

Assessment of a watersystem

Freshwater supply for agriculture on Zuid-Beveland

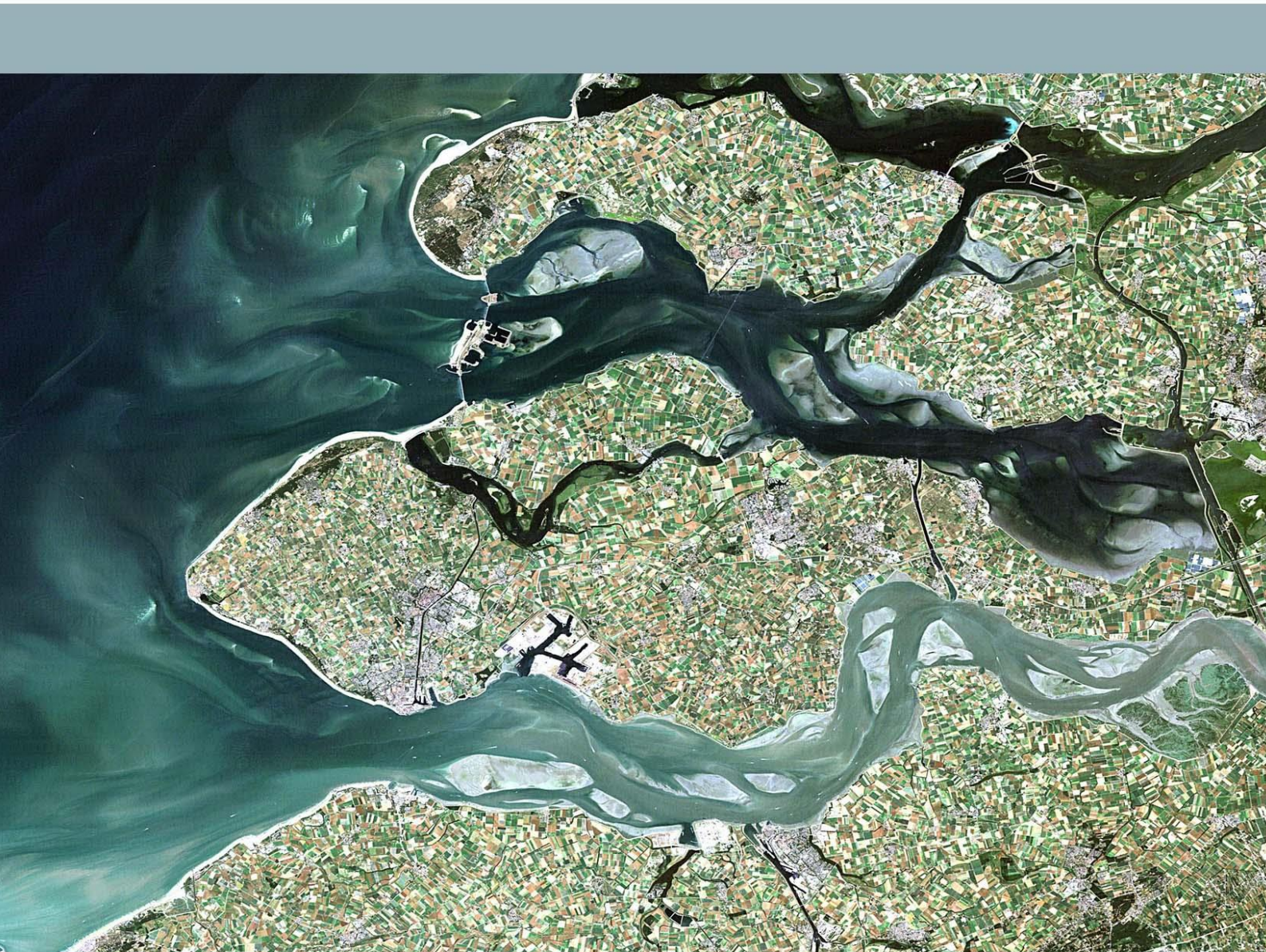


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1. Introduction

The province of Zeeland, located in the South-West of the Netherlands, holding the Scheldt river basin, is an area rich of agricultural land. Approximately 78 percent of the land in Zeeland has a agricultural destination (Province of Zeeland). On the southern peninsula of the province we find the island of Zuid-Beveland (figure 1.1). More than 1600 acres of the land on Zuid Beveland is in use as fruit orchards. The cultivation of these fruits requires water with low salinity, mainly acquired through rainwater. During the early spring and in periods of drought, natural precipitation is not sufficient to foresee in the water demand of the area. To meet the water demand, a pipeline has been constructed in the early 1990s (Figure 1.2). This pipeline, using water from outside the Scheldt river basin, transports water from the Biesbosch basin, which uses water from the Meuse and the Rhine river basins.

