Food processing in Reimerswaal

The impact of climate change effects on the food processing industry in Reimerswaal

Research Report

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Abstract

Reimerswaal is a municipality in the south west of the Netherland, it is connecting Zuid-Beveland and Walcheren with the mainland of Noord-Brabant. Reimerswaal is a small strip of land located in between the Oosterschelde and the Westerschelde. A lot of vital infrastructure systems are running through Reimerswaal. Besides the fact that Reimerswaal is important as a connection between Zuid-Beveland and the mainland, the food processing industry, which is also part of vital infrastructure is present on a large scale in Reimerswaal. Employing about 2000 persons and processing around 1,5 billion kilograms of food each year, it is safe to say that Reimerswaal is an important player on the national and international food market. The fact that parts of Reimerswaal are located below sea level and are prone to flooding, makes it a vulnerable area. Rising sea levels are the consequences of climate change. Whilst an inundation of Reimerswaal will have direct far spread consequences for the entire population, other climate change effects like droughts, salinization and sea water acidification will not have such a direct impact on the population, but have a large impact on the food processing industry, which is so vital to the economic welfare of Reimerswaal. The research was executed by making a theoretical framework, that was based on a literature review. The literature review was based on the problem statement. Interviewing experts of four different companies in the food processing industry was another way information gathering.The following research question was to be answered. What is the impact of climate change effects on critical infrastructure for the food processing industry and what can be done to limit these consequences? The first step was making an inventory of the present food processing companies in Reimerswaal. The second step was looking at the infrastructure that was vital for these companies. The third step was assessing the impact of climate change on the different sectors and the final step was coming up with possible adaptation strategies that could limit the threats and/ or cease the opportunities. Climate change effects such as heavy rainfall, drought, salinization and seawater acidification can cause serious damages to the onion, tomato, hardfruit and fishery sectors in Reimerswaal. Harvests can be ruined by heavy rainfall, salinization makes it impossible for some crops to grow and seawater acidification makes it harder for shellfish to create their shells, but climate change does not only poses a threat to the food processing industry, it also poses opportunities to the food processing industry. In order to limit these threats and benefit from the opportunities a number of adaptation measures can be taken by the food processing companies in Reimerswaal. Examples of measures are using solar panels instead of being connected to the electricity grid and catching rainwater in basins. In order for the companies to succeed in the upcoming challenge of climate change, they need to be aware of the threats and opportunities, look at the future of the product and be as independent as possible from the electricity grid and water supply.

Preface

This report is a part of the research minor on the HZ University of Applied Sciences in Vlissingen This report contains the outcomes of a research executed in . The aim of this report is to describe the impact of climate change on the food processing industry in Reimerswaal and its critical infrastructure.

The main part of this project was executed in Vlissingen at the HZ University of Applied Sciences between 01.02.2016- 29.06.2016. I would like to thank my coordinators and tutors: Jean-Marie Buijs, Lukas Papenborg, Dick Fundter and Jan van der Vleuten for giving valuable advice and support always when needed.

This research report was created by Raoul Lobbezoo, third year student Delta Management at the HZ University of Applied Sciences Vlissingen.

I hope you enjoy reading my report,

Vlissingen 20/07/2016
Raoul Lobbezoo

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1. Introduction

1.1 Background

This research is executed as a part of the research minor of the Delta Academy at the HZ University of Applied Sciences. The research fits within the framework of the Projectplan RAAK Publiek, Vital Infrastructure in a resilient delta. The research question of the Projectplan RAAK is: How can the cascading effects of disruptions in vital infrastructure be limited by measures in response and recovery? After some initial research, definitions of vital and critical infrastructure showed that the energy sector, communication sector, transport system sector as well as the food processing industry are part of 11 sectors that are necessary to keep society functioning properly without any major disruptions. (Ministerie van Binnenlandse Zaken en Koningsrelaties)

When errors do occur in one of these 11 sectors, this could lead to major disruptions in society. More on this subject in the theoretical framework. As was mentioned before, the food processing industry sector is also part of the critical infrastructure system. The food processing industry contributes to the economic prosperity in the municipality of Reimerswaal. As Reimerswaal has been affected by flooding in the Watersnoodramp of 1953(figure 1), the great vulnerability of these fertile soils was displayed. The levels of the dykes have been raised, the Delta works were constructed, but still there is a possible threat of an inundation of the Reimerswaal area. Climate change is enhancing the already present danger, not only by increasing water levels, but also with more frequent heatwaves, droughts and extreme precipitation, the threat is not only coming from the sea, but from other climate hazards as well. Therefore this research will concern the impacts of climate change on the infrastructure critical to the food processing industry in Reimerswaal and how the impacts can be limited byclimate adaptation measures.

Figure 1 Watersnoodramp 1953 source: weer.nl; Modified by Raoul Lobbezoo

1.2 Research Area

Reimerswaal is a municipality in the province of Zeeland. The eastern part of Reimerswaal is connected to the mainland of Noord-Brabant and Belgium. The western part of Reimerswaal is connected to the municipality Kapelle. The biggest part of Reimerswaal is located in between the Canal through Zuid Beveland and the Schelde-Rijn. The villages Yerseke, Kruiningen, Krabbendijke, Rilland, Waarde and Oostdijk are located in between the canals. The village of Hansweert is located west of the Canal through Zuid Beveland. Reimerswaal is connected to Kapelle with three bridges and one tunnel. A small part of Reimerswaal is located east of the Schelde-Rijn Canal, but there are no significant villages located in this part of Reimerswaal. Three bridges crossing the Scheldt-Rhine Canal are connecting the Reimerswaal to the mainland. A small strip of land and dyke is connecting Reimerswaal with Belgium. The Oesterdam is connecting Reimerswaal with Tholen. Reimerswaal is located in between the Oosterschelde in the north and the Westerschelde in the south.

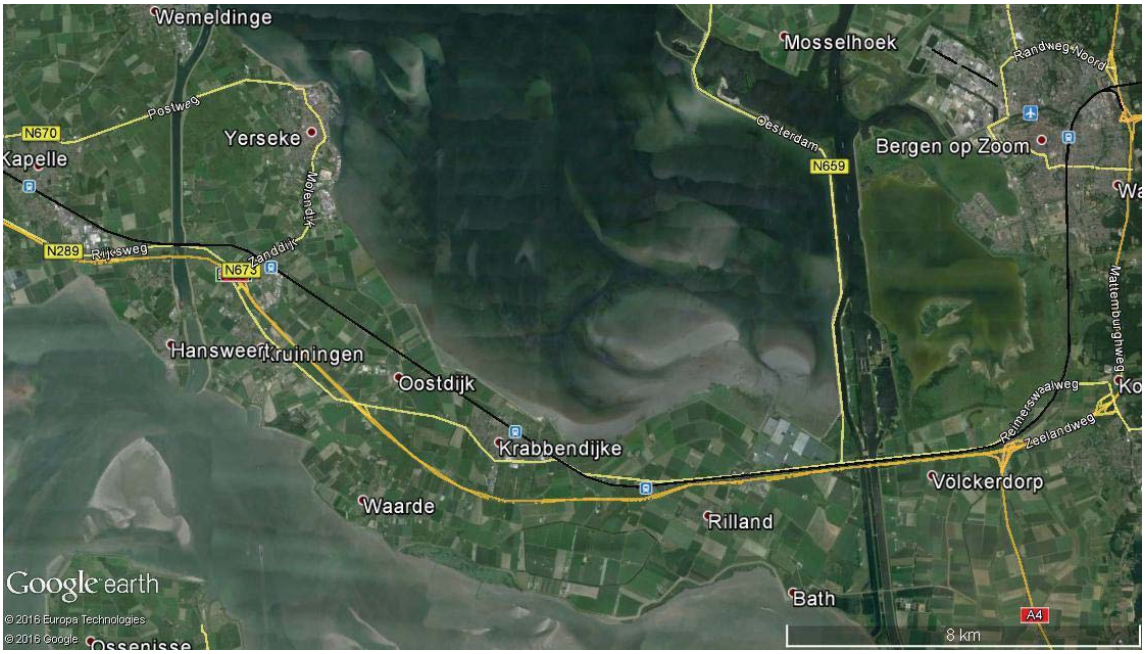


Figure 2 Map Reimerswaal source: Google Earth Pro

The main economic driver of Reimerswaal is the food and agriculture sector. (Kooren, 2012) Wiskerke Onions, Vogelaar Vredehof and LambWeston Meijer are examples of Reimerswaal based companies with large export volumes. The influence of the food and agriculture can be seen in public space, as a shared effort of onion farmers and processors created a sculpture that represents the importance of the onion in Reimerswaal (figure 3). The same goes for the fishery sector in Yerseke, where 'de Mosselman' is a representation of the large mussel production and processing industry in Yerseke (figure 4). Not only onions and mussels are produced and processed in Reimerswaal, but it is also the municipality with the fourth largest surface of orchards in the Netherlands. (PZC, 2016). Annualy Reimerswaal processes approximately 1,5 billion kilograms of food, this is an enormous amount and showcases the importance of Reimerswaal. In order to prevent climate change from having a large impact on this vital industry, adaptation measures need to be created.

1.3 Project limits

This research needs very clear boundaries in order to become successful, because there can be a lot of precious time lost by researching non relevant information, therefor this paragraph

Figure 3 Onion sculpture source: agf.nl

Figure 4 Mosselman in Yerseke source:wvy.nl

will make a division between information that is relevant and therefore must be researched and information that is not relevant. Starting off with the physical boundaries of the research area, the focus of this research will be on the municipality Reimerswaal. Literature studies from other areas might be interesting to use, but the research itself will only focus on Reimerswaal. The most important part to limit for this research is the definition of the food processing sector.

