DEFINING DROUGHT

TOWARDS A FUNCTIONAL DEFINITION OF DROUGHT FOR THE VECHTSTROMEN WATER AUTHORITY

PART 1

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PART 1

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SAMENVATTING

Van oudsher richt het watermanagement in waterrijke landen zich voornamelijk op het managen van een overvloed aan water. Maar nu het klimaat veranderd en daardoor de extremen toenemen, wordt de rol van droogte ook in deze landen steeds belangrijker. Het moderne watermanagement zoekt daarom naar de balans tussen te nat en te droog. Voor een goede balans is het belangrijk om scherp in beeld te hebben wanneer het te nat en te droog is. Wanneer het te nat is, is al redelijk scherp gedefinieerd. Onder andere wet en beleid stellen hier al duidelijke kaders voor. Maar wanneer het vanuit de watermanager gezien te droog is, dat is nog een stuk minder duidelijk.

Dit onderzoek heeft daarom als doel om te komen tot een operationele definitie voor droogte die recht doet aan het perspectief van de watermanager. Dit begint bij het definiëren van het probleem van droogte voor de watermanager. De eerste onderzoeksfase, waar dit rapport op in gaat, richt zich hierop. Om het probleem van droogte voor de watermanager te definiëren, wordt de rol van het watermanagement hoofdzakelijk gezien als het faciliteren van watergebruik. Droogte problemen voor een watermanager ontstaan dus wanneer zij niet meer in staat is haar faciliterende rol te vervullen. Om het probleem van droogte voor een watermanager te definiëren is daarom onderzocht welke problemen er ontstaan bij watergebruikers en wat de verantwoordelijkheid is van watermanagement ten aanzien van deze problemen. Droogteproblemen van watergebruikers waarvoor het watermanagement een verantwoordelijkheid draagt, worden gezien als problematisch voor het watermanagement. Om de scope van het onderzoek te beperken richt het onderzoek zich op een beperkt aantal watergebruikers. Enkel de problemen die zich voordoen bij melkveebedrijven, hoogvenen en natte heiden zijn onderzocht.

PROBLEMEN BIJ WATERGEBRUIKERS

Om de problemen bij de watergebruikers in beeld te brengen zijn er drie melkveehouders en twee natuurbeheerders geïnterviewd. Hieruit blijkt dat de melkveehouderij voornamelijk met vier droogteproblemen te kampen heeft, een verminderde grasopbrengst, een verminderde mais opbrengst, opkomend onkruid en het bodemleven wordt aangetast waardoor de waterbergende capaciteit afneemt. Deze problemen hebben zowel gevolgen voor de melkveehouder als voor de maatschappij in zijn algemeenheid. Voor de melkveehouder zijn de problemen met name van invloed op de winstgevendheid, op de duurzaamheid en de wetmatigheid. De maatschappij wordt geraakt door de impact van de problemen op de waterkwaliteit en door het risico op grootschalig faillissement wanneer droogte voor meerdere jaren aanhoudt. Dit laatste heeft nadelige economische en sociale gevolgen. Zo kan het bijvoorbeeld ten kosten gaan van aantrekkelijk praktisch werk. Ook de natuur wordt sterk geraakt door de droogte. Hoogvenen krijgen te kampen met verdroging, waardoor deze waardevolle vegetatiesoort schade oploopt, het hoogveenherstel vertraagd, diersoorten mogelijk verdwijnen en er veel CO_2 vrijkomt. Natte

heiden kennen andere droogteproblemen. Hier vallen poelen droog, loopt de grondwaterbuffering achter, is er in het voorjaar een vochttekort en ervaren planten droogtestress. Dit alles heeft zijn weerslag op de voor de natte heide typische vegetatie- en diersoorten en op de grotere natuur gradiënt waar natte heide onderdeel van is.