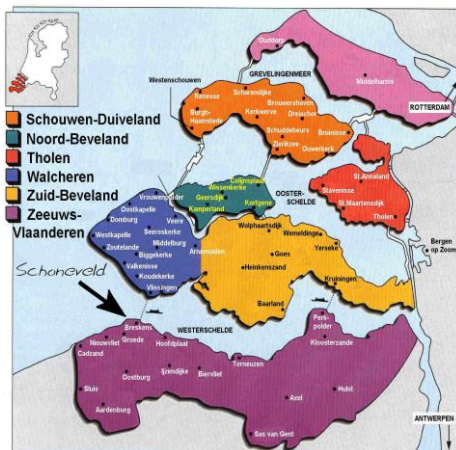


Figure 1.1: The sub regions of the Province of Zeeland (Wolfgang-Gruenewald, 2015)



Figure 1.2: The main water pipeline from the Biesbosch (brown) and the agriculture pipelines (green) in Zuid Beveland (Water uit de wal, 2012).

 main question of this paper is: what are the shortcomings, problems and possible improvements for the policy design in the Province of Zeeland, and Zuid Beveland in Specific? To answer this question and to assess the water governance in the province of Zeeland, and Zuid-Beveland in specific, the ‘Water Governance Assessment method’ as proposed by Rijswick et al. (2014) has been used. This multidisciplinary method uses three dimensions; respectively content, organization and implementation, that are divided into ten building blocks. We will use all these ten building blocks and their respective assessment criteria to assess the situation in Zeeland. This framework is visualized in figure 1.3 and outlines the structure and content of this paper. 

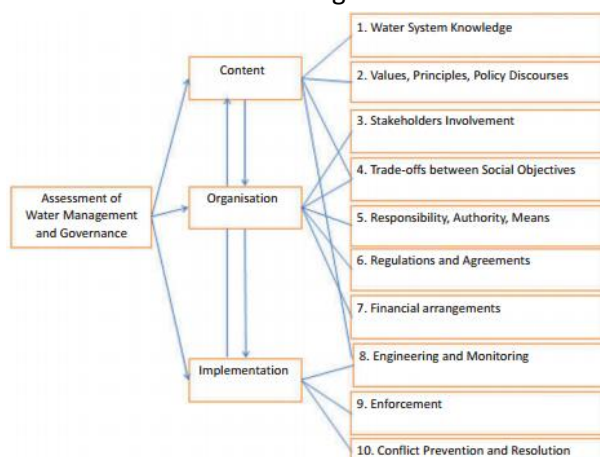


Figure 1.3: Multiple dimensions of water management and governance (Rijswick et al. 2014).

2. Water system knowledge

The first building block of the Water Governance Assessment method is 'Water System Knowledge'. This building block is about the combination of natural physical resources (rivers, seas, rainfall and lakes) and man-made infrastructure (canals, pumping stations, reservoirs and flood defenses). This entire water serves a purpose for society. These societal functions are extensive, but in this case of agriculture in Zeeland, we speak mainly of agricultural use. It stresses the importance of correct and complete knowledge with regard to the water system and institutions in place. Not only natural processes need to be understood but there should also be sufficient knowledge of the properties of the infrastructure. Epistemic uncertainties and natural variability need to be dealt with. Changes and fluctuations in the water system can influence its performance, and therefore the supply, demand, costs, benefits and risks. Water allocation should reach sustainable levels by reaching a balance the available amount of water within a specific time. Sufficient knowledge on the entire water system can contribute to reaching these sustainable levels.

The assessment criterion  is as follows: *"Is there sufficient knowledge of the existing water system in order to deliver the required service level of societal functions? If not, what are the gaps; is sufficient knowledge available to assess the impact on the water system because of changes in environment and societal functions?"* (Rijswick et al., 2014).

Zeeland has a rich and dynamic water history. During the Holocene, sea level rise occurred and Zeeland undergone several transgressions (Berendsen, 2008). The First dikes, to decrease the influence of the sea and to reclaim land, were built by the local people in the Middle Ages (ibid.). The reclaimed land was fertile and was often used for agricultural purposes. From the Middle Ages more and more dikes were built and more land was reclaimed. Storm surges swept occasionally large parts of the land away. In 1953, the biggest flood in the history of the Netherlands occurred whereby large parts of Zeeland were flooded. Based on this, the Delta Commission was established to guarantee the safety of the land against flooding and to protect the land against salinization (Deltawerken, 2004). Since the storm surge of 1953  many barriers were built (figure 2.1), sea arms were closed and dikes were strengthened in Zeeland.



Figure 2.1: The Deltawerken of Zeeland built after the storm surge of 1953. 1: Schelde-Rijnkanaal (Deltawerken, 2004).

Due to the recent Holocene transgressions and the low lying land in Zuid Beveland is the salt groundwater not far from the surface, mostly between zero to five meters under the surface. Fresh water is often only present in the shape of thin rainwater lenses (less than two meter) that are floating on the salt water (De Louw et al., 2015). These lenses are essential for the agricultural sector of Zuid Beveland because they prevent that salt water could reach the root zone (ibid.). The biggest threat of the thin rainwater lenses is climate change. The Royal Netherlands Metrological Institute (Dutch: Koninklijk Nederlands Meteorologisch Instituut: KNMI) predicted that there will become more droughts in the summer season (KNMI, 2014). The summer has also the highest evaporation rate whereby salt groundwater via capillary rise could reach the root zone (De Louw et al., 2015). This could lead to damage to the crops and a lesser harvest. Groundwater recharge (irrigation or precipitation), seepage flux and drainage depth are important factors that define the characteristics of the rainwater lenses (De Louw et al., 2015). The effect of changes of these factors on rainwater lenses is tested currently in the project GO-FRESH (ibid.). Inter alia the 'Freshmaker' that extracts salt or brackish water and infiltrates fresh water are promising developments (figure 2.2).