According to Homeland Security (2015) the food and agriculture sector is composed out of the following elements:

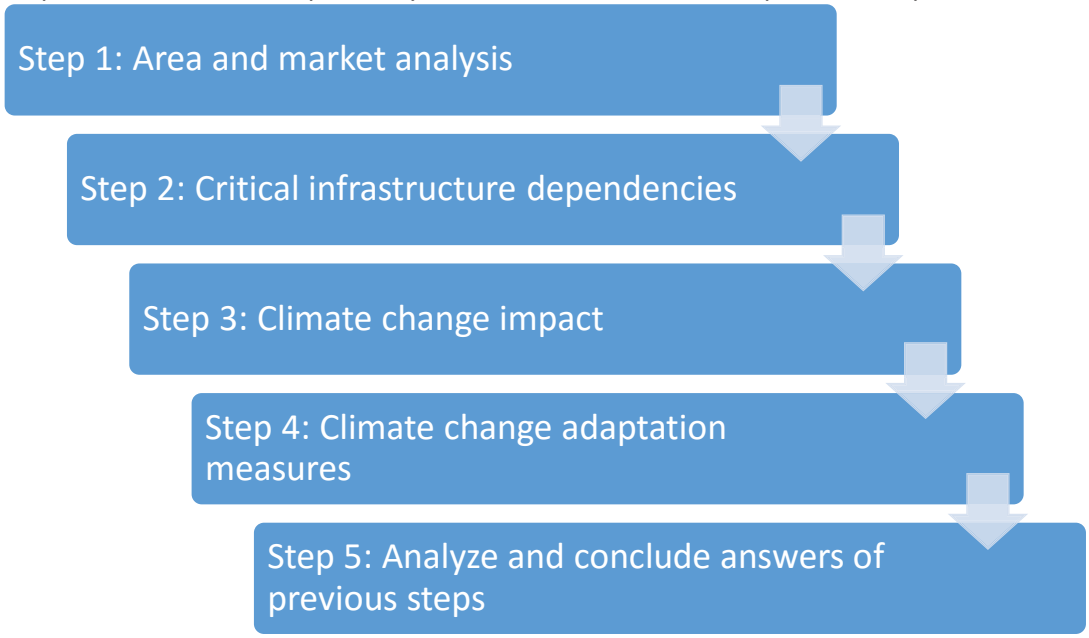
- Supply
- Processing, Packaging, and Production
- Agricultural and Food Product Storage
- Agricultural and Food Product Transportation
- Agricultural and Food Processing Product Distribution
- Agricultural and Food Supporting Facilities
- Regulatory, Oversight, and Industry Organizations
- Other Agriculture and Food

The focus of this research will be on the processing, packaging and production. The choice for processing, packaging and production is made based on the fact that these are important economic drivers for Reimerswaal and are present on a large scale. The focus will be on the food processing industry, which differs from agriculture and fishery sectors on the fact that it adds value to the product, instead of harvesting or catching a product. The food processing industry belongs to the secondary economic sector and agriculture and fishery belong to the primary economic sector. Some companies included might also be active in the primary economic sector, but the focus will be on the food industry in the secondary sector. The main subject of this research is the food processing industry, which comprises of companies that want to make a profit on a short term, the most relevant for this project would be looking at short term impacts of climate change. (Friends Provident Foundation, 2011) Most companies do not think ahead that many years, because none of the employees currently working there will still work there in 2085, that can be assumed based on the average age of retirement and life expectancy. Therefor the climate scenario used in this research will be the KNMI 2014 scenario for 2030. This is a climate scenario created for the Netherlands and is on a relative short term compared to scenarios for 2050 or 2085.

1.4 Research question

What is the impact of climate change effects on critical infrastructure for the food processing industry and what can be done to limit these consequences?

The research focusses on the impact of climate change effects on the food processing industry in Reimerswaal and how the consequences could be limited. The answer to this research question should display the vulnerabilities and opportunities of the food processing industry and related critical infrastructure. The answer to the research question is a combination and conclusion of the answer of the separate sub questions that will be described in detail later on. Basically this question can be answered in 5 steps. Step 1 area and market analysis. Step 2 Critical infrastructure dependencies Step 3 Climate change impact. Step 4 Climate change adaptation measures. Step 5 Analyze and conclude answers of previous steps.



1.5 Sub questions

1. **Which parts of the food processing industry are present in Reimerswaal and where are they located?**

The answer to this sub question should be an inventory of the existing companies that are active within the food processing industry of Reimerswaal. This inventory will tell how much employees a certain company has and how much they process. The method of finding an answer to this question exist out of desk research, but also approaching companies directly via emails or phone calls. The first step is to map the companies as much as possible and gather the basic information such as what they produce and where they are located. The second step is to find more specific information that might not be found on the internet such as their occupations, processing volumes and number of employees. The third step will then be analyzing the data and processing it into an inventory catalogue. When all of the information is gathered, companies for the case study will be selected based on the fact that they are of the biggest importance to the area, because of their size and number of employees. The biggest company from different sectors will be used: from the fruit processing sector, onion

processing sector, fish and shellfish processing sector. These are the sectors present in Reimerswaal.

2. **Which infrastructure systems are critical to food processing companies in Reimerswaal and where are they located?**

This sub question is mainly about the importance of the different infrastructure systems to the food processing industry. The answer to this question should comprise of the outcomes of interviews with the subject companies. Based on literature research and interviews, an overview of the infrastructure systems that are most relevant to the companies should be made. When these systems are known, a company specific analysis can be made, based on the location of the company and the relevant critical infrastructure systems. Answering this question accordingly is crucial for successfully answering the following questions and coming up with relevant measures.

3. **What is the impact of climate change effects on the critical infrastructure (derived in question 2) in Reimerswaal?**

The answer to this sub question is the product of analyzing and comparing the answers to the first two sub questions. The consequences of climate change are based on the location of a company and its relevant critical infrastructure systems and the climate change effects on this area heath waves, extreme precipitation and droughts. To know what the damage could be in numbers, it is necessary to have the correct information from question one, to be able to make an accurate estimation of the impact. A proper answer to this question will lead to a more accurate answer to the fourth sub question.

4. **How can the consequences of climate change effects on the food processing industry in Reimerswaal be limited?**

Assuming there are negative consequences linked to climate change impact on the infrastructure critical to the food processing industry in Reimerswaal, the next step would be to implement adaptation measures that can help limit these consequences. The answer to this sub question should be a recommendation to the food processing industry in Reimerswaal. It proposes adaptive measures that can be taken by companies themselves or by the municipality. Four cases will be discussed concerning the companies of four different sectors with the biggest importance for the area.

1.6 Objective

The food processing industry in Reimerswaal is part of and relies on multiple critical infrastructure systems, these systems could be harmed by climate change effects, such as droughts, extreme precipitation and heatwaves. The objective of this research is to gain an insight into the effects of climate change on the food processing industry and the relevant critical infrastructure. Creating knowledge and awareness about the impact of climate change of the food processing industry, could increase the resilience of the sector. By gaining this insight, adaptation measures can be taken in order to prevent and/or limit the possible negative impacts and benefit the positive impacts as much as possible.

2. Theoretical Framework

In the theoretical framework, the most important concepts will be defined by using previously conducted research and theoretical explanations. In order to be able to answer the research question an understanding of the most relevant concepts is necessary. What is the impact of climate change effects on critical infrastructure for the food processing industry and what can be done to limit these consequences? Explaining the concepts by using literature will clarify the research question and make it operational. In the explanation of these concepts, definitions of critical infrastructure will be used to show the essence of the food processing industry within society. The concept of climate change will be discussed as well.

2.1 Food processing industry within Critical Infrastructure

In this paragraph the definition of critical infrastructure will be discussed by looking at definitions used by four different governmental institutes that safeguard critical infrastructure. The definitions of critical or vital infrastructure from the Netherlands, UK, USA and Canada will be discussed and compared. Also every governmental body decided to divide the critical infrastructure in sectors, this will be displayed in table 1.

In the Netherlands, vital infrastructure is divided in vital sectors, concerning products, services and the underlying processes that, if they fail, can cause societal disruption. That can be because of many casualties or large economic damage, or when recovery takes a very long time and there are no alternatives available, while these products or services can't be missed. (Ministerie van Binnenlandse Zaken en Koningsrelaties)

The definition of critical infrastructure in the UK is as follows: "major detrimental impact on the availability, integrity or delivery of essential services – including those services, whose integrity, if compromised, could result in significant loss of life or casualties – taking into account significant economic or social impacts; significant impact on national security, national defense, or the functioning of the state". (CPNI, sd)

In the USA, there are 16 critical infrastructure sectors whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof (Department of Homeland Security, 2015)

In Canada, critical infrastructure refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence. (Government of Canada, 2015)

Canada	The Netherlands	U.S.A.	U.K.
Health	Health	Healthcare and Public Health	Health
Food	Food	Food and Agriculture	Food
Water	Drinking Water	Water and Wastewater Systems	Water
Information and Communication Technology	Telecommunication/ICT	1. Information Technology 2. Communications	Communications
Finance	Financial	Financial Services	Financial Services
Transportation	Transport	Transport System	Transport
Government	Public Governance	Government Facilities	Government
Energy and Utilities	Energy	Energy	Energy
Safety			
Manufacturing		Critical Manufacturing	
	Chemical and Nuclear Industry	1. Nuclear Reactors, Materials and Waste 2. Chemicals	3. Chemicals 4. Civil Nuclear
	Retain and Maintain Surface Water	Dams Sector	
	Law and Order	Emergency Services	Emergency Services
	Public Order and Safety	Defense Industrial Base	Defense
			Space
		Commercial Facilities	

Table 1 Sectors per country

According to all of the definitions above, when economic damage is the consequence of infrastructure failure, this sector can be seen as a part of critical infrastructure. Casualties or loss of life are an indicator for critical infrastructure as well, mentioned in all of the above definitions. Basically to summarize the definitions very briefly: a sector belongs to critical infrastructure when failure of its networks, products or services societal is causing a disruption of society, because of economic damage or loss of life or casualties. According to every definition, the food sector is also a part of critical infrastructure. A disruption in the food processing industry can cause widespread economic damage, especially in areas that rely on their food processing industry. Disruption in the food processing sector can also cause loss of life or casualties, when resources are very limited due to a lack of own food and isolation to food transport in the area. Therefor the food processing industry definitely is part of the critical infrastructure.

2.2 Climate change

In this paragraph the concept of climate change will be discussed in order to create a better understanding on the possible effects and impacts of climate change. The definition, causes, the change, effects and uncertainty and skepticism on climate change will be discussed.

2.2.1 Definition of climate change

The IPCC (International Panel on Climate Change) is an organization that is part of the United Nations. The objective of the IPCC is to evaluate the risks of climate change. According to the IPCC the definition of climate change is as follows: “Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.” (IPCC, 2007)

2.2.2 Causes of climate change

According to the IPCC definition of climate change, climate change can be caused in two ways, by variations in natural circumstances and by anthropogenic influences. Examples of natural influences are the El Niño effect which causes worldwide deviations in temperature, precipitation and wind, volcanic eruptions can also cause a change in climate (Slezak, 2015) (KNMI, 2011). However from the beginning of the industrial revolution, the climate has been influenced by men. Since then the average world temperature has increased with 0,8 degrees Celsius. The average temperature in the Netherlands increased by 1,5 degrees Celsius. The sea water level has risen 20 centimeters and the most glaciers are rapidly decreasing in size. Up until 1950, natural influences were more important than human influences on the climate. From 1950 the increase in temperature can only be clarified by taking the human influence into account. Despite that fact, the temperatures decreased from the 40’s until the 70’s. This decrease is related to amount of cooling aerosols, emitted by large scale industrialization in the western world after the second world war. Also a decrease in solar activity and a number of large volcanic eruptions were contributing to the declining temperature. According to the most recent IPCC report, the probability is more than 90% that the majority of the warming of the earth can be blamed on the increase of greenhouses gasses in the atmosphere. (Wagening UR, sd)

2.2.3 The actual change

For the actual changes in climate that will probably occur, the KNMI 2014 scenario for 2030 is used. The table shows projected changes in climate concerning temperature, precipitation, sea level rise, evaporation, solar radiation, mist and humidity in relation to the reference period between 1981 and 2010. The natural variations over a period of 30 years are also shown.

