT: Ik, zolang ik blijf werken. Samen met de ondernemers en een aannemer die we nog moeten aanwijzen. Er moet natuurlijk gegraven worden want er moet vers water in. Ben je er wel eens wezen kijken bij de lagune?

Interviewer: Ja, ik kom daar vandaan en ben daar geboren dus ik ken het gebied wel goed.

WT: Oh, kom je uit Camperduin?

Interviewer: Uit Groet.

WT: Oh, en je komt er nog wel eens?

Interviewer: Ja, zeker.

WT: Oh, dan hoef ik je niks uit te leggen.

Interviewer: Ja, het is een heel mooi gebied.

WT: Ja, precies.

Interviewer: Het vraagstuk over of de lagune open gehouden moet worden of niet. Daar is de gemeente wel bij betrokken? En op welke manier?

WT: Het was zo: de gemeente stond voor de vraag: 'Willen we de lagune behouden, ja of nee.' Want in het contract met de aannemer was afgesloten voor onderhoud van het project was afgesloten dat de lagune na vijf jaar dichtgeschoven zou worden. Toen is samen met de ondernemers en inwoners besloten van: 'Willen we het behouden, ja of nee'. Er is onderzoek gedaan onder de inwoners. Een heleboel waren voor; mooi gebied. We hebben flitspeilingen gedaan. De ondernemers willen ook graag dat het open blijft want het is een goed marketinginstrument. Waar vind je zoets. Omdat het enerzijds verbonden is aan de ruimtelijke kwaliteit van Camperduin. Het geheel is meer dan de som der delen: haal je de lagune daar weg dan verlies je een stuk van die kracht. Dat weet je zelf ook wel want je loopt naar Luctor (et Emergo – strandpaviljoen op het strand van Camperduin) en je ziet daar leuk die lagune liggen als je naar het Zuiden kijkt. En anders zie je een of andere zandvlakte want dat komt er dan als hij dichtgeschoven wordt. Uit dat oogpunt, om ook het hele strand van Bergen te behouden. Egmond-Binnen heeft zijn eigen kwaliteiten, Egmond aan Zee heeft zijn eigen kwaliteiten, Bergen aan Zee heeft zijn eigen kwaliteiten, Hargen en Schoorl hebben hun eigen kwaliteiten. Nu heeft Camperduin ook zijn eigen kwaliteit. Dat palet van strand van de gemeente Bergen wordt alleen maar rijker.

Interviewer: Dus de gemeente stond er wel achter om de lagune open te houden?

WT: Ja. We hebben toen ook gezegd: ‘Omdat vooral de ondernemers van Camperduin ervan profiteren, vinden we dat de ondernemers financieel moeten bijdragen’.

Interviewer: Oké, dat begrijp ik. Is er vanuit de ondernemers een actief initiatief ontstaan om de lagune open te houden?

WT: Ja, ze hebben natuurlijk belang daarbij. We moeten natuurlijk per 1 januari 2021 het beheer overnemen. Er moet daarvoor ook een soort beheergroep komen om dat handen en voeten te geven want er moet uitgegraven worden. Wanneer ga je uitgraven, er moet iemand bij staan om toe te zien wat we hebben afgesproken. Dus dat moet gebeuren. Daar gaan de ondernemers een belangrijke rol in spelen.

Interviewers: Heeft u samen met de ondernemers een kostenplaatje hiervan gemaakt? Het gaat natuurlijk wat kosten, maar heeft u ook enig idee wat het gaat opleveren?

WT: Nee, dat zijn maatschappelijke effecten. Die zijn heel moeilijk te meten. Dan zou je een maand op de strandafgang moeten staan en mensen gaan tellen; waar gaan ze heen? Gaan ze naar de lagune of gaan ze naar het strand? Ik zeg altijd maar: ‘Toen ik zes jaar geleden op Camperduin kwam. In de winter durfde ik gerust een kanon af te schieten want hij raakte toch niemand. Nu durf ik dat niet meer’.

Interviewer: Het is inderdaad veel drukker geworden.

WT: Dat is nu meer beleven dan dat je dat in harde cijfers kunt uitdrukken.

Interviewer: Ik zou dat eigenlijk wel moeten doen, aan elke bezoeker een soort ‘opbrengsten’ moeten toekennen. Maar dat zou afhangen van een schatting en een aanname.

WT: Ja, je kan zeggen dat de lagune echt geschikt is voor kinderen en gezinnen met kinderen. Er staat natuurlijk ook een speelschip. En voor watersporters en kitesurfers en vakantie- en groepsactiviteiten. Er komen ook veel scholen en schoolreisjes. Er worden veel lessen gegeven door scholen over natuur en schoonmaken en plastic soep en dat soort dingen. Dat speelt allemaal, educatie over natuur en bewustwording over milieu.

Interviewer: Als ik het zo hoor zijn er veel verschillende doelgroepen met verschillende activiteiten.

WT: Ja, precies.

Interviewer: Zien jullie dat vooral terug in de opbrengsten voor de omliggende paviljoens en de vakantiehuisjes?

WT: Nee, dat weten wij natuurlijk niet want de paviljoens zijn ondernemers. Zij gaan niet elk jaar hun omzet aan de gemeente laten zien. Dat hoeven ze ook niet en dat willen wij ook niet. Er is een parkeerplaats maar die is ook niet van ons, die is particulier.

Interviewer: Oh, ja. Daarvoor zou ik misschien met iemand anders contact op moeten nemen. Dan over de besluitvorming over het openhouden van de lagune. Als het niet opengehouden wordt, laten jullie de natuur dan zijn gang gaan of wordt het actief dichtgeschoven?

WT: Nee, dan zou het dichtgeschoven worden met het zand van de voorduinen. Die zouden dan over de lagune geschoven worden. Dan zou de natuur verder zijn gang gaan.

Interviewer: De rol van de gemeente was daarin dus wel doorslaggevend? Klopt het dat jullie uiteindelijk het besluit hebben genomen om het over te dragen?

WT: Ja, over te nemen. Het instandhouden van de lagune.

Interviewer: En dan kan ik de rol van de ondernemers, de bewoners en de bezoekers zien als adviserend?

WT: Ja, participerend en meedenkend. En de ondernemers meebehalend. Dat is eigenlijk als je het zo vertaalt, de mening van de inwoners en de mening van de direct betrokken ondernemers is allebei net zo belangrijk. Als de bewoners bij wijze van komen van: ‘We vinden het niks’. Dan is het richting de gemeenteraad van: ‘Stop er maar mee’.

Interviewer: En als het om de ondernemers gaat, wie zijn dat dan?