Morele verantwoordelijkheid van de watermanager

Om de verantwoordelijkheid van de watermanager ten aanzien van de droogteproblemen bij watergebruikers te schetsen, is er een toetsingskader ontwikkeld dat de morele verantwoordelijkheid van het watermanagement reflecteert. Hiervoor is onderzocht welke morele waarden ten grondslag moeten liggen aan het watermanagement en wat deze waarden betekenen in een watermanagement context. De voor watermanagement belangrijke waarden zijn bepaald door nationale wet- en beleidsdocumenten en regionale partijprogramma's te analyseren op de waarden die zij reflecteren. Hieruit zijn zeven waarden herleid waarvan het belang algemeen erkend is. Op basis van de voor watermanagement specifieke betekenis van deze waarden, is voor elk van deze zeven waarden een evaluatieve vraag opgesteld die toetst of de specifieke waarde wordt aangetast door een probleem bij de watergebruiker. Dit heeft geleidt tot de volgende evaluatieve vragen die het eerste onderdeel van het morele toetsingskader vormen:

1. **Bescherming:** Resulteert het probleem in onomkeerbare gevolgen voor zaken van significant belang?

2. **Sociale stabiliteit:** Schaadt het probleem de sociale stabiliteit door de impact op vitale infrastructuur of sociale structuren?

3. **Rijkdom:** Beinvloed het probleem de economische stabiliteit in zodanige mate dat het vestigingsklimaat onaantrekkelijk wordt?

4. **Milieubescherming:** Schaadt het probleem planten, dieren of hun onderlinge relatie in onnatuurlijke mate?

5. **Eenheid met de natuur:** Komt het probleem voort uit een gebrek aan natuurlijke watersysteem karakteristieken, die verloren zijn gegaan door historische ingrepen van het watermanagement**?**

6. **Harmonie:** Is het probleem een gevolg van onbedoelde inconsistenties tussen de verschillende watermanagement disciplines of tussen de verschillende ruimtelijke ambities?

7. **Verantwoordelijkheid:** Leidt het niet acteren op dit probleem, dat ontstaat in het regionale watersysteem, tot significante problemen voor anderen nu of in de toekomst?

Er zijn ook waarden waar juist geen consensus over bestaat, maar die wel van belang kunnen zijn voor de morele verantwoordelijkheid. De verschillende

politieke partijen onderscheiden zich namelijk van elkaar door de verschillende waarden die ze nastreven. Deze onderscheidende waarden zijn op zichzelf niet breed genoeg gedragen om een morele verantwoordelijkheid te bepalen. Echter wanneer een probleem meerdere van zulke waarden raakt, kan dit probleem weldegelijk een watermanagement verantwoordelijkheid met zich meebrengen. In zo'n geval bestaat er binnen het bestuur genoeg consensus. Om met deze partij specifieke waarden rekening te houden is er daarom een tweede element aan het morele kader toegevoegd, de bediscussieerde moraliteit. Deze omvat een achtste vraag:

8. **Bediscussieerde waarden:** Raakt het probleem meerdere partij specifieke waarden waardoor er alsnog voldoende draagvlak is om als watermanagement een verantwoordelijkheid te voelen?

Bovenstaande vragen geven aan welke problemen een watermanager zich vanuit zijn morele verantwoordelijkheid moet aantrekken. Dit betekend echter niet dat een watermanager zich het gehele probleem moet aantrekken. Waterproblemen ontstaan vanuit twee kanten, zonder gebruik zou geen enkele watertoestand problematisch zijn. Daarom sluit het morele kader af met een vuistregel die nader specificeert wat de watermanager zich wel en niet moet aantrekken. Deze is gebaseerd op de adviezen van de adviescommissie water en stelt dat de watermanager een verantwoordelijkheid moet voelen voor de problemen die ondanks redelijk en doordacht gebruik ontstaan.

Het probleem van droogte voor watermanagers

Om het probleem van droogte vanuit een watermanagement perspectief te bepalen, zijn de problemen van de watergebruikers afgewogen aan de hand van het morele verantwoordelijkheidskader. De nodige informatie voor deze afweging komt voort uit de interviews met de watergebruikers. Voor ieder probleem is er getoetst of de impact van het probleem een van de kernwaarden, zoals beschreven in de evaluatieve vragen, schaadt. Deze afweging richt zich op de specifieke aspecten uit de evaluatieve vragen die het kantelpunt beschrijven. Bescherming richt zich bijvoorbeeld op onomkeerbaarheid en zaken van significant belang. Voor ieder probleem is er daarom getoetst of het probleem onomkeerbare impact heeft op zaken van significant belang. Problemen die een impact hebben waar een watermanager een morele verantwoordelijkheid toe moet voelen, zijn watermanagement problemen.