Table 2 KNMI 14 Climate scenario 2030 source: klimaatscenarios.nl

Seizoen[A)]	Variabele	Indicator	Klimaat[B)] 1981-2010 =referentieperiode	Gemiddelde verandering voor het klimaat rond 2030[C)] (2016-2045)	Natuurlijke variaties gemiddeld over 30 jaar[D)]
Jaar	Zeespiegel bij Noordzeekust	absolute niveau[E)]	3 cm boven NAP	+10 tot +25 cm	± 1,4 cm
		tempo van verandering	2,0 mm/jaar	+1 tot +6 mm/jaar	± 1,4 mm/jaar
	Temperatuur	gemiddelde	10,1 °C	+1,0 °C	± 0,16 °C
	Neerslag	gemiddelde hoeveelheid	851 mm	+5%	± 4,2%
	Zonnestraling	zonnestraling	354 kJ/cm2	+0,2%	± 1,6%
	Verdamping	potentiele verdamping (Makkink)	559 mm	+2,5%	± 1,9%
	Mist	aantal uren met zicht minder dan 1 km	300 uur[G)]	-100 uur	± 39 uur
Winter	Temperatuur	gemiddelde	3,4 °C	+1,2 °C	± 0,48 °C
	Neerslag	gemiddelde hoeveelheid	211 mm	+8,5%	± 8,3%
		10-daagse neerslagsom die eens in de 10 jaar wordt overschreden[I)]	89 mm	+9%	± 11%
		aantal natte dagen (≥ 0,1 mm)	55 dagen	+1,5%	± 4,7%
	Wind	gemiddelde windsnelheid	6,9 m/s	+0,5%	± 3,6%
		hoogste daggemiddelde windsnelheid per jaar	15 m/s	-1%	± 3,9%
		aantal dagen met windrichting tussen zuid en west	49 dagen	+2,5%	± 6,4%
Lente	Temperatuur	gemiddelde	9,5 °C	+0,8 °C	± 0,24 °C
	Neerslag	gemiddelde hoeveelheid	173 mm	+5,5%	± 8,0%
Zomer	Temperatuur	gemiddelde	17,0 °C	+0,9 °C	± 0,25 °C
	Neerslag	gemiddelde hoeveelheid	224 mm	+0,2%	± 9,2%
		dagelijkse hoeveelheid die eens in de 10 jaar wordt overschreden[I)]	44 mm	+1,7 tot +10%	± 15%
		maximum uurneerslag per jaar	15,1 mm/uur	+5,5 tot +11%	± 14%
		aantal natte dagen (≥ 0,1 mm)	43 dagen	+0,5%	± 6,4%
	Zonnestraling	zonnestraling	153 kJ/cm2	+1,9%	± 2,4%
	Vochtigheid	relatieve vochtigheid	77%	-0,6%	± 0,86%
	Verdamping	potentiele verdamping (Makkink)	266 mm	+3,5%	± 2,8%
	Droogte	gemiddeld hoogste neerslagtekort gedurende het groeiseizoen[J)]	144 mm	+4%	± 13%
Herfst	Temperatuur	gemiddelde	10,6 °C	+1,0 °C	± 0,27 °C
	Neerslag	gemiddelde hoeveelheid	245 mm	+5,5%	± 9,0%

The following conclusions can be drawn from the table:

- Temperature maintains to increase.
- Soft winters and hot summers become more frequent.
- Precipitation and extreme precipitation during the winter increase.
- The intensity of extreme rainfall increases.
- Hail and thunder become more severe.
- The sea level continues to rise.
- The solar radiation close to the surface increases mildly. (KNMI, 2015)

2.2.4 Effects of climate change

The change of climate will have a vast amount of consequences, some of the most relevant and important consequences are listed below:

Flooding caused by rising sea levels and extreme weather
When the temperature rises, the sea level rises. Water expands when it gets warmer. Glaciers and icecaps will melt, more mass is added to the water which causes the sea level to rise. The risk of extreme precipitation increases and with that the possibility of a pluvial flood grows. (Rijksoverheid, 2011)

Insufficient amount of fresh water due to drought
Climate change can cause periods of drought, during these periods a shortage of fresh water can occur. These shortages will have negative impacts on agriculture. (PBL, 2012)

Bad harvests due to salinization
Salinization can be caused by rising sea water levels and drought, it can have a serious impact on crops. It affects the roots of the crops and harvests can be lost. (Blom-Zandstra & Goosen, 2010)

Shortage of cooling water for power plants
Power plants need cooling water to produce electricity, a decrease in river water levels during drought and an increase of water temperature during heatwaves can cause serious issues to power generation. (EPA, 2016)

Change in biodiversity
As the temperature rises, plants and species can disappear. Some kinds cannot live with higher temperatures. An increase of exotic invasive species could also suppress the native species. (Rijksoverheid, 2011)

Sea water acidification
Oceans do not only absorb heath, they also store carbon dioxide. The more CO2 gets emitted into the atmosphere, the more C02 gets absorbed by the ocean, where it changes into carbon acid due to a chemical reaction with water, which leads to acidification of the ocean. Acidification has multiple consequences to marine life, including the fact that mussels and oysters have a harder time to create their shells in an environment with a higher pH-level.
(European Environmental Agency, 2015)

2.2.5 Uncertainty and skepticism

Climate change is happening, that is fact, but the exact impacts and effects are hard to predict. This is caused by the uncertainty of future pollution, which depends on economic growth. On the other hand, it is also uncertain how the climate will react, the so called climate sensitivity. Because of this uncertainty, not everyone is agreeing on the fact that climate change is a fact. Among the people, but also among politicians, there is a lot of skepticism surrounding climate change. The uncertainty and skepticism make climate change an ever bigger challenge. (Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011)

2.3 Climate adaptation

There countless ways to tackle the climate change effects mentioned above, but they can be divided into two groups, mitigation and adaptation. According to IPCC the definitions of mitigation and adaptation are as follows:

Mitigation: An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

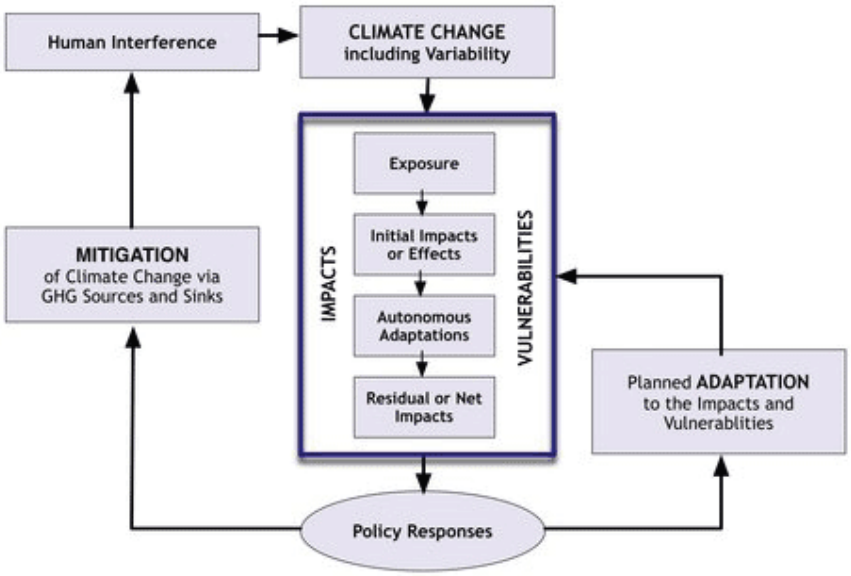


Figure 5 Mitigation and Adaptation Source: e-education.psu.edu

So, mitigation is the reduction of greenhouse gas emission, or capturing and storing greenhouse gasses to prevent them from polluting the atmosphere. Adaptation is a response to climate effects, in order to limit the impact and consequences and or benefit the opportunities. Each company could take measures to limit their greenhouse gas emission, but it would not have a direct positive effect for the company itself. It takes effort and investments, which will not be returned immediately. Adaptation also take effort and investments, and might not be returned immediately, if they are returned at all, but adaptation measures can limit the impact of climate change effects on the specific company and have a noticeable positive influence. There are different types of adaptation measures, there are no regret, low regret, win-win and flexible or adaptive management options.

No regret options are adaptation measures that deliver a socio-economic benefit, independent of the climate impact. They limit possible climate effects, but in case these effects never occur, the adaptation still was worth it, because it had other positive effects as well and they are at least cost neutral.

Low regret options are adaptation measures that require relatively low investments, but have a large impact by decreasing possible threats and benefiting from possible opportunities.

When the climate change effects, for which this measures was implemented, does not occur, losses are relatively low due to the low cost of the measure.

Win- win options are measures that minimize the potential risk or exploit potential benefits and have other socio-economic or environmental benefits.

Flexible or adaptive management options are adaptation measures that can be adapted over a period of time. For instance in ten years, the exact impact of a specific climate change effect can be predicted much more accurate, the measures already taken can be enhanced, instead of being replaced by measures that are more suitable according to the new predictions. (UKCIP)

In order for companies to decide which measures should be taken, they could use BCM or business continuity management. According to the BS25999-1 British Standards Institution's Code of Practice for Business Continuity Management, the definition of BCM is:

"A holistic management process that identifies potential threats to an organization and the impacts to business operations that those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities."

The company directors should assess what parts of the organization cannot be lost and plans should be made how to maintain these, if an incident occurs. Incidents in this specific case, caused by climate change can cause major disruptions to companies. When planning in advance instead of acting afterwards, the impact can be limited by implementing the right adaptation measures and the company needs less time to recover.(Woodman, 2007)

3. Method

Data Collection is essential to research, therefore it is necessary to gather and organize the data in a structured way. In this chapter the method of data collection is stated, described and discussed. Arguments will be provided for the choice of the data collection method. Furthermore, the size of the expected and necessary data pool will be discussed. Every stage of the research has its different methods for gathering data, that's why the data gathering methods are discussed per sub question.