WT: Zij zijn verenigd in de stichting ‘Camperduin aan Zee’. Dat is Jos van het hotel, Richard Minkema en Joost Botman.

Interviewer: En zit Luctor (et Emergo) daar ook bij?

WT: Nee.

Interviewer: En waarom niet?

WT: Die is uit de stichting gestapt. Luctor heeft niet een direct belang bij de lagune. Want je gaat naar het strand, of je gaat naar de lagune. Je gaat niet naar allebei. Volgens mij is dat ook een keuze als je naar Camperduin gaat; of je gaat naar de lagune of je gaat naar het strand. Voor het overgrote deel is dat zo. Je gaat bewust naar de lagune omdat je kleine kinderen hebt, je hebt sportactiviteiten in de lagune. Naar het strand ga je echt als je naar het strand gaat of naar de zee.

Interviewer: Ja, ik kan me voorstellen dat daar een soort overweging in zit.

WT: Vanuit die optiek heeft Luctor ook helemaal geen belang bij de lagune. Zij halen hun verdiensten uit mensen die naar het strand gaan en naar het paviljoen gaan om daar te eten en op een terrasje te zitten. Die mensen blijven toch wel komen, met of zonder lagune.

Interviewer: Zou je dan misschien kunnen zeggen dat de ondernemer van Luctor liever niet heeft dat de lagune open blijft? Omdat dat misschien mensen bij hun weghoudt?

WT: Nee, hoor. Dat is toch een andere doelgroep.

Interviewer: Ja, ik probeer het hele plaatje met verschillende partijen in beeld te brengen. Zijn er volgens jou nog meer partijen of mensen die invloed hebben op het besluitproces rond de lagune?

WT: Ja, we hebben natuurlijk ook te maken met Rijkswaterstaat en het Hoogheemraadschap.

Interviewer: Ja, die heb ik twee weken geleden gesproken inderdaad.

WT: Zij zijn bevoegd gezag op het strand, zoals dat heet. Zij zijn de baas over het strand.

Interviewer: Op welke manier moet ik dat zien?

WT: Voor het instandhouden met de lagune moeten we overleggen met hun, omdat we de waterveiligheid niet in gevaar mogen brengen. De waterveiligheid, dus de kustverdediging, staat altijd boven het instandhouden van de lagune.

Interviewer: En kan dat nu gewaarborgd worden?

WT: Daar moeten we nu goede afspraken over maken. Wat als dit, en wat als dat?

Interviewer: Dus voor het Hoogheemraadschap en de Rijkswaterstaat was de enige eis dat de waterveiligheid gewaarborgd kan worden?

WT: Ja, en het Hoogheemraadschap en Rijkswaterstaat moeten ook een vergunning afgeven voor het uitgraven van de getijdengeul. Als je in zand gaat graven, heb je een happervergunning nodig.

Interviewer: Is die vergunning al afgegeven?

WT: Nee, die moeten we nog aanvragen. We hebben eerst volgende week overleg over de kustverdediging en waterveiligheid. Als dat rond is, kunnen we de vergunning aanvragen.

Interviewer: En is verder alles al rond?

WT: De raad is akkoord. Nu moeten we met Rijkswaterstaat en Hoogheemraadschap in overleg: 'Onder welke voorwaarden'. Stapje voor stapje.

Interviewer: Ik denk eigenlijk dat ik heb waar ik naar op zoek was. Ik ben vooral in kaart aan het brengen wie welke rol speelt en hoe zich dat onderling verhoudt. Ik heb twee weken geleden Rijkswaterstaat en het Hoogheemraadschap ook al gesproken dus ik heb wel een volledig beeld. Ik ben vooral nu nog op zoek naar een kostenplaatje om meetbaar te maken wat het op kan leveren.

WT: Bij de gemeente hebben wel een inschatting gemaakt dat het instandhouden ongeveer veertig tot vijftigduizend euro per jaar kost. Dat is een inschatting, dat weten wij niet. Dat moeten wij gaan leren. Wat het opbrengt, zijn bezoekersaantallen enzo.

Interviewer: Dat is natuurlijk niet te meten.

WT: Je kan wel refereren aan bijvoorbeeld Camping de Bocht. Daar is altijd nog een plan om daar vakantiehuizen of vakantiebungalows te bouwen. Een inversteerdeerder gaat dat niet doen als er geen mensen komen. Het gebied is ontzegelijk aantrekkelijker geworden. Maar het is niet te zeggen, 10 jaar geleden kwamen er zoveel mensen, en nu komen er zoveel mensen. Dat is met dit soort dingen lastig.

Interviewer: Oké, ik heb nu wel een volledig beeld denk ik over wat er speelt.

WT: Oké, je mag altijd bellen of een mailtje om een afspraak te maken als je vastzit.

Interviewer: Dat is fijn. Dankjewel.

WT: Sterkte ermee en tot ziens.

Interviewer: Bedankt, fijne dag.

Interview with Richard Minkema

Representative De Jongens uit Schoorl (DJUS)

RM: Met Richard, goedendag.

Interviewer: Hoi, goedemiddag. Je spreekt met Laura Alblas. Komt het nu even uit om even kort wat vragen te stellen of zal ik een ander moment bellen?

RM: Nee hoor, kom maar op.

Interviewer: Ik zal even kort vertellen. Ik schrijf mijn scriptie over de lagune en daarbij ga ik een model maken waarbij alle stakeholders in het gebied worden meegenomen. Dat zijn vooral jullie als ondernemers en de gemeente. Ik heb ook begrepen dat het Hoogheemraadschap en Van Oord/Boskalis ook een rol in speelt. Daarnaast ga ik ook het toerisme meenemen.

RM: Voor wie schrijf je?

Interviewer: Voor mijn studie, Geografisch Informatie Management aan de Universiteit van Utrecht.

RM: Oke, en dat doe je echt voor jezelf? Of heeft de gemeente je gestuurd?

Interviewer: Nee, ik doe dat helemaal voor mezelf. Ik ben begonnen met een meer globaal project over allerlei projecten aan de kust en uiteindelijk is mijn focus steeds kleiner geworden en heb ik besloten mij vooral te richten op de lagune zelf. Uiteindelijk is dit mijn invalshoek geworden.

RM: Leuk. Ik denk dat eerst jij los moet branden.

Interviewer: Vind je het goed als ik dit opneem?

RM: Ja, hoor.

Interviewer: Bedankt. Kun je kort vertellen wat jullie doen als De Jongens uit Schoorl?

RM: DJUS is van origine een evenementenbureau die verzorgt groeps- en bedrijfsuitjes, zomerkampen, schooluitjes en we hebben Laguna Beach Camping afgelopen jaar opgestart. Daarnaast wat evenementen vanuit de lagune.