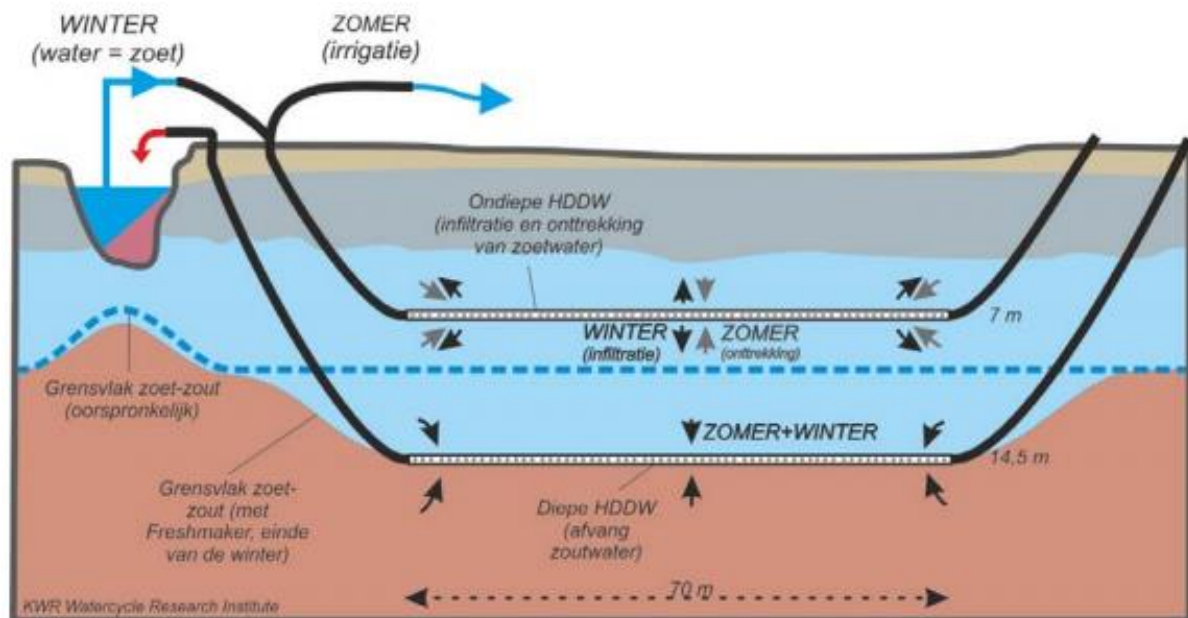


Figure 2.2: The 'Freshmaker'. HDDW: horizontal directional drilled well (Zuurbier et al., 2015)

The infrastructure of Zeeland changed drastically due to the Deltawerken. The water east of Oesterdam, Philipsdam and Haringvlietdam became fresh after the completion of the dams. The Oosterscheldedam has sluices that are normally open allowing salt water to flow through. Therefore, the water north of Zuid Beveland is salt. The only undammed sea arm is the Western Scheldt (figure 2.1) because this is the main shipping route for the port of Antwerp. Here is still a strong tidal influence through which dikes adjacent to the Western Scheldt (South of Zuid Beveland) were strengthened. All the water surrounding Zuid Beveland is thus salt water and cannot be used as irrigation for the agricultural sector. This is the reason why the water pipeline (figure 1.2) from the Biesbosch area to Zuid Beveland is constructed in the early 1990s (Deltares, 2011).

In the case of Zeeland, the pipeline is exploited by Evides Industriewater B.V. More information about the stakeholders and history of the pipeline and the area will follow, but it is important to note that this company owns private contracts between local users and EIW. Because the contracts are private, the conditions are not known. This creates a gap in the knowledge about the water system.

In conclusion, there is sufficient knowledge of the existing water system  however the pressure on the fresh water system increases due to growing fresh water demand of the agricultural sector and the changing climate. More research has to be done about the behavior of fresh water lenses. The project GO-FRESH is a good start.

3. Values, principles and discourses

When dealing with water issues, we cannot ignore the normative dimension and therefore we touch upon different values, principles and policy discourses. Shared values in a specific region can lead to legitimate solutions with a larger chance at successful implementation. These values can translate into principles, which also still have a general character, and combined with values they play a guiding role in establishing policy and in the decision making process. Additionally, policy discourses shape the way a group of actors perceive and frame a certain water problem. This narrative contains story lines, frames, values and principles. The discourse is a tool to construct a certain problem.

This assessment criterion is as follows: *“Is there sufficient knowledge of shared or conflicting values, viewpoints and principles (represented by different policy discourse coalitions) for water issues and their consequences for facing water management issues?”*

There are different stakeholders with different interest in Zuid Beveland. This could lead to conflicting values but also to shared values. The values, viewpoints and principles per stakeholder will be discussed in this chapter. More information about stakeholders will be given in chapter three. EIW, the farmers and the Province of Zeeland are distinguished as stakeholders in this chapter. These stakeholders have in common that they all want enough fresh water supply in Zuid Beveland. However they disagree in which way this has to be realized and who has to pay for a new pipeline, for example.