1. **Which food processing companies are located in Reimerswaal and where are they located?**

   For this sub question the gathering data is done by a desk research and contacting different stakeholders such as Kamer van Koophandel, the municipality and associations and unions of companies in the food processing industry. Addressing a stakeholder that has knowledge about multiple stakeholder will save time compared trying to find every individual company by googling. The quantity of sampling for this research question will be hard to determine already, because it is not known yet how much companies and stakeholders within the food processing industry are located in Reimerswaal. The objective of this question is to find as much as possible and by addressing the agencies that have records of every legal company in Reimerswaal, this should be possible. After the companies are organized into the different sectors they belong to, for instance fishery, agriculture or horticulture, information about each individual company is necessary. The number of employees, volumes of production and occupation are the indicators that should be gathered. The first step to gather this specific information is by searching the internet, some companies have websites that show this type of information. When this is not available on the website, emailing or calling the company will be the next step. When gathering all of the information is not possible, due to not being able to get in touch with the specific companies, then the import and export of for instance the entire mussel industry will be used to come up with an estimation for that company. After gathering all of the data, the data will be described and shown in an inventory.

2. **Which infrastructure systems are critical to food processing companies in Reimerswaal and where are they located?**

   The method that will be used for finding the data to this question will be mainly by interviewing the representatives of the food processing industry as well as defining critical infrastructure by literature studies. The interviews will be semi-structured, a list of questions is prepared to guide the interview, but when other interesting topics come along they can be discussed as well. An example of a question list can be found in appendix VI. The interviews were prepared by looking up information about the company on the internet, to get to know the company before interviewing. The interviews are recorded and transcribed. Without transcription, a lot of information is lost or forgotten, now it can all be read afterwards.

3. **What is the impact of climate change effects on the critical infrastructure (derived in question 2) in Reimerswaal?**

Using the answer to question 2 as a starting point, the collection of data for this question is done by comparing the current climate situation with the KNMI 2014 climate scenario for 2030. Projecting the changes of climate onto the infrastructure that is critical for the food processing industry gives an image of the possible impact. Interviewing representatives of the companies in the food processing industry will also contribute to being able to answer this question.

4. **How can the consequences of climate change effects on the food processing industry in Reimerswaal be limited?**

The method of data collection for this question will mainly involve desk research, by looking at similar case studies with comparable issues knowledge for this specific area can be gathered. Interviews will be conducted with representatives from companies operating in the food processing industry. Combining this knowledge from case studies with the outcomes of question 1,2 and 3 will provide the information to be able to answer this question.

4. Results

4.1 The food processing industry of Reimerswaal

This chapter will contain an inventory of the companies within Reimerswaal that are active in the food processing industry. The food processing industry in Reimerswaal has four specific sectors: fish processing, tomato processing, fruit processing and onion processing. Besides the four sectors that are characteristic for Reimerswaal, there are some other companies that will be discussed under the name diverse. Within the diverse sector there is a potato processing company and a mushroom processing company. The food processing industry in Reimerswaal is comprised out of 25 companies, these 25 companies create a total of 2000 fulltime jobs and an additional couple hundred of seasonal and temporary jobs. In the pie chart below, the division of employees per sector can be found. In appendix I, the employees for each company can be found. The largest employers within Reimerswaal are the diverse sector and the fish and shellfish(mussels) processing sector.

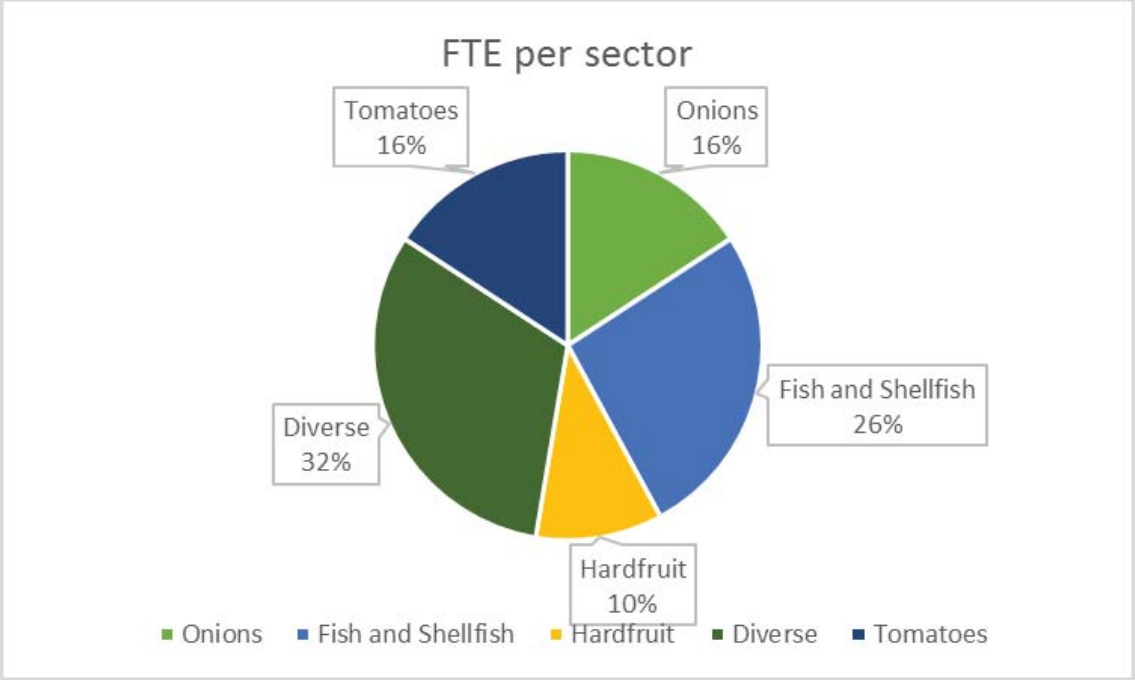


Figure 6 Pie chart FTE Reimerswaal

The 25 companies have a combined annual processing volume of 1,5 billion kilograms. In the pie chart below, the processing volume per sector can be found. In appendix I, the processing volume per company can be found.

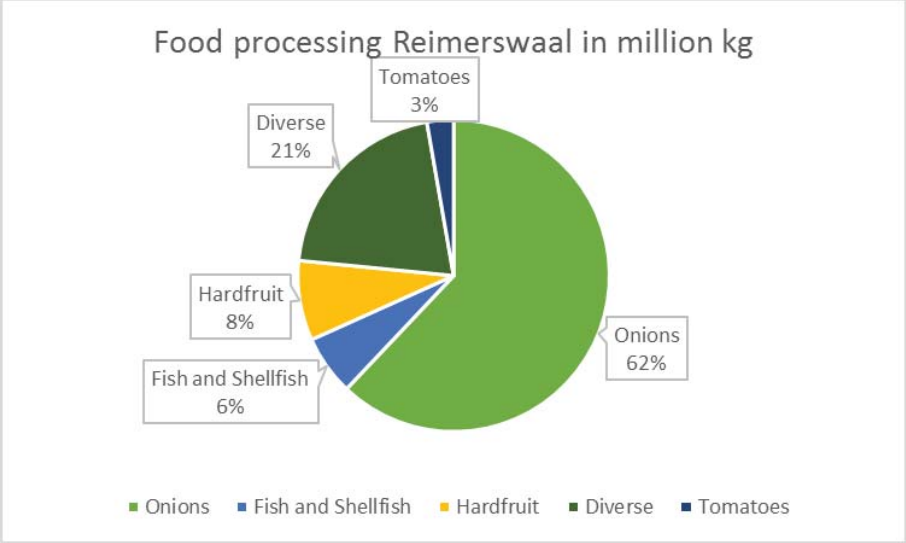


Figure 7 Pie chart Food processing

When looking at both pie charts, an interesting fact is that the onion sector is responsible for 62% of the processing, but has only 16% of the FTE's. This is caused by the relative low input of hand labor and large parts of the processing are done by machines. When looking at the locations of the companies, it becomes clear that the companies of different sectors aren't spread out over the entire municipality of Reimerswaal, but each sector has a specific location. The fish and shellfish sector is located solely in Yerseke, the tomato sector can be found north east of Rilland and is noticeable on the map as a blue patch. The hardfruit processing companies are located in Krabbendijke and the onion processing industry is located in between Kruiningen and Oostdijk.

Figure 8 Map of Reimerswaal source: Google Earth

For the four sectors: the fish and shellfish, tomato, onion and hard fruit one specific company was chosen as subject of a case study. These companies were chosen based on their relevance and importance, this was done by looking at the number of employees and the volume of processing, the biggest companies being the most important and relevant. What follows is a description of each sector and the case study company.

4.1.1 Fish and shellfish processing

The fish and shellfish processing industry of Reimerswaal is solely located in Yerseke, this has everything to do with the fact that Yerseke is located on the shore of the Oosterschelde.
The entire mussel sector in Yerseke processes about 90 million kg mussels from shell to final product like fresh mussels, conserved mussels, frozen mussels and variations. A kilogram of mussels contains on average 25% of its weight in fish. Besides mussels, 30 to 40 million oysters are processed each year in Yerseke. The only mussel auction in the world is located in Yerseke.

The company of interest for this sector is Zeeland's Roem. Zeeland's Roem is the processer of fish and shellfish in Europe, with a number of 150 employees. The processing volume is classified. Zeeland's Roem cultivates, processes and packs their own mussels, oysters and has a wide range of preparations of these sea foods.

Figure 9 Zeeland's Roem Logo source: roemvanyerseke.nl

4.1.2 Tomato processing

Located solely in Rilland, the tomato sector exist out of three companies: Lans, Agro Care and Combivliet. The tomatoes are grown in greenhouses and are packed on site or moved to another location and transported over there. The company of interest for this sector is
Agro Care. Agro Care has multiple locations in Middenmeer, Wieringermeer, Rilland and Tunisia. Agro Care is responsible for the growth, harvest and packaging of the tomatoes. Annually Agro Care Rilland processes 10 million kilograms of tomatoes.

Figure 10 Greenhouses Rilland source:agrocare.nl

Figure 11 Agro Care Logo source: agrocare.nl

4.1.3 Onion processing

With 1.3 billion kilos of onions each year, the Netherlands only produces 2% of the worlds onions. Despite this fact, the Netherlands are still the largest exporters of onions in the world. 70% of the production of the Netherlands is processed in Reimerswaal, therefore Reimerswaal is one of the most important regions in the world when it comes down to the processing of onions. (Zuver, sd) The company of interest for this sector is Wiskerke Onions. Wiskerke is the biggest onion processing company in the world with an annual processing volume of 150 million kilograms. Wiskerke Onions has 90 employees and exports to 85 different countries. Wiskerke grows, buys, sorts, dries and pack onions.