Interviewer: Oké, en bestonden jullie al voordat de lagune kwam in 2015 of zijn jullie daar gekomen tegelijkertijd met aanleg van de lagune?

RM: Nee, we bestaan al ruim 20 jaar.

Interviewer: Was dat op een andere locatie?

RM: Nee, dat was wel op die locatie.

Interviewer: Hoe zijn jullie veranderd toen de lagune aangelegd werd?

RM: We werkten vanuit een aanhanger. Onze locatie en opslag was vanachter het duin. De deelnemers en kinderen moesten met een surfplank over het duin lopen, we werkten met een aanhanger. Doordat die ontwikkelingen plaats hebben gevonden, Kust op Kracht, kwam er heel veel strand bij en kwam er ineens een lagune. Dat bood heel veel mogelijkheden.

Interviewer: Dat is inderdaad mijn volgende vraag. Zien jullie de lagune als een toegevoegde waarde voor het gebied? Ik hoor al dat dat wel zo is.

RM: Ja, ik denk dat die zichzelf met name de laatste twee jaar heeft bewezen. Ik denk dat het nog wel het best bewaarde geheim van Bergen en Noord-Holland is. Mensen uit Bergen staan met hun mond open en die weten niet eens dat er een lagune is in hun eigen gemeente.

Interviewer: Ja? Denk je dat veel mensen niet weten dat de lagune bestaat?

RM: Ik denk het niet alleen, ik weet het wel zeker.

Interviewer: Dus eigenlijk zou er nog wat meer bekendheid aan gegeven moeten worden.

RM: Dat is de vraag. In principe wel natuurlijk. Naast ons is het heel interessant dat wij met name merken – ik zie het zelf met mijn eigen ogen – dat het steeds drukker wordt. Dat heeft deels ook te maken met corona dat mensen niet op vakantie kunnen en het dichter in de buurt zoeken. Dan vraag ik ook: ‘Hoe zijn jullie hier terecht gekomen?’.

Interviewer: Denk je dat mensen liever naar jullie komen, als in naar de lagune, of liever naar het gewone deel van het strand?

RM: Ja, dat hangt heel erg af van de voorkeur. Kijk, gezinnen die kinderen hebben met een jonge leeftijd komen vaker naar de lagune. Dat is veiliger omdat het water stil staat. Dan is er ook nog de doelgroep die actief naar het strand wil, die kunnen ook bij ons terecht.

Interviewer: Ja, en daarmee bedoel je activiteiten zoals windsurfen, suppen en dat soort dingen?

RM: Ja, dat klopt.

Interviewer: Maken jullie onderscheid in verschillende gebruikersgroepen van de lagune?

RM: Ja, we hebben wel verschillende blokken in zogenaamde gebruikersgroepen. Wij faciliteren veel uitjes voor bijvoorbeeld scholen en bedrijfsuitjes. Maar ook gewoon gezinnen die een actieve dagbesteding of een actieve vakantie willen. Zij huren zelf spullen om het water op te gaan. Er zijn ook mensen die dus zelf komen recreëren. Maar het verschilt ook heel erg. Dus je kan er niet heel veel over zeggen. Van de zomer bijvoorbeeld was het 's avonds om 9 uur drukker dan het jaar ervoor.

Interviewer: En deze mensen huren bij jullie de spullen om het water op te gaan?

RM: Ja, dat klopt.

Interviewer: En is er dan ook nog een groep die zelf naar de plek gaat, en waar jullie niet zo veel mee te maken hebben?

RM: Ja, ja zeker. Dat zijn bijvoorbeeld mensen die alleen komen zwemmen of wandelen.

Interviewer: Dan, over de lagune hoe die zich ontwikkelt. Kun je wat meer vertellen over de geul en de lagune zelf. De hoogte van het water en hoe dat zich ontwikkelt door het jaar heen?

RM: Ja, de lagune loopt met name vol met kwelwater uit zee en regenwater. In de basis is dat zuiver water. Maar als dit te lang stilstaat, ontstaat er algvorming. Dan moet er ingegrepen worden. Het meeste van de tijd is de lagune afgesloten van de zee.

Interviewer: Dus het meeste water komt eigenlijk niet uit zee?

RM: Ja, de lagune wordt vooral gevuld met kwelwater uit de duinen en regenwater. Alleen als de geul open wordt gegraven wordt er zeewater toegevoegd.

Interviewer: Is dat om de waterkwaliteit weer te verbeteren?

RM: Ja, zo kun je dat zien.

Interviewer: En dat is dat baggeren, dat gebeurt als de waterkwaliteit minder wordt?

RM: Juist, het schap (Hoogheemraadschap) en Rijkswaterstaat houden dat in de gaten. Als het zoutgehalte in de lagune niet goed zit, dan moet de geul gebaggerd worden.

Interviewer: En, dat moet hoog zijn (het zoutgehalte), of is dat vaak te laag?

RM: Nou ja, het zoutgehalte moet niet te hoog en te laag zijn. Maar als er zeewater in de lagune komt, verandert het zoutgehalte van het water. Zee is namelijk zout. Daar heb je nooit last van algen.

Interviewer: Oke, dus dat bevordert de waterkwaliteit?

RM: Inderdaad.

Interviewer: En op dit moment speelt het vraagstuk of de lagune open of dicht moet blijven. Daar zijn jullie bij betrokken. Wat is daar uiteindelijk uit gekomen?

RM: Ja, dat is dat de gemeente hem nog vier jaar open houdt en wij betalen mee aan de kosten van het onderhoud.

Interviewer: Oké, en wat waren daar uiteindelijk de afwegingen?

RM: Dat is voornamelijk het stukje ruimtelijke kwaliteit dat het toevoegt voor de omgeving. De lagune is natuurlijk een USP, een Unique Selling Point. Het trekt veel mensen aan.

Interviewer: Ja, en dat de waterkwaliteit af en toe laag is, hebben jullie dat ook meegenomen?

RM: Ja, we hebben toch besloten dat we hier wel in willen investeren en daarbij moet de waterkwaliteit goed in de gaten gehouden worden.

Interviewer: En de kosten daarvan, gaan jullie en de gemeente ervan uit dat dat wel weer wordt terugverdiend?

RM: Ja, ja dat zeker. Dat zie je nu al. Er komen toch veel mensen op af en die geven ook wel wat uit. Niet altijd bij ons maar ook voor de gemeente levert het een hoop op.

Interviewer: Ja, inderdaad. Dat zijn dan indirecte kosten.

RM: Ja, precies. Het is lastig te zeggen hoe veel dat is maar het levert zeker op. Maar daar kan de gemeente je zelf misschien meer over vertellen.