The farmers on Zuid Beveland want to make as much profit per hectare as possible. Ideal circumstances, including enough freshwater, are required for realizing this. More and more farmers want to be connected to the current pipeline and the farmers that already are connected wish to enlarge their irrigated fields (De werkgroep, 2012; Rijswick et al., 2014). The farmers attach great value to a reliable water supply that delivers always enough water. A switch to rainwater dependency instead of pipe dependency decreases the reliability of the fresh water supply for the farmers (Rijswick et al., 2015). This means less water intensive crops and thus less valuable crops (ibid.). Besides that less fresh water reliability implies greater uncertainty about the delivery of the crops (ibid.). Freshwater availability from local sources is not yet sufficient for the amount of irrigation that is required but maybe with the aid of the ‘Freshmaker’ there will be enough in the future. However the ‘Freshmaker’ is still in its development phase so it is still uncertain if it can be applied on a larger scale. Farmers need a reliable freshwater supply for maximizing yields (ibid.) so that is the reason why the pipeline is of great value for them.

The province of Zeeland (2015) aims for sustainability and at the same time for a strong economy. The province has declared that it will not invest in a new pipeline because freshwater supply is seen as the responsibility of the agricultural sector itself (Provincie Zeeland, 2012). However it will support and invest in local measures like the ‘Freshmaker’. This shift in policy is remarkable because in the early 1990s, when the pipeline was constructed, the policy mainly focused on increasing the production by means of investments in the agricultural sector (Welvaart & leefomgeving, 2006). Nowadays sustainability and self-sufficiency are key factors for development in Zeeland (Provincie Zeeland, 2012). On the long term the province of Zeeland want to chose for a balanced and sustainable development of the economy, society and the environment (ibid.).

EIW want to guarantee a reliable water supply to its customers. Despite the lack of exact numbers statements from, among others EIW, declare that a new pipeline is not profitable (Water uit de Wal, 2012). This is inter alia because of the government will not finance the project. Besides that the

current payment scheme for agricultural water does not provide a viable business case for extension (Rijswick et al., 2015).

In conclusion, there is enough knowledge about the values, viewpoints and principles of the main stakeholders. There are no major conflicting values but there are mainly different viewpoint for facing the freshwater issue in Zeeland. The farmers just want to have access to enough freshwater. It does not matter for them where this water comes from. However, the government wants to promote sustainability and stimulate local sources whereby they do not invest in a new pipeline. Hereby is a new pipeline not profitable following EIW.

4. Stakeholders involvement

In the complex process of water management and water governance there are inevitably various actors involved. These actors often differ in power, influence, interests, values and viewpoints. Water governance causes the formation of different networks of actors where actors from the public, private and semi-private spheres are in cooperation or conflict with each other. The government is highly dependent on other stakeholders for support, knowledge or financial reasons and they therefore have to take all interests into account when designing a policy. This has several advantages, especially when we talk about the quality of policy. Stakeholder involvement generates more support, increases transparency in the policy making process, improves public understanding and stimulates different bodies of the government to coordinate their actions better. The implementation of new or adapted policies is smoother and can count on more support (van Rijswijk et al., 2014: 7-8).

When talking about stakeholder involvement we use Berry's two dimensions of strong participation; width and depth of participation. The width of participation is about inclusiveness (Young, 2000), which means the degree to which actor has the chance to participate in the decision making process. The depth of participation is determined by the extent to which an actor has the chance to determine or alter the outcome of the policy process. (Rijswijk et al., 2014: 7).

The assessment criterion is as follows: *"Are all relevant stakeholders involved? Are their interests, concerns and values sufficiently balanced considered in the problem analysis, solution search process and decision-making?"*

When assessing stakeholder involvement, it first is important to establish who we consider to be the most important stakeholders in the case of Zeeland. The list below may be incomplete, but offers an overview of the most important stakeholders.

- ZLTO
- Local farmers
- Evides Industriewater B.V.
- Vereniging van Waterbedrijven Nederland
- Province of Zeeland
- Province of Zuid Holland
- Province of Noord Brabant
- Ministerie van Landbouw, Natuur en Voedsel

In the case of Zeeland, a solution was requested by the people. Local farmers urged for a solution for periods of drought and to the threats of night frost in early spring. Therefore, the construction of a pipeline from the Biesbosch basin was proposed and the construction began in the early 1990s with provincial funding. This shows that in this case the local farmers and their branch organization ZLTO have had the opportunity for both width and depth of participation. They used their opportunity to participate in the initial phase of the policy process. They influenced the final outcome by urging for their specific solution (Course Manual Water Policy, Governance and Law, 2015).

Another important actor is the daughter company of the publicly owned Evides N.V.: Evides Industriewater B.V. They started exploited the pipeline after its construction in the early 1990s. This company has signed private contracts with the EIW; the conditions of these contracts are unknown. This suggests that transparency within in the network is compromised. These private contracts

exclude the participation of other actors, mainly public actors. In general, Dutch consumers and other (industrial) users pay a fixed tariff for water, usually connected to the capacity of their connections. These tariffs and charges are usually set by the 'Vereniging van Waterbedrijven in Nederland' (Tarievenoverzicht Drinkwater, report, January 2013). This organization develops an overview of tariffs on drinking water and is therefore another important actor.

Then finally, we have the public actors. These are the involved provinces (Zeeland, Zuid-Holland and Noord-Brabant), the ministries, and to some extent the national government. These public actors are in charge of policy making and can decide to provide subsidies or additional funding. In this case the province has an important role since it is the body in charge of policy regarding water issues. They can decide whether or not a new or improved pipeline can be built, and if so, they can decide whether or not to supply funds for this project. In this case however, the province has declared that they will not invest money in the construction of a new pipeline. They do however want to offer support in other ways for local initiatives to deal with the water issues (Omgevingsplan Zeeland, 2012-2022).