Figure 12 Wiskerke Onions Logo source:wiskerke-onions.nl

4.1.4 Hard Fruit processing

The hard fruit processing sector concerns the processing of apples and pears. Within Reimerswaal, apples and pears are processed by two companies in Krabbendijke. Vogelaar Vredehof is the company of interest for this sector. The main occupations of Vogelaar Vredehof are storing, sorting, packaging and trading apples and pears. Annually Vogelaar Vredehof processes between 100 and 120 million kilograms of food with 150 employees. Vogelaar Vredehof also has a location in Enspijk. All of the apples and pears that are sold by Albert Heijn are processed by Vogelaar Vredehof.

Figure 13 Vogelaar Vredehof Logo source:vogelaar.com

4.2 Critical infrastructure and food processing industry

4.2.1 Introduction

In this chapter, the relation between the food processing industry is described. On which critical infrastructure systems do they depend and how do they manage they energy and water supplies. For each sector the company of interest will be used. There will be a division between the general infrastructure systems and infrastructure used inside the companies. The information in this chapter was gained by executing interviews, the transcripts of the interviews can be found in appendix II, III, IV and V.

4.2.2 General infrastructure systems

The interviews pointed out that some infrastructure systems are critical to the business continuation of the companies. The two most mentioned systems were the ICT/communication system and the road system. Without communication with clients, no sales can be done and without a properly functioning road network, the sold products and necessary goods cannot be delivered. These aspects are mentioned, but because of the lack of possibilities for companies to interfere in a road network that is disrupted or destroyed and data cables and systems for ICT/communication that are not working, this subject will not be discussed any further. This research is focused on the infrastructural systems which, when disrupted or damaged, can be replaced or substituted by adaptation measures for the company itself.

Figure 14 Sectors Reimerswaal source: Google Earth modified by Raoul Lobbezoo

4.2.3 Zeeland's Roem

Electricity

Zeeland's Roem does not possess any solar panels and are operating on electricity from the electricity net. During a power outage, the vital processes that cannot be interrupted, continue with the use of electricity that is generated by an aggregate.

Figure 15 Aggregate source: wikipedia.com

Water

Zeeland's Roem is connected to a saltwater line. During the processing of the fish and shellfish, saltwater is used. This pipeline is connected to most of the fish and shellfish processing companies in Yerseke and is rather unique. Water from the Oosterschelde cannot be used.

4.2.4 Agro Care

Electricity

Agro Care is connected to electricity net, but not to use electricity, but to get rid of excess electricity. This electricity is generated by a cogeneration installation. A cogeneration installation generates electricity, heat and CO2. The production of CO2 is the primary goal of using the cogeneration installation, because high levels of CO2 are necessary within the greenhouses to reach the desired production quality and quantity. Heat is also a product that is used a lot by Agro Care. All of the heat and CO2 produced by the cogeneration installation are used, but large amounts of electricity are sold back to the net. Together with the locations in Middenmeer, Wieringermeer and Rilland about 10.000 households get their electricity from Agro Care. The cogeneration installations run on gas and has an efficiency of 99% which means that only 1% of the used energy is lost. The heat that is produced is stored in warm water buffers next to the greenhouses and is used to heat the greenhouses when the outside temperature drops.

Figure 16 Cogeneration installation source: lekhabo.nl

Water

All of the water used by Agro Care is rainwater. The rainwater that falls on the roofs of the greenhouses is drained into large basins. These basins need to be around 10% of the total greenhouse surface, in order to store sufficient water. The tomatoes are cultivated in hanging structures that are elevated from the floor and are connected to large gutters. The water is dripped directly into the roots of the tomato plant and the excess water gets discharged by the gutters. Agro Care possesses a water purification installation which cleans the excess water of all pesticides and nutrients and can be used again, as well as the nutrients and pesticides.

Figure 17 Greenhouses Rilland source: Google Earth

4.2.5 Wiskerke Onions

Electricity

At this moment Wiskerke Onions does not possess any solar panels. All of the electricity used is regular electricity provided via the electricity network. In case of a power outage, backup generators keep the communication and ICT systems running, but the entire production process is out of order. No more onions can be processed when the power is down, but onions that were already processed can still be sold and shipped. The ICT is protected because of its importance to the company, without communication it is impossible to trade. The processing machines consume a large amount of energy, which would need a large investment in order to keep them running with backup generators.

Water

During the processing of the onions, water is barely used.

Gas

Gas is used for the drying process of the unions. There are plans for the future that will replace the use of gas for drying the onions, by excess heat that comes from the neighboring company. This is done to increase the companies sustainability. Currently there is a plan proposed to the municipality and Wiskerke Onions is awaiting their decision making. This would mean that gas would be replaced by excess heat.

4.2.6 Vogelaar Vredehof

Electricity

25% of the electricity used by Vogelaar Vredehof is generated by the solar panels located on their rooftops. Due to the unfavorable positioning of the buildings in relation to the sun, this was the highest percentage that was still profitable. The other 75% is regular electricity provided via the electricity network. Vogelaar Vredehof does not possess any backup generators.

Figure 18 Solar panels source: aardvast.nl

Water

Vogelaar Vredehof possesses a water purification installation. This installation treats the used industrial water in order to improve the physical land chemical quality of the water. The main pollutions that need to be removed from the water are fungi, bacteria, yeast and pesticides. The water circulation is not entirely closed, because the apples and pears are not entirely dry when they leave the water, so the water level needs to be restored by adding regular fresh water from pipelines.

4.3 The impact of climate change on food processing companies

4.3.1 Introduction

In this chapter the impact of climate change is discussed per company. For each company a SWOT analysis is made (strengths, weaknesses, opportunities and threats) in relation to infrastructure and climate change. For every company specific climate change effects are discussed, for instance salinization does not affect Agro Care, but does affect Wiskerke Onions. For each impact, there is a source of former research and an expert opinion. The interviews from with the expert opinions were used can be found in appendix II,III,IV and V.

4.3.2 Agro Care

Extreme events

Research

The increase of extreme events such as storms, thunder and hail can cause large damage to greenhouses. A recent example can be found in Noord-Brabant and Limburg, were several greenhouses were put out of business due to destruction of the glass structures.
(Aarsbergen, 2014) (Slobbe, Breukers, & Ruijs, 2010) (Gersdorf, 2016)

Expert opinion

Not mentioned

Precipitation

Research

The primary source of water used in greenhouses is rain, the rainwater that drops on the greenhouses is caught in large basins, which in an average year, can provide the sufficient amount of water all year round, but in periods of extreme drought, the rainwater basins can run empty. When the rainwaters basins run empty, surface and groundwater are used, but due to the increasing salinization of the water, (Provincie Zuid-Holland, 2012)

Expert opinion

The high peaks in rainfall and drought can cause problems for Agro Care, during extreme rainfall, the basins only have a limited volume and might not be able to store al of the water. The diverging division between periods of drought and extreme rainfall call for a more robust solution.

Temperature

Research

Rising temperatures can reduce the operating costs of the greenhouse industry, because the amount of heath that needs to be produced decreases and therefor the costs drop.
(Slobbe, Breukers, & Ruijs, 2010)

Expert opinion

Increasing temperatures do not contribute to lower production costs. The CO2 production is the primary goal of using the cogeneration installation. Heat and electricity are useful as well, but are secondary products. The increasing temperatures might even lead to rising costs, because during extreme heat, we need to cool the greenhouses. Steady outside temperatures are the most efficient for greenhouses, because when windows are opened during extreme heat, CO2 escapes. When temperatures are too low, more heat needs to be produced. This is

very inefficient, so more highs and lows in temperature would mean a decrease in efficiency and an increase in costs

Strengths

- Produces own electricity, CO2 and heath

By producing their own electricity, CO2 and heath, Agro Care is not dependent of the electricity net and therefore will not be harmed during a power outage.

- Moderate climate

The moderate climate in which the greenhouses of Agro Care in Reimerswaal are situated, provide the best circumstances for the growth of tomatoes.

- Situated close to highway

The location of Agro Care close to the highway, logistically makes it easier for suppliers, customers and personnel to reach Agro Care.

- Large rainwater catchment basins

Agro Care possesses rainwater catchment basins that can provide the tomato plants with water all year round, not taking into account extreme droughts.

- Purifies own industrial water

Agro Care also possesses a water purification installation. This water purification installation does not only decrease the need of freshwater supply due to the fact that the water that does not evaporate or isn't imbibed by the plants can be reused, but it also filters out the nutrients and pesticides which can be used again.

Weaknesses

- Low CO2 levels in outside air

The outdoor CO2 levels in Reimerswaal are relatively low compared to the CO2 levels in the Westland, which means that more CO2 needs to be produced by the cogeneration installations and this leads to higher production costs.

- Vulnerability of crops to diseases and infections

The all year round high temperatures in the greenhouses and the high density of crops located next to each other make the tomatoes very vulnerable to diseases and infections.

- Increasing water usage due to intensifying cultivation

The intensification of the cultivation leads to an increase in water usage, which is a weakness due to the already large amounts of water used for the growth of tomatoes and the scarcity of freshwater supply.

Opportunities

- Foreign competition has larger negative effects of climate change

The effects of climate change are expected to be bigger in other areas where tomatoes are grown, for instance in the Mediterranean area. This could create a better market position for the tomato growers in the Netherlands.

- More possibilities to use CO2 from other industries

The increasing governmental pressure for companies to lower their CO2 emissions could lead to industrial CO2 becoming available for use in the greenhouses, which would lower production costs.

Threats

- Increasing salinity groundwater

The increasing salinity of the groundwater would not directly impact the crops, because they are not grown on the ground, but during periods of drought when the water basins run out, ground water could be used, but when the groundwater turns to saline, this is also not an option anymore.

- Higher peaks in rainfall and longer droughts

Higher peaks in rainfall might cause the water basins to overflow and not catch all of the rainwater, whereas this rainwater could be necessary during longer periods of droughts, which could lead to water shortages.

- New competition due to shifting climate zones

Shifting climate zones might create suitable climate circumstances for the growth of tomatoes in areas that were not suitable before and thus new competition could emerge.

- Higher temperatures during summer call for more cooling

Increasing summer temperatures need more cooling in the greenhouses, because extreme temperatures are not desirable. Cooling causes CO2 to be lost and this raises the production costs.

- Damage due to extremer hail

Extreme hail can cause huge damages to the greenhouses, because the hail could penetrate the glass and by doing so, destroying the greenhouse as well as the crops.