Interviewer: Oke, hartstikke goed. Ik denk dat ik wel een duidelijk beeld heb van wat er allemaal speelt. Ik heb inderdaad Willem Taal van de gemeente al gesproken, en hij heeft me ook al wel wat verteld. Denk je dat er andere personen of partijen zijn die ik zou kunnen spreken en een rol spelen?

RM: Even denken. Wie heb je allemaal al gesproken?

Interviewer: Ik heb Willem Taal gesproken, die komt vanuit De BUCH, vanuit de gemeente. Iemand van het Hoogheemraadschap en ik heb iemand van Rijkswaterstaat gesproken.

RM: Oh, kijk eens aan. Dan heb je de meeste denk ik al wel te pakken.

Interviewer: Oke, ik denk dat ik dan hierbij wel genoeg weet. Ik heb al veel informatie via de gemeente maar om het toch volledig te maken is het ook goed om jullie verhaal te horen. Bedankt voor je tijd dan.

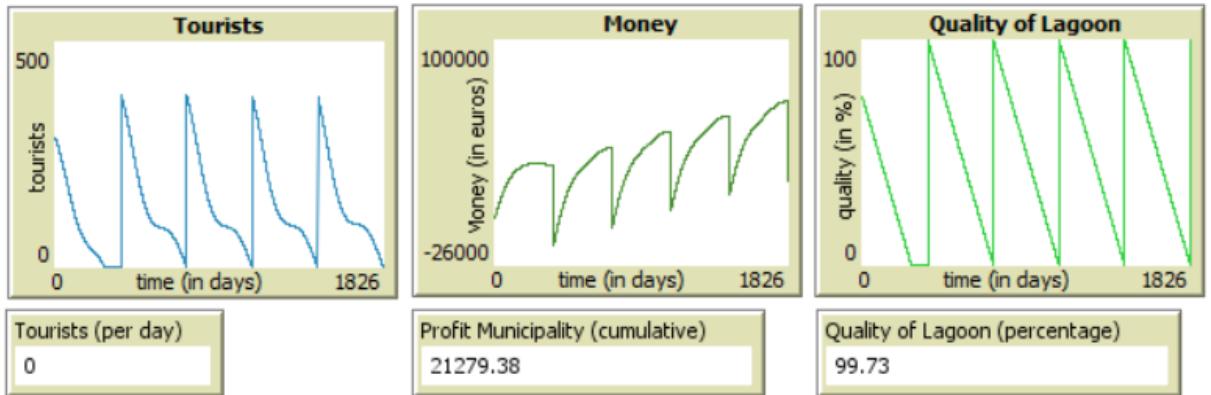
RM: Ja, geen probleem. Ik ben benieuwd wat er uit komt.

Interviewer: Ja, zeker. Ik ook. Bedankt voor je tijd.

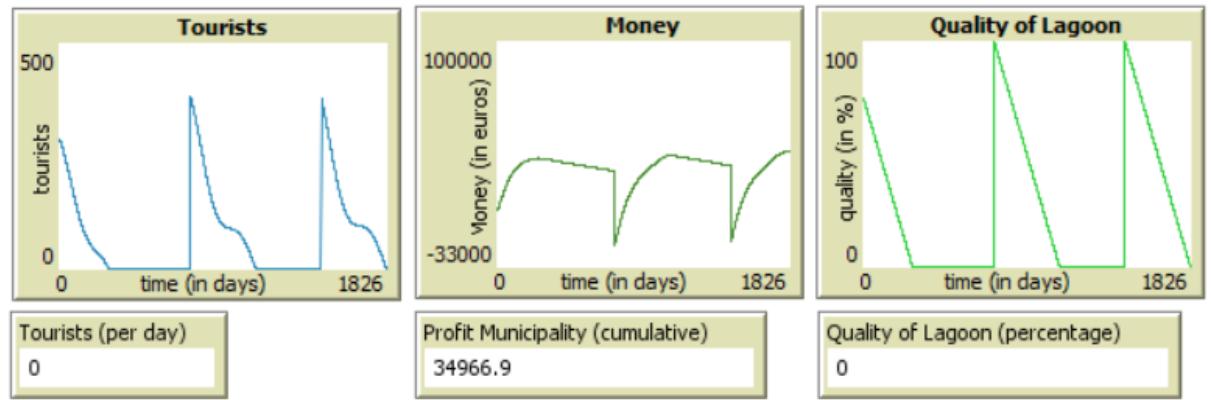
RM: Oke, dag.