Uit de evaluatie van de problemen blijkt dat watermanagement naar alle droogteproblemen voor melkveehouderij een verantwoordelijkheid moet voelen. Echter heeft deze verantwoordelijkheid geen betrekking op het volledige probleem. Een verminderde grasopbrengst moet als problematisch worden gezien wanneer deze leidt tot een te geringe autarkie of als de kosten hiervan zodanig oplopen dat het beheergebied een grootschalig faillissement van de melkveehouderij riskeert. Hierin draagt de boer de verantwoordelijkheid om te zorgen voor een gezonde robuuste bedrijfsvoering. De reductie in maisopbrengst en de veronkruiding zijn met name problematisch door hun weerslag op het financiële bedrijfsresultaat. Deze dragen dus bij aan het faillissementsrisico en moeten vanuit dat perspectief in ogenschouw worden genomen. Een aangetast

bodemleven versterkt voornamelijk de andere drie problemen en is dus wel van belang, maar uit zich in principe al via de andere problemen.

Ten aanzien van de natuur moet watermanagement vrijwel alle gevolgen in zekere mate als problematisch beschouwen. Vanuit de evaluatieve vraag voor milieubescherming blijkt dat problemen die zijn versterkt door het watermanagement als problematisch moeten worden beschouwd. Door de sterke verwevenheid van natuur en landbouw, is dit versterkte effect vrijwel overal aanwezig. In Nederland zijn er bijvoorbeeld geen hoogvenen meer die een volledig natuurlijke randzone kennen. Deze randzones zijn van belang voor de zelfregulatie van de vochttoestand in het hoogveen. Ook de grondwaterstanden rondom natte heiden zijn veelal onder invloed van met name landbouw activiteiten. Verdroging van hoogveen en het droogvallen van poelen, beperkte grondwaterbuffering en droogtestress zijn dus allemaal in zekere mate problematisch voor watermanagement.

VERVOLG

De eerste onderzoeksfase die in dit rapport behandeld wordt laat zien welke problemen inzichtelijk gemaakt moeten worden om problematische droogte vanuit een watermanagement perspectief te operationaliseren. Ook geeft het de nodige informatie ten aanzien van de ernst van de droogte. Het geeft niet alleen de mechanismen die van belang zijn, maar beschrijft tevens in kwalitatieve termen het punt waarop deze mechanismen echt problematisch functioneren. Dit vormt de basis om droogte in meer kwantitatieve termen te kunnen operationaliseren.


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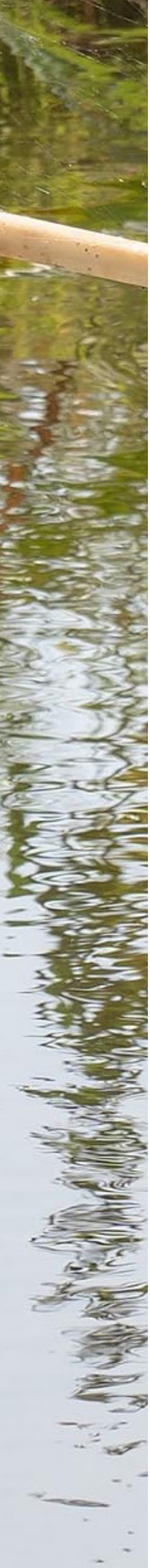

CONTENT


1

INTRODUCTION

THE PROBLEM

For centuries the Dutch delta mostly had one water related problem, there was too much of it. To get rid of the water surplus the Dutch have built an ingenious system of pumps and dikes to keep their land and polders dry. But while improving and mastering this system towards perfection drought problems have intensified (Bressers et al., 2016; Tielrooij et al., 2000). This because the discharging practice was hardly limited by the drought problems that might occur on the other side of the spectrum. For long the relevance of drought was underestimated, the country was believed to be too water abundant.