SWOT Analysis Agro Care

Strengths	**Weaknesses**
• Produces own electricity, CO2 and heath • Moderate climate • Situated close to highway • Large rainwater catchment basins • Purifies own industrial water	• Low CO2 levels in outside air • Vulnerability of crops to diseases and infections • Increasing water usage due to intensifying cultivation
Opportunities	**Threats**
• Foreign competition has larger negative effects of climate change • More possibilities to use CO2 from other industries	• Increasing salinity groundwater • Higher peaks in rainfall and longer droughts • New competition due to shifting climate zones • Higher temperatures during summer call for more cooling • Damage due to extremer hail

4.3.3 Vogelaar Vredehof

Extreme events

Research

Extreme events will become more frequent and more severe, for the fruit cultivation sector, hail is the biggest threat. Hail can cause enormous damage to the trees as well as the fruit. (Aarsbergen, 2014) (Slobbe, Breukers, & Ruijs, 2010)

Expert opinion

Not mentioned

Precipitation

Research

Extreme precipitation can cause damage to the fruit, as well as issues with storage and transport during harvest season. When the apples and pears are still in the orchards, but the orchards become hard to access due to high groundwater levels, the rotting process commences when apples and pears aren't stored in time. Extreme drought can cause a prohibition in irrigation, because drinking water or the preservation of nature reserves is prioritized. (Blom-Zandstra & Goosen, 2010)

Expert opinion

Not mentioned

Temperature

Research

Extreme heat and heatwaves can cause disruptions in the electricity network and power outages. (EPA, 2016) Late frosts can cause enormous damages to the flowering apples and pears. Posibilities for the cultivation of new races of apples and pears that need higher temperatures emerge. (Slobbe, Breukers, & Ruijs, 2010)

Expert opinion

Rising temperatures can create opportunities for the growth of other races. Suppliers from South-Africa, Chile, New-Zealand and Australia are moving hundreds of kilometers towards more suitable climates, they are already noticing higher temperatures, but in the Netherlands we are located in the moderate climate zone and on the long term, this will only be a benefit to us.

Salinization

Research

An increase in the salinity of the soil and groundwater can have a negative effect on the growth apple and pear trees.
(Blom-Zandstra & Goosen, 2010)

Expert opinion

Not mentioned

SWOT Analysis Vogelaar Vredehof

Strengths

- Situated close to highway

The location of Vogelaar Vredehof close to the highway, logistically makes it easier for suppliers, customers and personnel to reach Vogelaar Vredehof.

- 25% of energy use is produced by solar panels

Vogelaar Vredehof possesses solar panels that produce 25% of the energy use. This means a lower demand from the net and an increase in sustainability of the production process.

- Purifies own industrial water

Vogelaar Vredehof possesses a water purification installation that treats the water used in the production process in order to make it reusable. This lowers the water demand and makes the process more sustainable.

- Current climate is very favorable for fruit cultivation

The current climate is very favorable for fruit cultivation due to the soft winters and moderate summers. In this climate a high productivity can be reached, but also maintaining a good quality produce.

Weaknesses

- Dependent of external electricity and water

Vogelaar Vredehof is depending on external water and electricity, in the case of infrastructure failure, due to extreme heat or drought, water and electricity will not be available.

- Susceptible to plagues and diseases

Apples and pears are very susceptible to plagues and diseases and in a bad year entire harvests could be ruined.

- No backup generators in case of emergency

During a power outage, Vogelaar Vredehof does not possess any aggregates and will not be able to continue the production process.

Opportunities

- Production in competing countries will decrease due to limitations by climate change

Whereas the moderate Dutch climate will undergo changes, less moderate climates, in which fruit can still be cultivated right now, might become too hot or too dry in the future. Which creates a better position for Vogelaar Vredehof on the international market.

- Changing cultivation circumstances provides opportunities for new races.

With rising temperatures, apples that need more sunlight to thrive, can be cultivated. A more diverse offer in produce, strengthens the market position.

- Foreign knowledge and experience can be used from southern countries for future issues and problems.

With the shifting climate zones, issues that were already present in more southern countries might come to the Netherlands. The expertise that was created there in the past, can be used over here to decrease the impact of certain issues.

- Biological cultivation under southern climate circumstances appears to be less vulnerable than ordinary cultivation.

The changing climate circumstances make it easier for biological cultivation than for ordinary cultivation. Under the changed climate circumstances, less pesticides are necessary to successfully cultivate, which means lower costs and lower environmental impact.

Threats

- Drought damage

Increased periods of drought can cause large damages to the apples and pears.

- Storage issues due to wet circumstances in harvest season

When there is extreme rainfall during the harvest season, the orchard become less accessible and produce gets harder to move and store in cold stores and the rotting process will start earlier.

- Increase in plagues and diseases

Higher temperatures will increase the vulnerability of the produce to plagues and diseases.

- Salinization of groundwater

An increase in the salinization of the groundwater will make the water less suitable for growing apple and pear trees and therefore the soil becomes less suitable.

- Late frosts

Shifting climate circumstances can cause late frosts, which will cause a lot of damage when the trees are already flowering, the flowers will freeze and now apples or pears will grow out of them.

- Insufficient winters rest

When the winters are too warm, the trees do not get the sufficient amount of rest they need during the winter and harvest can be ruined.

- Hail damage

The increase in extreme events and in particular hail, can cause major damage to the trees and fruit.

- Possible new competition due to shifting climate zones

Shifting climate zones might create suitable climate circumstances for the growth of hard fruit in areas that were not suitable before and thus new competition could emerge.

Strengths	Weaknesses
• Situated close to highway • 25% of energy use is produced by solar panels • Purifies own industrial water • Current climate is very favorable for fruit cultivation	• Dependent of external electricity and water • Susceptible to plagues and diseases • No backup generators in case of emergency
Opportunities	**Threats**
• Production in competing countries will decrease due to limitations by climate change • Changing cultivation circumstances provides opportunities for new races. • Foreign knowledge and experience can be used from southern countries for future issues and problems. • Biological cultivation under southern climate circumstances appears to be less vulnerable than ordinary cultivation.	• Drought damage • Storage issues due to wet circumstances in harvest season • Hail damage • Increase in plagues and diseases • Salinization of groundwater • Late frosts • Insufficient winters rest • Possible new competition due to shifting climate zones

4.3.4 Wiskerke Onions

Precipitation

Research

Acres become inaccessible after heavy rainfall and will lead to losses in production, the rotting process will also commence earlier when onions are completely under water. Nutrients and pesticides get washed away by the rain and will not have the desired impact on the crops, which might decrease the quality of the crops and cause trouble with polluted surface water. (Blom-Zandstra & Goosen, 2010)

Expert opinion

Drought will not have that big of an effect on the growth of onions, because in this region there is plenty of water available for irrigation, besides that onions are robust product and despite the fact that they need a lot of water, they can endure a period of drought. A bigger threat is extreme rainfall, when the acres are too wet, they become inaccessible and the onions cannot be harvested which would ruin the entire harvest.

Temperature

Research

Extreme heat and heatwaves can cause disruptions in the electricity network and power outages (EPA, 2016).

Expert opinion

Not mentioned

Salinization

Research

Salinization could cause damage to onions, but by genetic modification a lot of these problems could be solved.(Blom-Zandstra & Goosen, 2010)Recent research in Zeeland has shown that onions are can be cultivated very well on increasingly saline soils. Despite the salinization, onions can still be grown in Zeeland. (van Doorsselaer, 2016)

Expert opinion

Salinization could be a threat, but the crop modification possibilities in the Netherlands are highly developed and will be able to cope with this issue, so it shouldn't be too much of a problem

SWOT Analysis Wiskerke Onions

Strengths

- Unique market position

Worldwide most countries have a shortage or very small surplus of onions, while the Netherlands has a huge surplus and can deliver worldwide to countries with large demands. Wiskerke Onions is the biggest onion exporter in the world.

- Onions are robust products

Onions can suffer quite large variations in precipitation and temperature and harvest will not be ruined very fast.

- Located nearby important ports

Wiskerke Onions is located relatively close to the ports of Antwerp, Rotterdam and Vlissingen. These ports are used a lot for worldwide shipments of onions and being located close to them is a big plus.

- Situated close to highway

The location of Wiskerke Onions close to the highway, logistically makes it easier for suppliers, customers and personnel to reach Wiskerke Onions.

- Backup generators for ICT/communication systems

Wiskerke Onions possesses backup generators for the ICT and communication systems, in case of a power outage, the trading can still continue.

- Current climate is very favorable for the growth of onions

The current climate is perfect for the growth of onions, the temperatures, precipitation and soil composition are very well suited for the growth of onions and therefor onions from the Reimerswaal area are known for its great quality.

- Product suppliers are spread out across Europe

The farmers that supply the onions for Wiskerke Onions are spread out across Europe, for instance if a flood ruins the German harvests, there are still harvests from France, the Netherlands and Belgium left to process.

Weaknesses

- Dependent of external electricity

During a power outage, the entire production process of Wiskerke Onions is down, because there are no backup generators for the machines.

- Crops can only be grown on the same field once in 7 years

The biggest weakness of the onion growth is the fact that onions can only be grown on the same field once every 7 years. If onions are grown on the same field with a higher frequency, the soil will degrade and diseases and infections will affect the onions more often.

Opportunities

- Bigger climate change impact on competing countries

Whereas the moderate Dutch climate will undergo changes, less moderate climates, in which onions can still be grown right now, might become too hot or too dry in the future. Which creates a better position for Wiskerke Onions on the international market.

- Working together with neighboring company to use excess heat

Wiskerke Onions is working together with LambWeston Meijer to create an excess heat transfer pipeline. LambWeston Meijer needs to get rid of its excess heat and Wiskerke Onions has a demand for heat. Building this pipeline would increase both companies sustainability and lower the use of fossil fuels by Wiskerke Onions.

- Modification of crops to make them more climate proof

The Dutch seed modification companies are busy working on crops that are more suitable to be grown on saline soils and thrive under extremer conditions.

Threats

- Salinization can damage the harvests

Despite the fact that crops can be modified and onions are robust, salinization is still a threat to onions growers in Reimerswaal.

- Extreme rainfall makes fields inaccessible and does harm to crops

During extreme rainfall fields can become inaccessible during harvest periods and harvests can be ruined.

- Long periods of drought can do harm to the crops

Extreme drought can also damage the crops, onions need a lot of freshwater to grow and when there is a shortage this will affect the quality of the onion.