Appendix II: Resulting plots and graphs experiments System Dynamics Model

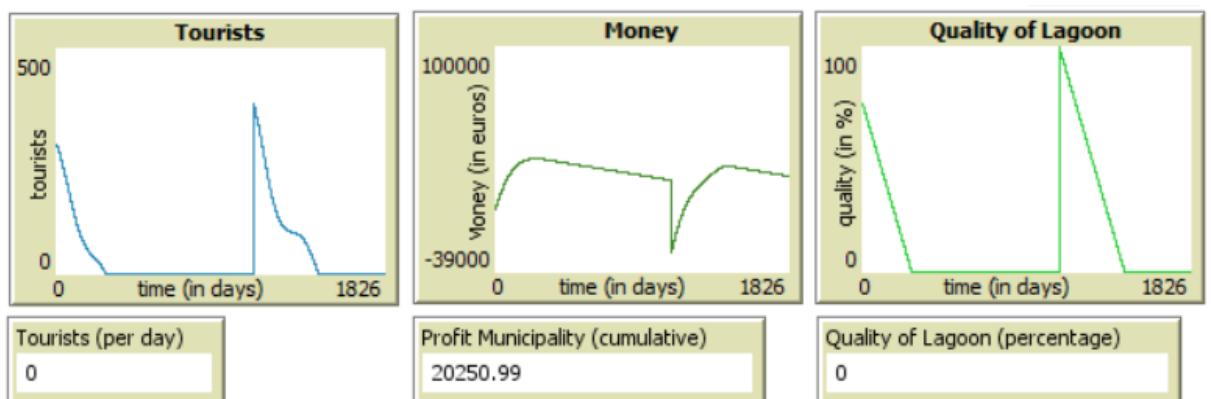
a. Resulting plots from experiment 1



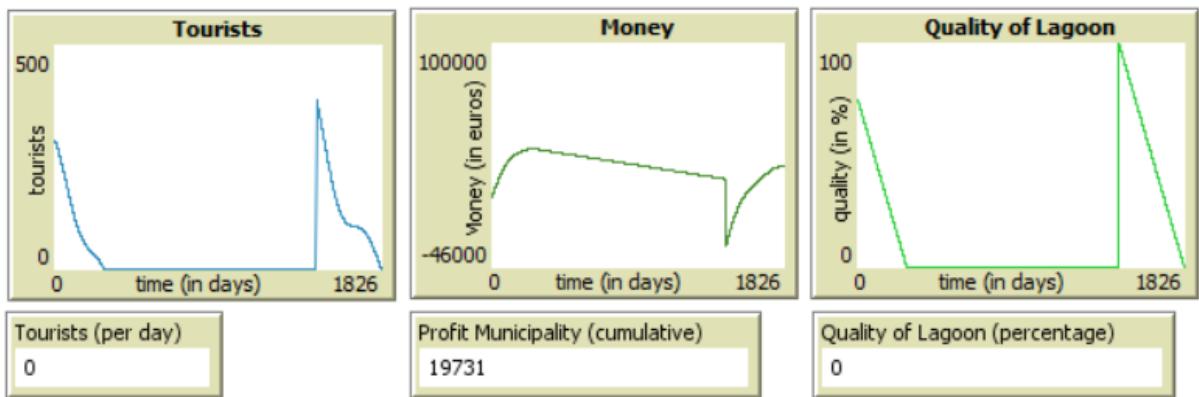
b. Resulting plots from experiment 2



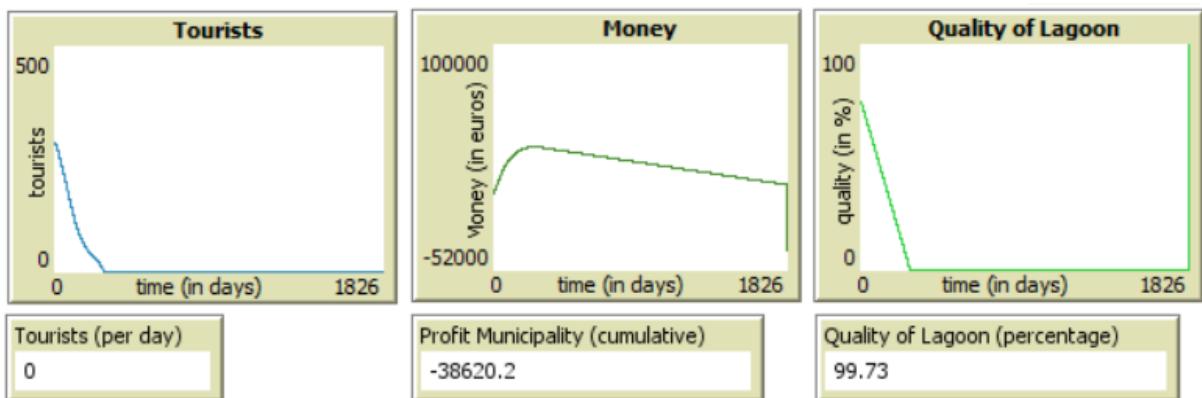
c. Resulting plots from experiment 3



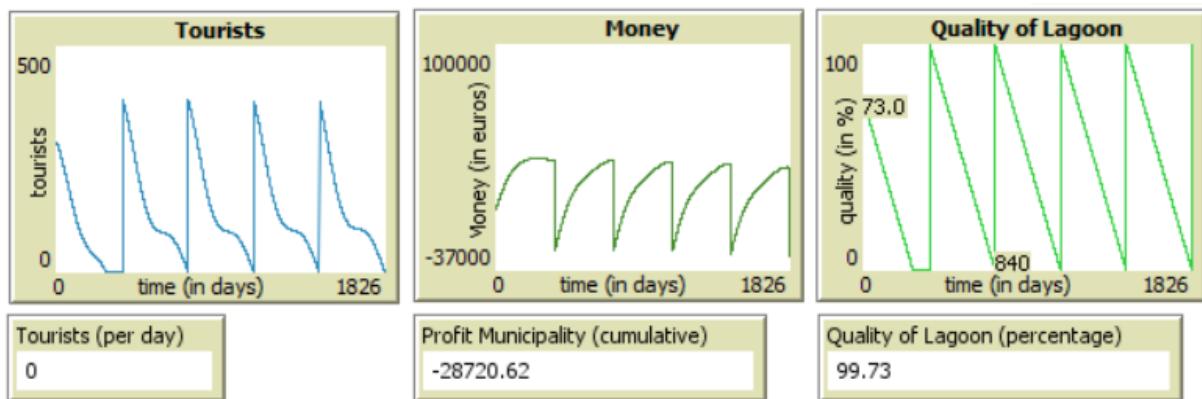
d. Resulting plots from experiment 4