To come back to the assessment criteria, in this case the relevant stakeholders are involved. They each have their interests and roles to play. Even though no clear solution has been found yet, there is willingness of all stakeholders to collaborate. They all have their responsibilities, objectives and power, and only if they reach a common understanding, a viable solution can be found.

5. Trade-offs between social objectives

Zeeland has different social objectives but as the focus of this paper is fresh water supply, this section will try to focus only on the trade-offs that have to be made to achieve a reliable fresh water supply. Nowadays, important social objectives for the province of Zeeland are sustainability and economic development. These objectives could be contradictory whereby alternative measures must be considered (van Rijswijk et al., 2014).

The assessment criterion is as follows: *“Are agreed service level decisions based on trade-offs of costs, benefits and distributional effects of various alternatives?”*

As previously discussed in chapter two, there are no major conflicting values but there are mainly different viewpoints for facing the freshwater issue in Zeeland. In the early 1990s the policy was predominantly oriented on the idea of increasing the agricultural production (Welvaart en leefomgeving, 2006). At the same time environmental policy was in attendance (ibid.). Nowadays this environmental policy is partially included in the concept of sustainability which is an important aspect of policy making in the province of Zeeland (Provincie Zeeland, 2012).

As said in chapter two the water demand increases because more and more farmers want to be connected to the current pipeline and the farmers that already are connected wish to enlarge their irrigated fields (De werkgroep, 2012; Rijswijk et al., 2014). A new pipeline was seen as the best solution following the farmers but the government did not want to provide financial support for that. Firstly because the government wants to reduce the dependency of the Biesbosch area (Stuurgroep zuidwestelijke delta, 2014). This is because more areas in the southwestern part of the Netherlands, including the city of Rotterdam, are dependant for their fresh water supply from the Biesbosch area (ibid.). It is expected that the water demand of these areas will increase which increases pressure on the fresh water distribution from the Biesbosch area (ibid.). Secondly the province of Zeeland wants to promote the use of local sources in the areas that are not connected to the water pipeline. Besides that it wants to focus on innovative solutions aimed at water efficiency (ibid.). Because of this policy, the pipeline is not profitable anymore for the farmers and the EIW.

The province of Zeeland made a trade-off between the short term and long term and chose clearly for the long term. It chose for sustainable measures. A stagnation of the water supply will probably result in less economic growth on the short term. However if the local measures will become successful, the area of Zuid Beveland will become less dependent of other areas which could lead to a stronger economy (ibid.)



6. Responsibility, authority and means

When we assess the responsibility, the authority and the means we divide this subject in property rights, allocating authority and responsibilities and means: participative capacity. Property rights are the social relations which define who are the owner of the water resources. We distinguish private property, common property, state or public property and no property. The type of property rights can determine who is titleholder, who is in charge and who is responsible, and what the restrictions on the use of property are. The communalization of water ownership and rights is an ongoing trend in the public domain. The allocation of authority and responsibilities means to restrict property rights. This enables the public domain to get authority at both central and decentral administrative levels. The public domain also needs to assign and distribute responsibilities to both public and non-public actors. Also, means need to be created to empower authority (Van Rijswijk & Havekes, 2012; Van Rijswijk & Tappeiner, 2014). The participative capacity of the public domain is about the opportunity for all water uses to become equally expressed, recognized and considered important. In other words, participation is favored as a way to create means (van Rijswijk et al., 2014).

The assessment criterion is as follows: *Are authorities, responsibilities and means well-organized to deal with water issues at the appropriate administrative scale(s) in a participative and integrative way?*

When we talk about property rights in the case of the water basin in Zuid Beveland, we speak of state property. The ownership of the waters of the Meuse, Rhine and Scheldt and their branch rivers and lakes is in hands of the state or subdivisions of the government. The responsibilities and authority in this case are delegated from the central government to the provinces. The provinces of mainly Zeeland but also Noord Brabant and Zuid Holland are responsible for the quantity and quality of the water. The province of Zeeland sees fresh water supply as the responsibility of the agricultural sector in the report 'Provincial Land Use, Environment, Water and Nature Policy (Omgevingsplan Zeeland, 2012-2018)', it is described how the authorities, responsibilities and means are divided.

The province of Zeeland sees itself as a governing body which carries out its previously determined core tasks. These core jobs are determined by law and policy by the 'Provinciale Staten'. In those policy fields where other governing bodies also have jurisdiction, the province wants to aim at the local scale level. They see it as their job to make policy for an area, region or specific theme, rather than policy for individuals, companies or municipalities. They give direction to developments in the field of spatial planning, nature and economy by creating a supra-local strategy. They also are safe keepers on the quality of the environment and do the supervision and advocacy on this area. They are willing to invest in sustainability and innovation in the form of subsidies, leadership, participation and knowledge. Furthermore, they promise to represent the interest of the area on a provincial, national, regional (Rijn-Schelde Delta) and international (or EU) scale (Omgevingsplan Zeeland, 2012-2018).

To carry out this ambitious job they are in favor of participation and cooperation. They state that freshwater supply is the responsibility of the agricultural sector. Companies (employers and employees), societal organizations, societal institutions, and civilians are the ones who have to shape the everyday practice.

So, authorities, responsibilities and means are organized in the sense that it is clear which role every stakeholder needs to play. This however does not mean that participation is flawless. It seems that the province delegates responsibilities to other stakeholders. Since there are still so many

unclearities and no viable solution found, one might argue whether this is the right structure. There is some form of participation and intentions to deal with issues in an integrative and participative way, but before this fully successful there still is a long way to go.