Strengths	Weaknesses
• Unique market position • Onions are robust products • Located nearby important ports • Situated close to highway • Backup generators for ICT/communication systems • Current climate is very favorable for the growth of onions • Product suppliers are spread out across Europe	• Dependent of external electricity • Crops can only be grown on the same field once in 7 years
Opportunities	**Threats**
• Bigger climate change impact on competing countries • Working together with neighboring company to use excess heat • Modification of crops to make them more climate proof	• Salinization can damage the harvests • Extreme rainfall makes fields inaccessible and does harm to crops • Long periods of drought can do harm to the crops

4.3.5 Zeeland's Roem

Extreme events

Research

It is not very likely for mussels to be carried away by waves and streams during a storm, because mussels are attached to each other and therefor remain on the same location. (Weerman, 2011)

Expert opinion

During extreme events such as storms, mussels can drift away from their original plot, this could mean a loss of mussels and is a negative effect. Storms can also impact the business continuity, because during a storm, we will not be able to work on the sea with our ships.

Precipitation

Research

Extensive rainfall can lead to pollution of estuaries, British estuaries are influenced by contaminated rainwater run-off into the sea which ruins the oyster and mussel cultivation. (Carter, 2014) Recently pluvial flooding occurred in Yerseke, the drainage of the rainwater was challenging, because the water could not be dumped into the Oosterschelde. This would do harm to the oysters and mussels, therefore looking for another solution took more time and streets were inundated for a couple of days. (Reformatorisch Dagblad, 2016)

Expert opinion

Droughts will not impact our business continuity, because we are not dependent of fresh water. On the other hand, heavy rainfall can decrease the salinity of the sea water and this has a negative effect on the growth of mussels and oysters.

Temperature

Research

An increase in temperature can cause decreasing O2 levels in the sea, which can lead to dead zones in which no organism can live. (European Environmental Agency, 2015) Extreme heat and heatwaves can cause disruptions in the electricity network and power outages.
(EPA, 2016)

Expert opinion

Rising water temperatures may increase diseases and infections of the mussels and oysters.

Seawater acidification

Research

Oceans do not only absorb heath, they also store carbon dioxide. The more CO2 gets emitted into the atmosphere, the more CO2 gets absorbed by the ocean, where it changes into carbon acid due to a chemical reaction with water, which leads to acidification of the ocean. Acidification has multiple consequences to marine life, including the fact that mussels and oysters have a harder time to create their shells in an environment with a higher pH-level.
(European Environmental Agency, 2015)

Expert opinion

We aren't noticing any negative benefits from seawater acidification right now, maybe we will in the future but there is not much to do about it.

SWOT analysis Zeeland's Roem

Strengths

- Presence of salt water pipe line

Due to changes in regulation, it was no longer allowed to take water directly from the Oosterschelde. Nowadays the fish and shellfish share a salt water pipeline that gets is salt water from underneath the Oosterschelde. A pipeline like this is unique and is vital to the industry.

- Possesses backup generator to keep vital processes going

During a power outage, the vital processes going on at Roem van Yerseke that cannot bear any interruption, will continue with the use of backup generators. Therefor no damage will be done to the products.

- Located close to highway

The location of Zeeland's Roem close to the highway, logistically makes it easier for suppliers, customers and personnel to reach Zeeland's Roem.

Weaknesses

- Depending on external electricity

Zeeland's Roem is depending on electricity from the net and during power outages only the vital processes maintain, but the company is not operable anymore.

- High levels of toxic in mussels and oysters found

Currently oysters and mussels that are cultivated in specific areas in the Oosterschelde show levels of toxicity that are too high for consuming. This causes negative press attention and people that are afraid to eat mussels, despite the fact that were tested and proven edible.

Opportunities

- Look at possibilities for inland growth of mussels

Due to increasing climate threats, mussel growth on a larger scale on the mainland should be considered. Research has shown that it is indeed possible.

Threats

- Sea water acidification

Rising CO2 concentration in the atmosphere cause sea water to become more acid, the pH level drops and it becomes harder for shellfish like mussels and oysters to grow their shells.

- Polluted rainwater runoff into sea

During extreme rainfall, the rainwater can run into the sea and this would pollute the water in which the mussels and oysters are grown.

- Rising water temperatures

Rising water temperatures can cause an increase in diseases and infections and also a larger threat from alien species that thrive with higher temperatures.

- Opposition by environmental organizations

Environmental organizations consider the mussel and oyster cultivation as hostile to the environment and oppose the companies by demonstrating and trying to shut down the fishery.

- Increasing severity of storms makes seas inaccessible

The increase of extreme events such as storms could increase the number of days that seas become inaccessible and on these days no mussels or oysters can be caught, which means a economical loss.

Strengths	**Weaknesses**
• Presence of salt water pipe line • Possesses backup generator to keep vital processes going • Located close to highway	• Depending on external electricity • High levels of toxic in mussels and oysters found
Opportunities	**Threats**
• Look at possibilities for inland growth of mussels	• Sea water acidification • Polluted rainwater runoff into sea • Rising water temperatures • Opposition by environmental organizations • Increasing severity of storms makes seas inaccessible

4.4 Climate change adaptation measures

4.4.1 Introduction

In the previous paragraphs, the possible positive and negative impacts on the food processing industry and it's critical infrastructure were discussed. In this chapter possible adaptation measures to cease the opportunities and limit the threats that climate change creates, are being proposed.

4.4.2 Agro Care

To limit the negative impacts and benefit the positive impacts to the fullest, Agro Care can take some measures to become more climate proof. As was described in the previous paragraph, the biggest threats for Agro Care are hail damage, increasing fluctuations in rainfall together with increasing salinization. In the field of electricity, Agro Care doesn't need any measures, because they are already generating their own electricity. Considering the CO2 demand of Agro Care, there are opportunities that can be ceased as well.

Increasing surface and capacity water basins to store more rainwater. The increasing fluctuations of heavy rainfall and drought call for an increase in the surface and capacity of the rainwater storage basins. The basins are built to provide enough water all year round, but during extreme droughts the basins can run out and during extreme rainfall, they can overflow. To prevent this from happening, the surface and capacity of the rainwater storage basins should be increased.

CO2 is very important for the cultivation of tomatoes, nowadays the CO2 is produced by Agro Care itself. The production of CO2 takes up a large share of the production costs. The increasing governmental pressure on companies that emit too much CO2 and have to capture this instead of releasing it into the atmosphere, creates an opportunity for Agro Care to lower its production costs by using excess CO2 from other industries. This measure can be put under the label of mitigation, but also has economic benefit for Agro Care. This would be a win-win measure.

A hail protection construction would be recommended, because of the increasing extreme hail, which can cause extreme damage to the greenhouses itself, as well as the crops. Recently entire greenhouses were destroyed in Noord-Brabant and Limburg. In order to prevent this from happening, different measures could be taken. The greenhouses could be made out of reinforced materials, which do not shatter and break as easily as glass. This would take quite a large investment, since all of the glass should be replaced. Another solution could be nets on top of the greenhouses that catch the hail before it even hits the glass. This would require quite an investment, but when hail would actually hit Agro Care, the damage would be much bigger, therefore this could put under the low regret adaptation measures.

4.4.3 Vogelaar Vredehof

For Vogelaar Vredehof, there are some measures to be taken as well, in order to become more climate proof. With the use of a water treatment installation, they have set a step in the right direction, but the water that needs to be added is still coming from pipelines. The increasing possibility of a power outage during a hot and dry period, cannot not be replaced by the solar panels they are already using, because the solar panels only provide 25% of their electricity usage. Despite the fact that Vogelaar Vredehof is not a cultivator of apples and pears itself, they are very dependent on the cultivation of their suppliers.

Vogelaar Vredehof already possesses a water purification installation, which decreases the water demand, but still freshwater from pipelines is used. By constructing rainwater catchment basins and purifying the water with the already existing equipment, the dependency of freshwater would decrease.

Vogelaar Vredehof already possesses the maximum amount of solar panels they could fit on their roofs, but they do not possess an energy storage unit. For more efficient use of the energy and to be sure that no energy is lost, it could be stored in large batteries. Tesla has developed these modules and they are also suitable for companies. In the case of a power outage, Vogelaar Vredehof is not able to continue its production. Therefor a backup generator would be a good investment, since the projection is that power outages will become more frequent.

Look at opportunities for new races, together with their suppliers and clients, Vogelaar Vredehof should discuss possible changes in assortment. When the temperature rises, some races might not thrive as well as they did before and new races could be better suitable for the new climate circumstances.

4.4.4 Wiskerke Onions

For Wiskerke Onions, climate change brings more opportunities than threats, but still the threats need to be eliminated as much as possible. The production process of Wiskerke Onions is completely dependent of electricity from the net. A power outage would also impact Wiskerke Onions, the company would not be operable anymore except for the ICT and communication systems that are necessary for sales. Therefore possible measures for Wiskerke Onions would be investing in becoming self-sufficient concerning energy, for example by placing solar panels in combination with energy storage units.

For the possible threat of salinization, research is necessary. Some onion races can endure salinization better than others. When customers demand the races that are not very well suitable for cultivation on saline soils, there should be invested in the modification of the crops in order to get them more resilient to then new climate circumstances.

Currently Wiskerke Onions uses gas to dry the onions. LambWeston Meijer is large potato processing company located next to Wiskerke Onions and it has excess heat in abundance. Instead of releasing the heat into the atmosphere, Wiskerke Onions could use this heat in order to dry their onions. This would make Wiskerke Onions less dependent on gas and it would be a very sustainable solution.

4.4.5 Zeeland's Roem

The biggest challenge for Zeeland's Roem is a decreasing quality of the sea water, due to acidification, polluted rainwater runoff and increase of diseases and infections due to rising water temperatures. A power outage would also impact Zeeland's Roem, the company would not be operable anymore except for some vital processes that cannot endure any interruption. Therefore possible measures for Zeeland's Roem would be investing in becoming self-sufficient concerning energy, for example by placing solar panels in combination with energy storage units.

For the decreasing quality of the sea water, one measure could be taken which is quite rigorous. When the quality drops to a certain level and cultivation of mussels and oysters is no longer possible in sea, other options should be examined. There have already been successful tests with inland mussel farms, but to further develop this concept it requires a lot of research and investments, but when mussels can no longer be cultivated in sea, this seems to be the only option

5. Discussion

In this chapter the value of this research is discussed, together with the limitations and flaws of this research and ideas for a follow up research. The research had some limitations, off course time is limited and therefore decisions need to be made. Due to the fact that the research proposal took a lot more time than planned, lesser time was left for the actual execution of the research. One of the consequences of this was that an interview with key player in the food processing industry of Reimerswaal, LambWeston Meijer, was not interviewed. This was not only caused by a lack of time, but also bad communication. In order to make the outcomes of this research more reliable, more than one company per sector should be interviewed. A possibility is to execute a research per sector such as only looking at the onion processing. Another possibility is choosing one climate effect such as salinization and look at the effects of salinization on the food processing industry, or the effects of salinization on a single sector, such as the onion sector, to get a really in depth research. That might have been a pitfall of this research, that to many aspects needed to researched. Despite the fact that it goes into detail on the matter of the food processing industry instead of critical infrastructure as a whole, the food processing industry is still a large matter to tackle at once. On the other hand, it is interesting to see the differences between impacts on the sectors. For some sectors climate change provides more opportunities than threats and for other sectors opportunities are scarce and it is mainly a threat. At the start of this research, the idea of climate change might also have a positive impact didn't come to mind. This came to mind after the interviews with the experts in the food processing industry. This was really interesting to see. The differences between literature and the expert opinions were also results that weren't projected beforehand.