But as global temperatures rise and thereby the climatic extremes intensify new and more severe drought problems occur (Trenberth, 2011). This also holds for the water abundant North Western European countries like the Netherlands. This led the Dutch water managers to see that water management should focus more on balancing the water system between floods and droughts, instead of solely discharging water surpluses (Ritzema & Van loon-Steensma, 2017).

Efficiently balancing wet and dry seasons requires insights in the boundary conditions, when is it too wet and when is it too dry? During the centuries of flood management, the

first has been sharply defined by national law and policy. These documents present clear exceedance frequencies for land inundation and flooding. Also local politicians have a relatively clear view on when it is too wet. When it is too dry is, however, poorly defined by Dutch water management. There are many reasons why a too dry state lacks a clear definition. One reason for example is its relative novelty within the Dutch water management. There simply is less experience with drought management in the Netherlands. A second reason is the ranging perceptions on the phenomenon (Kohl & Knox, 2016). Droughts affect water users in many different ways on different moments in time. To better understand how water management should balance the wet and dry seasons, a more clear definition for a too dry state that fits a water managing perspective is thus required.

Drought can be defined in two distinct ways, either as a physical or as a societal phenomenon. Physical definitions tend to define the drought intensity relative to normal water conditions. Societal definitions define the drought intensity in relation to the societal impact it causes. As regional water management is largely about enhancing society by facilitating water use, balancing floods and droughts is about weighing the impacts of floods and droughts to society. To do so, a society focussed drought definition provides most useful information. Water management is, thus, mostly in need of a drought definition that is defined from a societal impact perspective.

STATE OF THE ART LITERATURE

Literature is studied to understand to what extent state of the art knowledge allows to define problematic drought from a water management perspective. Here it became clear that there is large scientific discussion regarding drought definitions.

Differences in defining drought start with the differentiation between drought and water scarcity. There is no commonly agreed definition of these terms. Pereira, et al. (2002) for example defines water scarcity as a water stressed situation as the result of drought, human activity or both. In this, drought is defined as a solely naturally caused negative anomaly in the water availability (Pereira, Cordery, & Iacovide, 2002). Schmidt, et al (2012) also define drought to be a natural phenomenon. To them drought is a temporary, negative and severe deviation from average precipitation values. Water scarcity on the other hand is a purely man-made phenomenon. They consider it as a recurrent imbalance that arises from an overuse of water resources, caused by a significant difference between the consumptive water use and the replenishing rate of the system (Schmidt, Benitez, & Benitez, 2012). To them, water scarcity is thus by definition not a result of natural variability, contrary to what Pereira, et al. (2002) defined. Van Loon, et al. (2016) defined drought and water scarcity even differently. They believe that water scarcity is the imbalance between the water demand and the average water availability. Here it is the demand that creates scarcity not the actual overuse of water, like Schmidt, et al (2012) defined. Drought, to van Loon, et al. (2016), is a situation with much less water in the hydrological system than normal regardless of the cause. This partly contradicts both the definition of Pereira, et al (2002) and Schmidt, et al. (2012), which

define droughts to be a solely natural phenomenon.

These different definitions illustrate the fundamental discussion on the cause of droughts and water scarcity. Droughts are traditionally considered to be natural phenomena (Paulo & Pereira, 2006; Pereira et al., 2002; Schmidt et al., 2012; Stein et al., 2016; Wilhite & Glantz, 1985). However, in line with the trend towards socio-hydrology, the human interference also enters the discussion concerning the drought definition (Bressers, Bressers, & Larrue, 2016; Mishra & Singh, 2010). Following the state of the art trends, this research will use the definition of drought as proposed by van Loon, et al. (2016) as a general conceptualisation of drought. Due to the intensive human related water use within the Vechtstromen area, it is believed that the human interference can hardly be separated from the natural variance. Besides, it is of no relevance to water policy to only gain insight in naturally caused drought, as the system that the waterboard aims to improve is a system with substantial human interference.