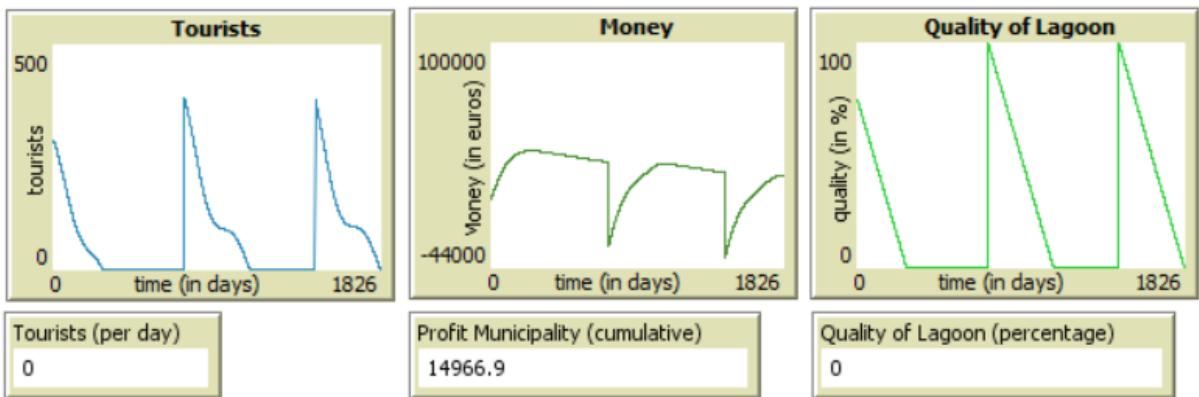
e. Resulting plots from experiment 5



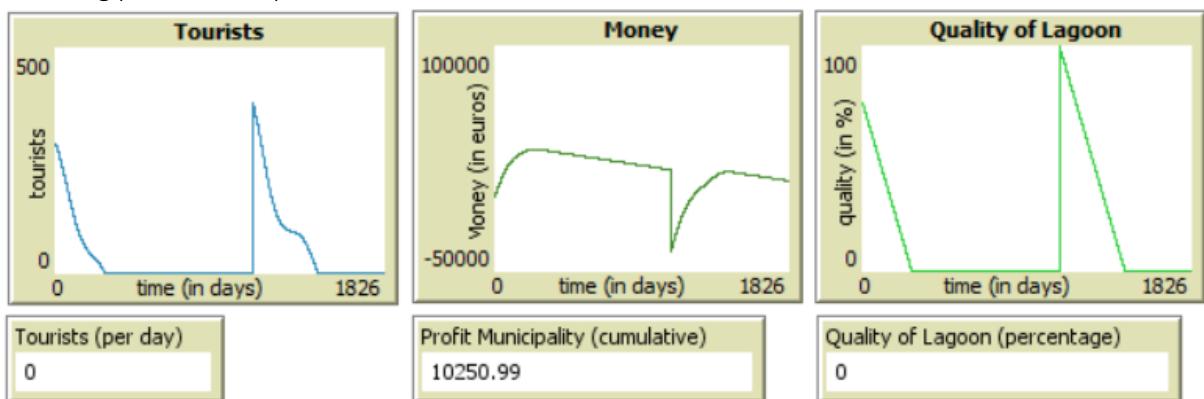
f. Resulting plots from experiment 6



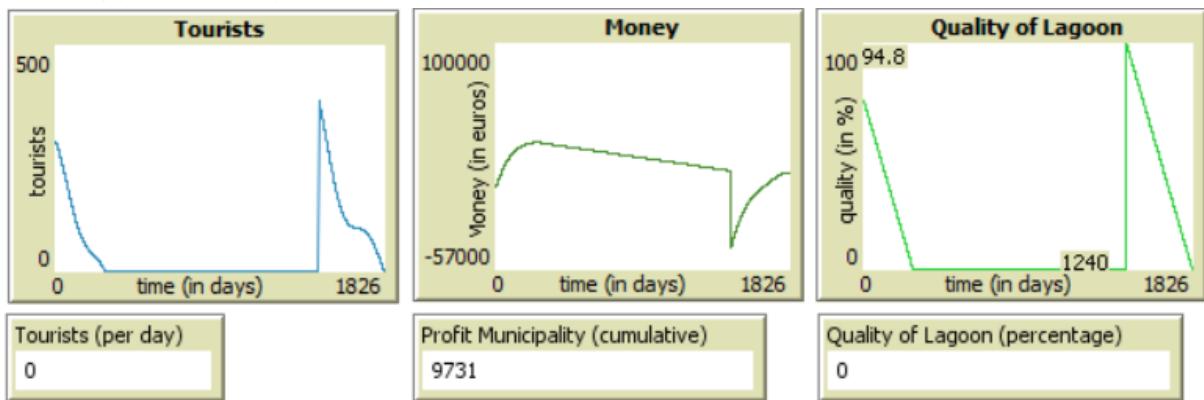
g. Resulting plots from experiment 7



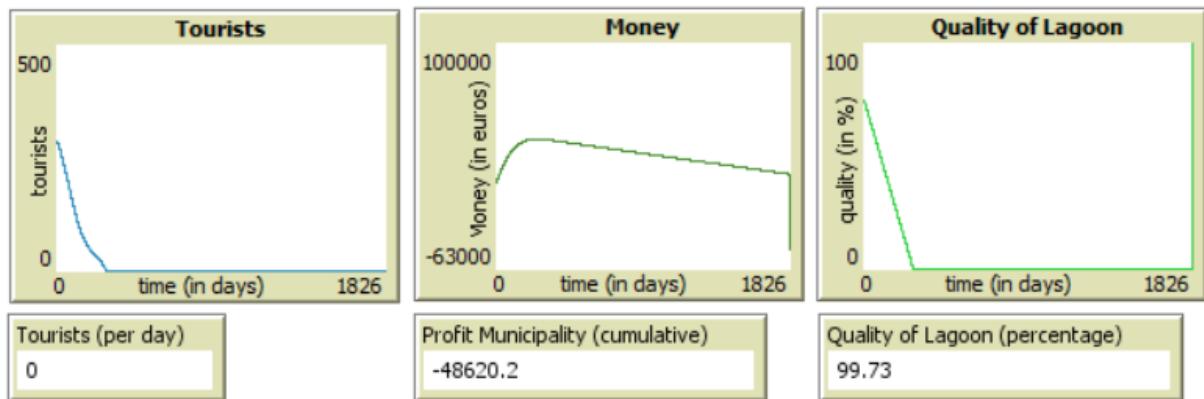
h. Resulting plots from experiment 8



i. Resulting plots from experiment 9

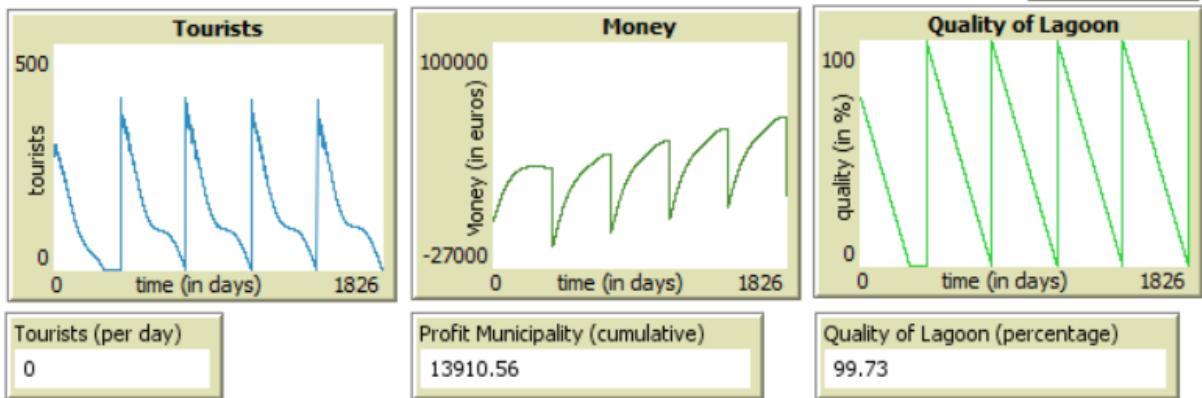


j. Resulting plots from experiment 10