7. Regulations and Agreements

Regulations and agreements serve as a link between the more theoretical part on methodology and the more practical part on content and implementation. The previously mentioned assessments of the building blocks are translated into rules, regulations, agreements and procedures (De Burca and Scott, 2006). Rules and agreements need to be appropriate for the current circumstances (cultural, economic, political and institutional). The most important aspect is that rules and agreements are legitimate. Furthermore, there needs to be a certain level of certainty and adaptiveness (van Rijswijk et al., 2014).

This translates into the following assessment criteria: *Are regulations and agreements legitimate and adaptive, and if not, what are the main problems with regard to the above mentioned legitimacy aspects?*

When we want to make an assessment of legitimacy in this case we need to consider several aspects. The policy is not entirely based on shared and agreed values and principles since these differ among the various actors. The province aims to consider economic factors such as competitiveness and financial concerns, but for the agricultural this is not enough. There are issues surrounding the availability of fresh water and this means that there is some conflict between the involved parties (local farmers, ZLTO and the EIW) and the current policies. Although many of the policies in place are in conformity with the rule of law and offer legal certainty with regards to duties, rights and accountability, this does not mean that it is equally suited for all stakeholders. Due to the proposed cooperation between the provinces, other governing entities, knowledge institutes, industries and trade, societal organization and institutions, the province Zeeland clearly stated what each and everyone their rights and duties are, and what is expected of them (Omgevingsplan Zeeland, 2012-2018).

The province states that they are in charge of the policy making process and that they cooperate with several other stakeholders, but they leave the implementation and everyday practices to the companies, civilians, societal organizations and institutions (Omgevingsplan Zeeland, 2012-2018).. Their policies are on a more supra-local level, which means that the enforceability and effectiveness of these policies are questionable. Also, the intended goals remain vague, considering that they do express their demand for sustainability and innovations and their willingness to support these projects, but there are no clear strict goals and there is no clear set plan to achieve these wishes.

Evides Industriewater B.V. and the agricultural sector are, according to the province, responsible for the supply of sufficient amounts of freshwater (Omgevingsplan Zeeland, 2012-2018). As a consequence, EIW developed contracts with local users. Those contracts are private and the exact conditions remain unknown (Course Manual Water Policy, Governance and Law, 2015). This deeply influences the transparency and makes us question how all the interests that are at stake are taken into account.

There is a mix of public and private instrument  both parties have strategies and the freedom to implement the adequate strategy. However, these do not always take distributional effects into account to avoid damage to the water system.

Next to legitimacy, adaptivity is important. The province Zeeland strives for their plans to be achievable, workable and affordable. In order to realize this, each plan will be evaluated before,

halfway and at the end of the term. In the case that there is no or insufficient progress being made, the goal and the plans will be reconsidered and possibly adapted.

As becomes clear  there are still enough issues with legitimacy and transparency; and therefore the regulations and agreements. But, since we discover that there are possibilities for adaptivity there might still be room for improvement.

8. Financial arrangements

As in every assessment, financial means are very important to consider. The financial aspect is crucial for good governance. In water management, there are several ways to arrange the financial aspects, depending on the context and principles in place (van Rijswijk et al., 2014).

The assessment criterion for the financial arrangement is as follows: *Is the financial arrangement sustainable and equitable?*

To look at financial arrangements, we need to go back in time some years. Local farmers, united in their branch organization ZLTO, requested the construction of a pipeline from the Biesbosch basin. This pipeline was built with provincial funding in the 1990s. Following, the pipeline has been exploited by the publicly owned water company; Evides Industriewater B.V. Since the province has made freshwater supply the responsibility of the agricultural sector, local users have signed contracts with price arrangements with EIW. Usually, consumers and industrial users pay a fixed tariff for their used water, but in the case of the farmers of Zuid Beveland, there is no such thing (Tarievenoverzicht Drinkwater, report, January 2013).

The current pipeline has not enough capacity to foresee in the growing demand of the farmers. Increasing the capacity of the pipeline requires funding. The province of Zeeland has already announced that there is no willingness from their side to provide the funds for improvements to the pipeline. There is however support for initiatives to increase local availability. Investments in the pipeline will have to be made by EIW. However, the current situation does not create room for a viable business case for extension. According to EIW, there is no prospect of profits in the future (Course Manual Water Policy, Governance and Law, 2015).

When we assess the financial arrangements, we stumble upon many difficulties. At this moment with this current system in place, the financial arrangement is not sustainable and not equitable. There is an unwillingness to pay from most involved parties. The farmers are in a unique position since they are historically excluded from extra taxation and fees. The water company does not see a viable business case and the province states that they will not invest in a new pipeline. So next to the previously mentioned 'political' issues, we see a clear challenge in the financial sphere.