6. Conclusion

In this chapter the research question will be answered based on the previously gathered information. What is the impact of climate change effects on critical infrastructure for the food processing industry and what can be done to limit these consequences? The food processing industry is a part of critical infrastructure and just like other infrastructure systems is strongly depending on other infrastructure systems. In Reimerswaal is a corridor of multiple critical infrastructure systems as well as a very large food processing industry. With an annual processing of 1.5 billion kilograms of food and 2000 employees, the food processing sector is main economic driver of Reimerswaal. The food processing sector of Reimerswaal can be divided into 5 sectors, tomato processing, onion processing, hard fruit processing, fish and shellfish processing and diverse processing. For each sector, except for the diverse sector, a case study about the impact of climate change was done. Critical infrastructure systems on which all the companies are depending in the same way are the road network and ICT/communication network. The roads are critical for the transportation of goods and without the proper ICT/communication network, trading and communicating with suppliers and customers is impossible. The focus of this research was more directed at the critical infrastructure systems that are critical to all of the companies as well, but can be filled in different ways. Food, water and electricity supply are critical to the business continuation, but can be provided in different ways such as the use of solar panels, a cogeneration installation, rainwater catchment basins, water treatment plant and a saltwater supply line. Because of the variable use of these infrastructure systems, the impact of climate change will be different for each sector. The impact of climate change does not only poses threats to the food processing industry, it also provides opportunities. Threats to the food processing industry are salinization of the soil, sea water acidification, droughts, extreme rainfall and increasing temperatures and heatwaves. Opportunities for the food processing industry are the possibility of growing other crops on more saline soils, other species because of shifting climate zones and a higher impact of climate change on competing countries and companies. The following measures can be taken to limit the negative impacts and benefit the positive impacts as much as possible. By becoming self-sufficient, impacts of climate change on the electricity grid and water supply will not harm the business continuation of the company in question. Generating electricity can be done by placing solar panels on the roof, in order to be completely self-sufficient by using solar panels, an energy storage is needed as well, due to the fact that solar panels generate less energy during the winter. A cogeneration installation is another solution to generate electricity, CO2 and heath. For water supply, rainwater catchment basins, combined with a water treatment plant can be installed in order to become self-sufficient. The rainwater catchment basins need a large surface, to be able to store large amounts of water during heavy rainfall and be robust enough to maintain the sufficient amount of water during a period of drought. For the products that need to be processed, there are ways to limit the impacts, such as choosing suppliers from different regions, to spread the chances of extreme events ruining the harvest everywhere. Some crops and species might not be suitable in the changing climate circumstances, but chances for other crops and species arise. Therefor it is important to evaluate the future of the product, this goes together with being aware of climate change. So in conclusion, the impacts of climate change can be positive

and negative. The impacts differ strongly per sector and can be limited or benefited by increasing self-sufficiency and looking at future of the product.

7. Recommendations

In this chapter the recommendations will be given, which will, when executed properly, decrease the negative effects and increase the positive effects of climate change. The first recommendation is the creation of awareness. Climate change awareness is the first step in taking action. When there is no awareness, no actions will be taken and the issue will not be tackled. What was proved by executing the interviews was, that some experts in the food processing industry are not entirely aware of the possible consequences of climate changes on their field of work, therefor they will not act. The earlier the awareness of climate change arises, the more time there is left to act, before it's too late to benefit from the positive effects or too late to decrease or limit the negative effects. Therefore it is recommended to plan workshops and symposia where food processing experts receive the necessary information to act as efficient as possible in their field of work, considering climate change. Examples of institutions that can provide this knowledge are Meteogroup and KNMI.

The second recommendation is: create independence of the electricity net and water supply. As has been mentioned before, the electricity net and fresh water supply can suffer critical impacts from climate change effects. In order to maintain an operating company, independence of these vulnerable networks is a key aspect. Complete independence might be difficult to achieve and urges some large investments, it makes the company more robust from exterior threats such as climate change. Examples of measures that can be taken to increase the independency and go more off the grid are the use of solar panels, combined with an energy storage installation, a cogeneration installation, rainwater catchment basins combined with a water treatment plant. All of these measures will contribute to a more climate proof company.

The third recommendation is: the measures need to be cost effective. For instance Zeeland's Roem is willing to place solar panels on their roof, but is held back of implementing this, because the agreement they have with their energy supplier, provides them with energy that is three times cheaper than using solar panels. In order for them to invest, a measure needs to be cost effective or mandatory. This recommendation is strongly connected to creating awareness. When companies are unaware of the impact and its potential damages, they will not invest. Possible measures that can be taken to increase the cost effectiveness are lowering the costs of the investments, this has to be done by a governmental body, such as the municipality of Reimerswaal, by giving subsidies for climate proof adaptations. Another measure could be increasing taxes on non-climate proof resources. This way the climate proof resource becomes more attractive, due to the higher price of the non-climate proof solution.

The fourth and final recommendation is: look at the future of the product. Changing climate circumstances call for an evaluation of the product. Changing circumstances can create threats for existing species and can create opportunities for new species. In order to achieve the maximum productivity and cost effectiveness an evaluation is mandatory. When there is no future for the current product due to increasing temperatures, higher peaks in drought and rainfall, shifting climate zones, sea water acidification and soil salinization, possibilities for the introduction of new crops and species should be assessed, in order to maintain the business continuity of the company.

Appendix I Company list

Fish and Shellfish Sector

AQUA-mossel
Activities: cultivation, processing and trading oysters, mussels, lobsters and cockles
Location: Yerseke
Processing volume: 9 million kg
FTE: 35, 10 for processing and 25 for cultivation

Krijn Verwijs Yerseke BV
Activities: cultivation, processing and trading oysters, mussels, lobsters and cockles
Location: Yerseke
Processing volume: 18-25 million kg
FTE: very fluctuating depending on the seasons

Roem van Yerseke
Activities: cultivation, processing and trading oysters, mussels and cockles
Location: Yerseke
Processing volume: Classified
FTE: 150

Delta Mossel BV
Activities: cultivation, processing and trading oysters, mussels, lobsters and cockles
Location: Yerseke
Processing volume: Classified
FTE: 20 + 8/12 temporary employees

Prins en Dingemanse BV
Activities: cultivation, processing and trading oysters, mussels, lobsters and cockles
Location: Yerseke
Processing volume: Classified
FTE: 100

Vette & Verhaart BV (Qualimer)
Activities: cultivation, processing and trading oysters and mussels
Location: Yerseke
Processing volume: n/a
FTE: n/a

Fish XL
Activities: fileting fish
Location: Yerseke
Processing volume: n/a
FTE: n/a

Triton Mosselen
Activities: cultivation, processing and trading oysters and mussels
Location: Yerseke
Processing volume: n/a
FTE: 21-50*

G&B
Activities: processing fish and meat
Location: Yerseke
Processing volume: n/a
FTE: n/a

Lenger Seafoods
Activities: cultivation, processing and trading shellfish
Location: Yerseke
Processing volume: n/a
FTE: 51-100*

Verwijs van der Endt
Activities: cultivation, processing and trading oysters, mussels and lobsters
Location: Yerseke
Processing volume:
FTE: 11-20*

Tomato Sector
Lans
Activities: cultivating and packaging tomatoes
Location: Rilland
Processing volume: n/a
FTE: n/a

Combivliet
Activities: cultivating and packaging tomatoes
Location: Rilland
Processing volume: 15 million kg
FTE: 90

AgroCare
Activities: cultivating and packaging tomatoes
Location: Rilland
Processing volume: 10 million kg
FTE: 25 + 120 temporary employees

Onion Sector
Onion Specialties
Activities: peeling, washing, cutting, battering and deep frying onions
Location: Kruiningen
Processing volume: n/a
FTE: n/a

Van den Berge
Activities: sorting and packaging onions, shallots, carrots and celery
Location: Kruiningen
Processing volume: 60 million kg
FTE: 20

Gebr. Boone
Activities: sorting and packaging
Location: Oostdijk
Processing volume: 35 million kg
FTE: 5 + additional seasonal employees

Stroosnijder B.V.
Activities: peeling onions
Location: Kruiningen
Processing volume: 2 million kg
FTE: 6 + additional seasonal employees

Franje Onions
Activities: drying, storing, sorting and packaging onions
Location: Gawege
Processing volume: n/a
FTE: 11-20*

Mosselman
Activities: cultivating, storing and processing onion sets
Location: Kruiningen
Processing volume: n/a
FTE: 21-50*

Jonika
Activities: cultivation, drying, storing, sorting and packaging onions
Location: Oostdijk
Processing volume: 70 million kg
FTE: 28

Marbo Onions
Activities: drying, processing, sorting and packaging onions, shallots and garlic
Location: Oostdijk
Processing volume: n/a
FTE: n/a

Wiskerke Onions
Activities: cultivation, drying, storing, sorting and packaging onions
Location: Kruiningen
Processing volume: 150 million kg
FTE: 90

Arjazon Uienhandel
Activities: sorting and packaging onions
Location: Kruiningen
Processing volume: n/a
FTE: 11-20*

Hard Fruit Sector

Vogelaar Fruvo
Activities: cultivation, storing, sorting and packaging of apples and pears.
Location: Krabbendijke
Processing volume: 12 million kg
FTE: 60 + 200 seasonal employees

Vogelaar Vredehof
Activities: storing, sorting and packaging of apples and pears
Location: Krabbendijke
Processing volume: 100-120 million kg
FTE: 150

Diverse Sector

Scelta Mushrooms
Activities: processing mushrooms
Location: Kruiningen
Processing volume: n/a
FTE: 6-10*

LambWeston Meijer
Activities: storing and processing potatos into fries and other potato snacks
Location: Kruiningen
Processing volume: 300 million kg
FTE: 625

Side note

The numbers of employees marked with * are derived from oozo.nl and are therefore not exact numbers but outlines. n/a means not available, some companies information was not available on the internet and they weren't willing to contribute to this research. Some companies were willing to contribute but weren't allowed to give their processing volume, therefore some processing volumes are classified instead of not available.

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