This general drought definition does not define when a reduced water availability should be considered as problematic drought. Such more operationalized definitions are provided by literature, however, only in relation to singular water system variables. These operational definitions are generally clustered in four drought categories: meteorological, hydrological, soil moisture and socio-economic drought (Kohl & Knox, 2016; Mishra & Singh, 2010; van Loon, 2015; Wilhite & Glantz, 1985), see Figure 1.1.

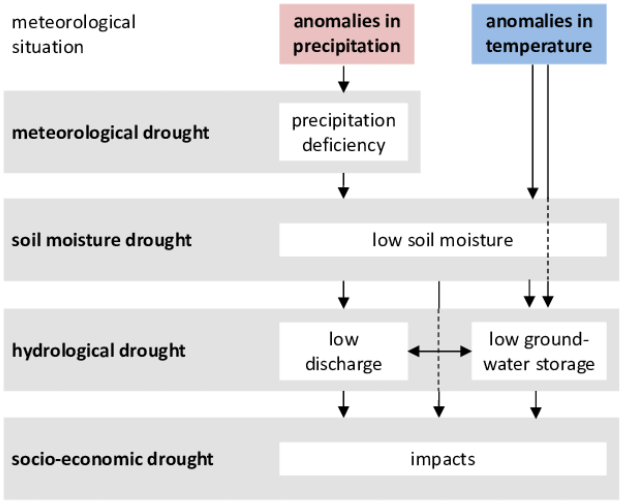

Figure 1.1: Drought types and their relations

RESEARCH GAP

Drought definitions that relate to singular variables generally suffice to operationalize drought from a water user perspective. These end users mostly rely on a specific part of the water system and therefore depend on few water system variables. Soil moisture drought, often referred to as agricultural drought (Schmidt et al., 2012), is for example a definition that well reflects the farmer's perspective on drought. Crop growth directly relates to soil moisture. A single variable suffices to describe drought. But while end users' perspectives can often be categorized among one of the drought categories, a water manager´s perspective cannot. This because a water manager is not an end user of a part of the hydrological system. Instead, water managers manage a large part of the hydrological system. Their influence cross the domains of the drought categories. Literature still runs short in providing a functional drought definition that fits the disciplinary view of water managers.

From the state of the art literature it can be derived how to determine

an operational water managing definition. Operational definitions defined in literature tend to describe drought by water system variables that can potentially cause problems to the actor. This principle can also be adopted in defining drought for water managers. This requires insights in the problem of drought to water management and subsequently in the water system variables that underlie these problems.

Multiple studies have been performed that study the impact of droughts (COGECA, 2003; Wilhite, Svoboda, & Hayes, 2007). Yet, these studies mostly focus on the impacts of droughts to water users, for example by defining the costs of drought to agriculture (van Bakel & Hoving, 2017). What the problem of drought is from a water managing perspective, is not defined by literature. It can for example be questioned if all financial impacts to agriculture are problematic to water management? A lack of understanding regarding the problem of drought from a water managing perspective is thus the first knowledge gap that withholds science from defining drought to water management.

RESEARCH AIM, QUESTIONS AND APPROACH

To be able to balance flood and drought management water management is in need of an operationalized drought definition that reflects the water managing perspective. From the literature study it appeared that science does not yet provide such drought definition. This is predominantly caused by a lack of understanding on the problem of drought to water management. As a first step towards an operational drought definition this research aims to define the problem of drought from a water managing perspective.

In this study a water managing problem is conceptualized as a water user's problem towards which water management should feel a responsibility. This definition has been applied since water management is there to facilitate water use. From this perspective, drought becomes problematic to water management when water management fails to adequately facilitate water use. This approach also corresponds with the need for a society focussed definition.

On the basis of this problem conceptualisation, three research questions are formulated. The first two aim at respectively the water user problems and the responsibility of water management towards water user problems. The third research question brings the answers to the first two questions together to define the problem of drought from a water managing perspective.