9. Engineering and monitoring

This chapter focuses on the engineering side of the water system. Nowadays, most water systems are regulated by means of engineering (e.g. pumps, sluices, weirs, turbines, etc.) and these works therefore hold a large share in the quality and performance of the water system. When the engineering works are not sufficient (anymore) or the monitoring is not right, problems arise. Visa versa, problems might be solved by upgrading the engineering works in the system. The assessment criterion for this chapter is the following:

Are SLAs sufficiently available (implicit or explicit) in order to redesign the existing infrastructure? Are the design and consequences of different alternatives sufficient available? Is there sufficient monitoring of the system and are the data analyzed? (Rijswick et al., 2014)

The pipeline currently in place is not economically feasible. This could be an engineering issue, however chances are small because initial construction of this pipeline was in 1990 thus this is recent technology. The efficiency of the system could probably be raised a little, however even when this is possible it will not be a decisive factor. Considering the current system cannot be upgraded to a level that suffices for the demand, different solutions have to be searched for. Has there been enough research for other sources of freshwater? Currently, the pipeline connects the Biesbosch area with Zuid-Beveland. Initially when the pipeline was constructed in the 1990s, the fresh water source was the Volkerak-Zoommeer. After major algae blooms caused this water to be unusable in summer, a lot of research was done on the alternatives and the potential solutions are published by Vries et al., (2009) in their paper “Vraag en aanbod van zoetwater in de zuidwestelijke delta”. This report concluded that using the Biesbosch area as the source of fresh water was the best option, as a result the idea was implemented and it is still in practice today. One alternative might be to fight the algae blooms in the Volkerak-Zoommeer and using this lake as a source of water again, since it is closer and thus more feasible. In 2015 however, it has been decided that the Volkerak-Zoommeer will be in open connection to the North Sea again in order to deal with the algae blooms (Ministerie van infrastructuur en milieu, 2014). This resolution aims for the algae blooms to disappear, however the Volkerak will turn into a salt water lake unfit for fresh water production.

A second solution regarding engineering applications is to make use of the available fresh water sources on the island with higher efficiency. This could be done by increasing the efficiency of the irrigation methods applied by the farmers. It is currently unknown however, what the status regarding the efficiency of the irrigation practice of these farmers. This efficiency needs assessment in order to see what gains can be made here. Another promising concept is the so-called Freshmaker. In 2013, Zuurbier et. al. have commenced with the first practical tests of this machine. The apparatus basically uses the water surplus in winter to replenish the deficit in summer. It does so by injecting the surplus of freshwater in winter in the freshwater lens under the surface and at the same time extracting the saltwater upward flux. In this way the freshwater buffer becomes bigger and thus the available fresh water in summer is increased.

Even though the province stated they are not willing to pay for an extra pipeline, increasing the water efficiency is something that does fit in their strategy. The Freshwater concept also fits in these strategies. In relation to enlarging the pipeline, both these measures have a high yield in relation to the low investment cost. Thus, the province could potentially provide organizational or financial support to implement these measures. Returning to the assessment criteria, from the report by Vries et al. (2009), we can conclude that sufficient research has been performed to search for engineering

alternatives. There is not going to be an engineering *panacea* which will supply large amounts of water at low cost. The results of the Freshmaker tests still have to be published, but we rely on them to solve the whole water shortage. Any engineering solution will only suffice in combination with policy measures.

10. Enforcement

The enforcement of made agreements is vital for a healthy organisation. When these agreements cannot or are not enforced, their effect is questionable. Therefore, the assessment in this chapter is:

Are regulations and agreements enforceable by public and/or private parties, and are there appropriate remedies available? (Rijswick et al., 2014)

Van Rijswick & Salet (2012) reasoned that agreements based on mutually shared principles and values will be easier to enforce since both parties are convinced they should act according to these rules. As concluded in chapter 3, the opposing parties potentially share principles and values, however their view regarding the aim of water supply differs. Industrial water is not a public good and thus cannot be regulated by government bodies. Disagreement can thus arise between EWI and the consumers (farmers) when one of these 2 parties is dissatisfied with the course of events. This agreement concerning the water supply between EWI and the consumers are private and therefore unable to be looked into. However, they are legitimate legal documents, thus in a matter of discontent they can go to court. So far, this has not been necessary since parties act according to their agreement. In 2013, for example, the summer drought caused the demand of the farmers to be higher than the capacity of the pipeline. Since EWI has an obligation to supply this water, they had to purchase extra water from Antwerp in order to satisfy the increased demand. Also, in this specific case there is also not a vulnerable value present (e.g. a vulnerable ecosystem which cannot represent itself and is easily abused)(Rijswick et al., 2014). The need for alert enforcement is therefore less urgent. Summarizing, we can conclude that enforcement has thus far not been necessary due to the good relationships which might be based on shared principles and values; however when necessary either one of the parties can fall back on the legal agreements.

11. Conflict prevention and resolution

Conflicts could arise in every situation and therefore a resolution method should be in place to handle this. This leads us to the following assessment question:

Are there sufficient conflict prevention and resolution mechanisms in place? (Rijswick et al., 2014)

The farmers on Zuid-Beveland which have a water deficit in summer are bound to industrial fresh water. They have no other choice than buy from EVIDES Industry BV (EIW), which currently has a monopoly. Because EIW is part of the drinking water company Evides, they are legally not allowed to aim for profits. Therefore, an unjust usage of their monopoly by increasing the prices too much, is unlikely to happen. However, EVIDES Industriewater BV is allowed and probably obliged to break-even their costs and benefits. The unfeasibility of the current pipe system may result in rising costs which will be reflected in the prices. This can result in friction and conflict between the EVIDES Industriewater BV and the farmers. When the farmers feel like EIW is abusing their power as a monopoly, which is illegal by law, they can state this at the Netherlands Competition Authority. When a conflict arises between two private parties, they can fight each other in civil court. The decision of the province to cut or extend their support in the form of subsidies is supposedly in line with their strategy. When the farmers or farmers' organisation feel like they are treated unjust by the province (or any other governmental body for that matter) and settling by mutual agreement does not work, the 'Nationale Ombudsman' can be addressed to intervene.