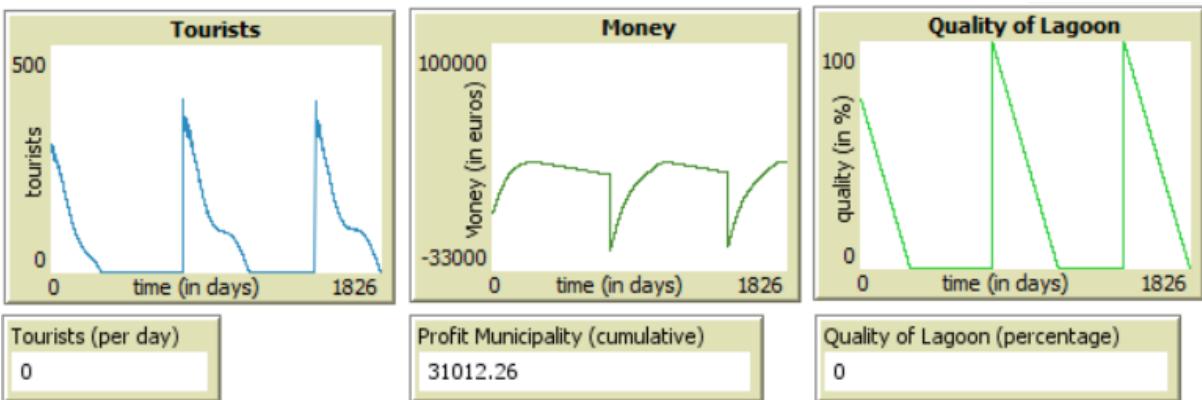


Appendix III: Resulting plots and graphs experiments Integrated Hybrid Model

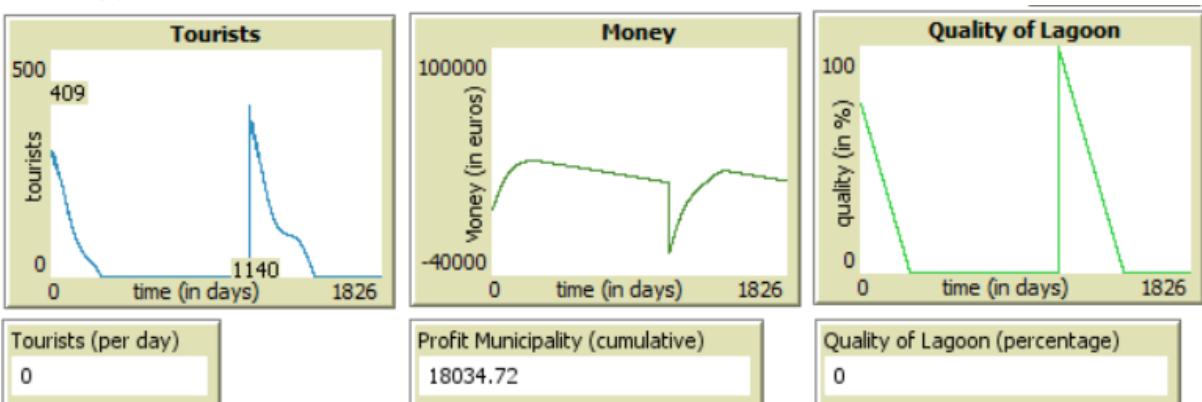
a. Resulting plots from experiment 1



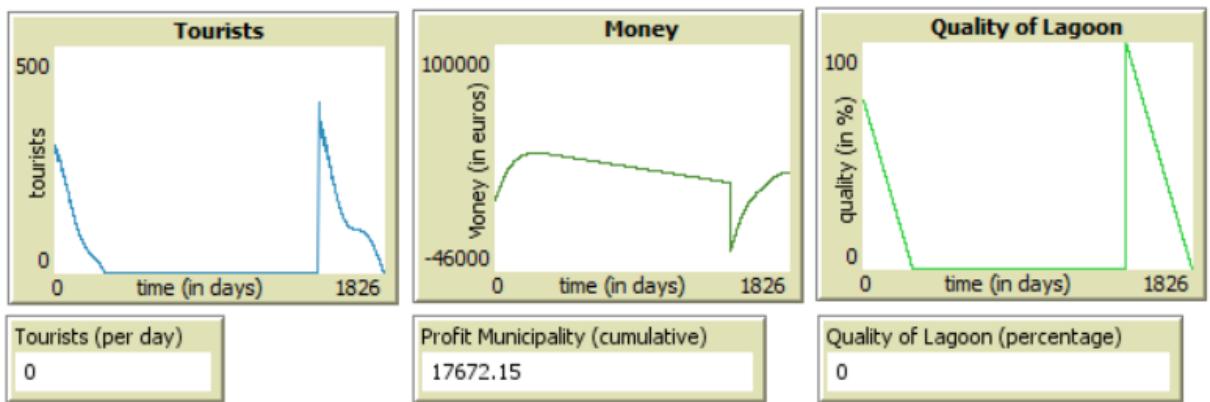
b. Resulting plots from experiment 2



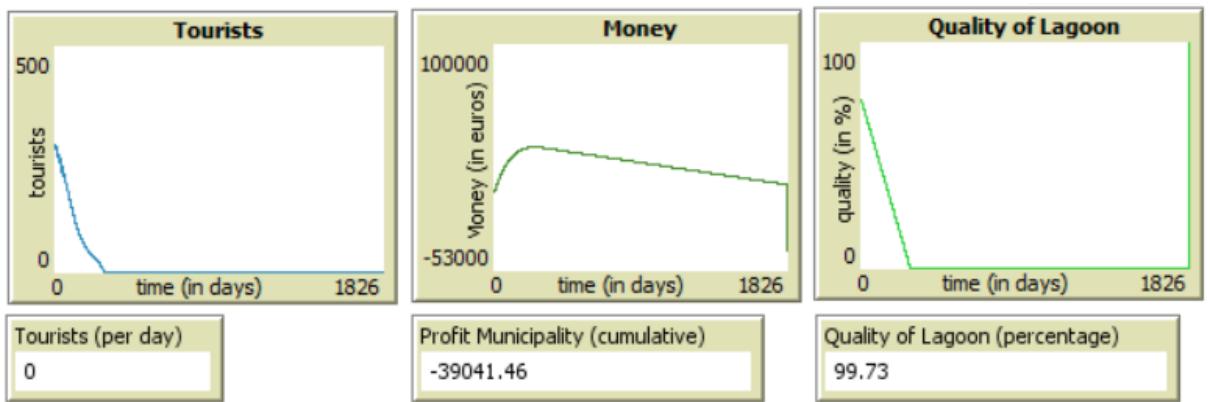
c. Resulting plots from experiment 3



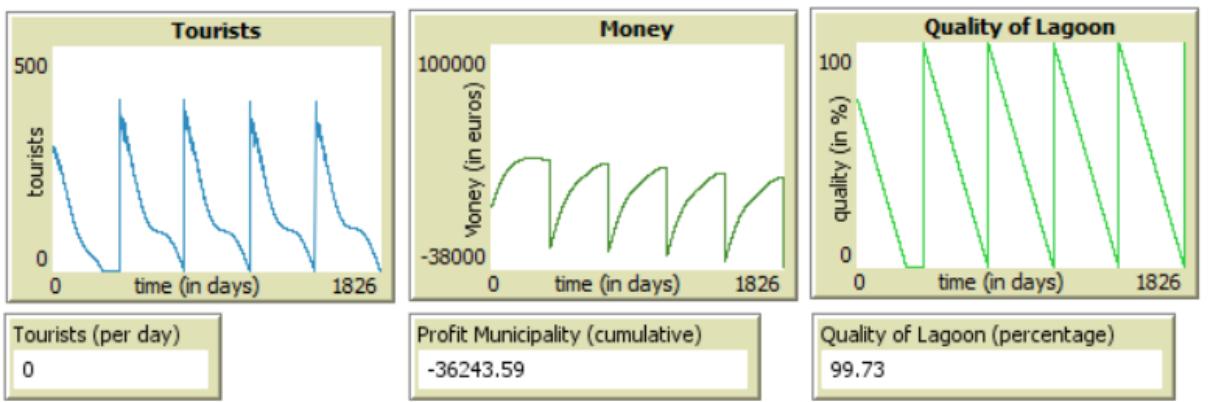