1. What problems do water users experience during drought and what are their consequences?
2. Towards what water user problems should water management feel a responsibility?
3. What is the problem of drought from a water management perspective, considering their responsibility towards water users?

Drought definitions and operationalisation are largely shaped by regional context. To account for the influence of local context, the research has been applied to the case of the Vechtstromen Water Authority. The Vechtstromen region belongs to the high sandy parts of the Netherlands, which are the country's

driest regions. The region predominantly depends on rain- and groundwater, since water inlet is limitedly possible. This makes the region highly vulnerable for water scarcity and drought (Bressers et al., 2016; Goijer et al., 2012). In this century alone, the Vechtstromen area suffered 6 extremely dry years, in 2003, 2006, 2009, 2010, 2013 and last year's, 2018, drought that was record breaking. These droughts cause some severe problems to nature and agriculture (Goijer et al., 2012; ter Braak et al., 2019). The need to balance wet and dry seasons, and thus to obtain a clear definition of drought, is therefore prominent to the Vechtstromen region.

READING GUIDE

While defining the responsibility of water management towards water users, it became clear that the responsibility that was being defined applied more generally than to drought only. To make sure that this more general result does not disappear in a drought report, it has been decided to detach the responsibility framework from the drought case and present these two parts in independently readable chapters. The first chapter, chapter two in this report, delves into the moral responsibility of water management. Thereby it provides the answer to the second research question. The second chapter, chapter three in this report, applies this view on responsibility to the case of defining the problem of drought to water management. This chapter thus provides the answers to the first and third research question. The fourth chapter concludes on the presented work by providing a brief overview of the answers to the three research questions.

DATA

Please contact the author if you are interested in obtaining the underlying data. Contact details can be found in the colophon.

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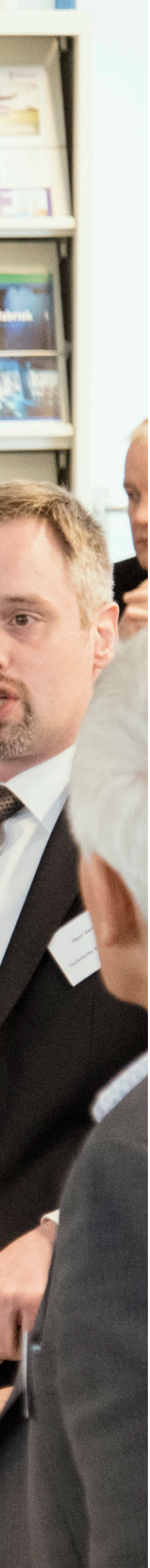


MORAL RESPONSIBILITY IN DUTCH REGIONAL WATER MANAGEMENT

A VALUES BASED EVALUATIVE FRAMEWORK

ABSTRACT

Integrated water resources management is about unifying and balancing different water user perspectives to facilitate water use. But when water management fails to fulfil this task, is understood rather poorly. To narrow this gap, this chapter constructs a values based moral responsibility framework that allows to assess if the problem of a water user is also problematic to water management. The moral values that underly water management form the basis of this framework. To identify these values, national law and policy and regional political party lines have been analysed and coded for the moral values they express. Based on the coded data, the most important values and their water management definitions are defined and translated into evaluative questions that reflect their water managing interpretation. The values Security, Social Order, Wealth, Protecting the Environment, Unity with Nature, Harmony and Responsibility appeared to be most fundamental to water management and have therefore been translated into evaluative questions. Besides, the analysis showed that on a regional level political parties disagree on which additional values to adopt. To account for this debated morality a second element has been added to the responsibility framework. Finally, the framework concludes with a third element that accounts for the fact that water problems are mutually caused by water management and water users. Their reciprocal responsibilities are therefore roughly defined by a rule of thumb.