12. Conclusion

By means of the blocks proposed by Rijswick et. al. (2014), we have made an assessment of the current water system of agricultural freshwater supply in Zuid-Beveland. In short, we can conclude that the main problems are the following:

- In summer there is a deficit of freshwater for agricultural purposes on Zuid-Beveland.
- The current pipeline supplying freshwater is not feasible. Any expansion will not be feasible.
- Inequality due to non functioning of market forces. EWI can raise the prices if they want, however the extent of this problem is limited due to the fact that EWI is not allowed to aim for profits.
- Climate change will reinforce the water drought in summer, hereby increasing the scale of the problem in time.

From the chapter 8 'Engineering and monitoring' we conclude that there will not be a *panacea* in the form of a freshwater source which can be easily tapped. Thus, we have to approach this problem with policy. Within this, all possible solutions can be divided into two different categories: Retaining the current situation or adapting to a naturally working situation. This vision is shared by the national government in the 'Deltaprogramma Zoetwater' (Rijksoverheid, 2014) where they express this as:

"... de vraag uit het hoofdwatersysteem worden verminderd (of de toename beperkt) en de buffercapaciteit van het regionale systeem worden vergroot."

Or translated: "...the demand from the main water system needs to be decreased and the buffering capacity of the regional system needs to be enlarged."

With this statement, they already exclude the possibility of expanding the supply capacity, however further decisions are not being made, since they claim this is done by the 'regio'. The choice between both categories of solutions is a matter of importance given to the agriculture sector of Zeeland. Without measures, a natural good-working situation is not possible. By implementing measures, the current system is retained, however with significant costs. By adapting to a natural situation, the cost of measures is saved, however certain sacrifices are necessary. If we keep a very broad scope for the sake of not excluding any option, we can come to the following potential solutions:

Retaining the current situation

- Specific farmers pay extra for water
- Evides Industriewater BV pays extra, thus all Evides Industry consumers pay extra
- Tapping alternative water sources
- Subsidy by the province or national government

Adaptation to a naturally situation

- Stimulating farmers to cultivate drought-tolerant crops
- Stimulate farmers to cultivate saline-tolerant crops
- Decreasing the number of farmers and surface for agriculture.

In the Deltaprogramma Zoetwater (Rijksoverheid, 2014) the national government announced there are ongoing investments on increasing the robustness of the freshwater system in Zuid-Beveland. Part of this investments is the research on the possibility of supplying water from the Haringvliet and Hollandsch Diep in order to increase the buffer capacity, however further elaborations on this cannot

be found. Anyhow, the best solution will be one that takes best of both categories stated above. Thus; the water efficiency of farmers needs to be addressed (adapting) as well as the buffer capacity which needs to be increased (retaining the situation).

13. Recommendations

The agriculture system in Zuid-Beveland is worth a lot, but the measures necessary to supply the water demand might be too high for the current system to be healthy. Regardless of the fact that currently it is unclear whether the additional fresh water supply weighs up against the benefits of the agricultural sector, we know for certain that -given climate change with the increase in summer drought combined with the rising number of farmers- the problem will only increase with time. This is an important fact to take into account, since any efforts made to retain the current situation will become useless in time. Therefore, even if a solution might be found today, the problem will arise again tomorrow. Fighting to keep the current situation in existence is therefore useless in a matter of time. Adaptation towards a natural situation is thus the preferable solution. Equilibrium will arise when the demand of water by the farmers will be equal to the supply by the current pipeline. The supply of freshwater, therefore, has to be restricted to those who already receive water currently. New farmers who request a connection have to be refused. This will create an incentive for farmers to cultivate drought-tolerant crops. The cost of the water supply to the farmers, who are connected to the system, has to be allocated -to a certain extent- to these specific farmers. This cost distribution causes the farmers who produce the high-quality crops (apples, pears) to pay more, which is fair because their crop is worth more. This could be implemented by increasing the price for a fresh water connection by either the fee per m³ or a fixed charge for the connection. The province of Zeeland already made clear that they are not interested in funding a new pipeline; however they are a shareholder of Evides so they might be interested in upgrading the current water system to create a higher efficiency. They might also be interested in facilitating or providing funding for farmers who convert their farm to low-quality crops.

Summarizing:

- System is currently not healthy and this problem will only increase in time if it is nurtured. The current system needs to be phased out slowly.
- No new farmer connections to the pipeline
- Allocate costs of fresh water to farmers who receive this. Analysis needs to show to what extent these costs can be directed to these farmers.
- Facilitate help or funding for farmers to cultivate low-quality crops.
- Upgrading the water efficiency of the farmers by potentially funding of the province.
- Upgrading the buffer capacity of the freshwater lens in summer by means of e.g. the Freshmaker

These successive measures will cause a more healthy system in time. It is almost needless to say that further research is needed to assess to what extent the Freshmaker and concepts alike are effective, since these concepts are a gain for everybody. The farmers who produce high-quality crops because of the connection to the fresh water pipe have higher revenues, therefore they can pay more. This is an extrapolation of the 'polluter pays' principle, one of the basics in the Water Framework Directive. These measures altogether will result in a more sustainable water governance system on Zuid-Beveland in the long term, so that in the future they are once again able to claim "*Luctor et emergo*".

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