d. Resulting plots from experiment 4



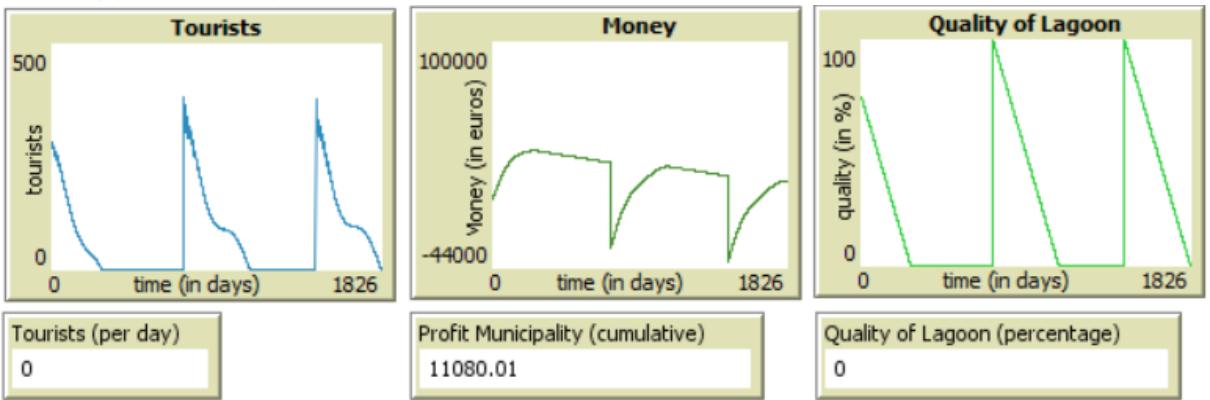
e. Resulting plots from experiment 5



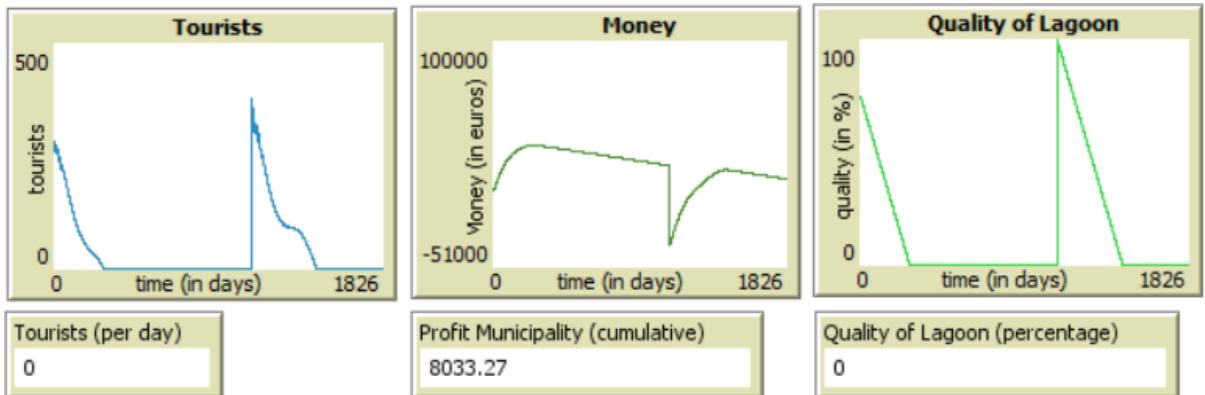
f. Resulting plots from experiment 6



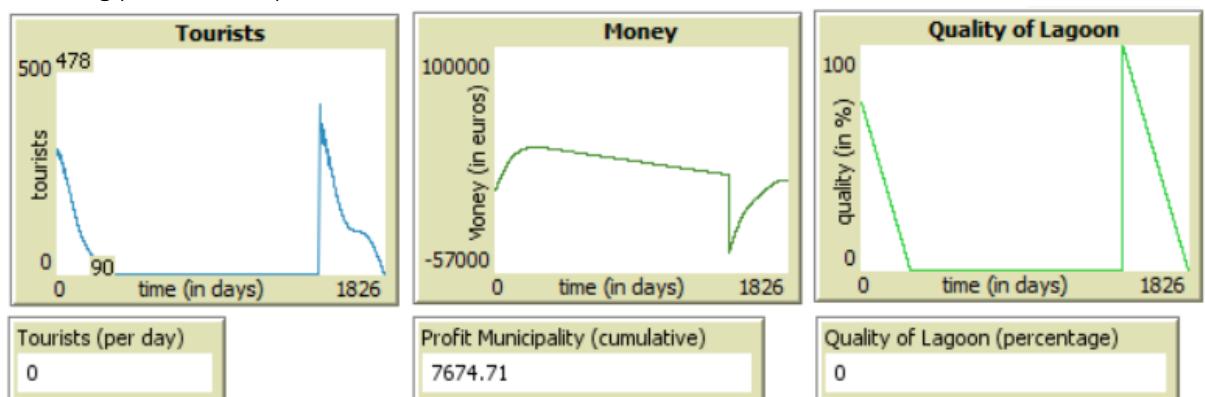
g. Resulting plots from experiment 7



h. Resulting plots from experiment 8



i. Resulting plots from experiment 9



j. Resulting plots from experiment 10