INTRODUCTION

Integrated Water Resource Management (IWRM) is about unifying and balancing views (Grigg, 2008). But as extreme water system conditions, like floods and droughts, intensify (Trenberth, 2011) and occur more frequently due to climate change and our water system demands increase (AdviescommissieWater, 2013), balancing views becomes increasingly challenging. The range in which a water system fulfils the stakeholder expectations in sufficiently balanced way narrows down. But how narrow it precisely is, is not understood strongly by water managing agents in north-west Europe. Especially in relation to drought, they do not understand when stakeholder views are harmed to such extent that the balance is lost and drought needs to be considered problematic. For centuries these water managers have focused on managing floods. But how to balance this practice with not ending up in droughts did not receive sufficient attention. Now droughts tend to occur more frequently (Stein et al., 2016) it needs to be better understood when extreme hydrological conditions, both floods and droughts, harm the balancing of stakeholder interests. This is necessary to understand the range in which water system conditions are acceptable.

Where water system conditions change water users are affected (Neuvel, 2004). Some impacts might form minor issues, other might threat the user´s most fundamental interests. This does not necessarily mean that when fundamental stakeholder interests are affected, the water system state should be deemed problematic by water management. To understand when water system conditions do become problematic to water management, it needs to be understood towards what stakeholder problems water management should feel a responsibility. This responsibility is partly defined by national law and policy. In relation to flooding, Dutch law and policy for example provide clear inundation frequencies that are deemed acceptable (Nationaal Bestuursakkoord Water, 2003; "Waterwet," 2018). Yet, in relation to droughts no clear line is defined (van den Bos, 2018). Also it is believed that the lines defined by law and policy are mostly the outer lines of acceptability. Moral expectations might be more demanding. What is legally acceptable might morally be unacceptable to the citizens served by water management. It is believed that to define a responsibility framework the moral responsibility best describes what stakeholder impacts define a problematic water system state.

What is deemed morally important is defined by the values one adopts (Schwartz, 2012). According to Schwartz (2012), values among others define our desirable goals and guide our evaluation of events. These are two characteristics that seamlessly fit the need to define a problematic water system state. Understanding what values need to be adopted by water management, therefore, forms the basis for our moral responsibility framework. The importance of values to water management is supported by recent literature on water ethics (Doorn, 2012; Groenfeldt, 2013; Groenfeldt & Schmidt, 2013; Rossi, 2015). In fact, according to Groenfeldt and Schmidt (2013), values already unconsciously pervade all approaches to water governance. Yet, despite the agreement on the importance of ethics, literature does not define what values are to be adopted by water managing agents.

This paper aims to define a values-based evaluative morality framework that can assess if water system conditions are problematic to regional water authorities. For this, first, the values that need to underlie the water authorities'

perspective, and their specific meaning to water governance, are identified. When the values are identified and understood, an evaluative framework is constructed by translating their water management meaning into evaluative questions. By studying and defining the values that underly water management, this is the first study that actually identifies the values that pervade water management and helps to better understand and evaluate morality by translating these insights in a framework to evaluate morality.

For this the case of the Vechtstromen water authority has been studied. The Vechtstromen region is a part of the Netherlands that is located at relatively high elevation on mostly sandy grounds. It is an area that predominantly depends on rain- and groundwater. This because the inlet of foreign water is only limitedly possible due to the relatively high elevation. Thereby, the Vechtstromen region is one of the driest regions in the Netherlands.

METHOD

In this research water managing values are believed to be defined by society, as Dutch regional water management is democratically shaped. Values that need to underlie the water management practice can thus be found where regional water management is shaped by democracy. This democratic influence comprises two levels, a national and a regional level. On a national level, society elects a government that defines national water law and policy. Since these plans are thus shaped by a democratically assigned government, they are believed to reflect the values society deems important for the country. This is in line with what Groenfeldt and Schmidt (2013) meant when they claimed that values already pervade water management. On a regional level, society has a more direct democratic influence on the values that the regional water authority adopts, by electing representatives who take seat in the board. Therefore, national law and policies and regional political party lines will be analysed to obtain the values that are important to regional water management. The provinces are not included in this research, their influence on the values that are adopted by regional water management is assumed to be negligible.

Identifying national values

To identify national values the Waterlaw, the National Waterplan, the Deltaprogram and Decisions, the Water Framework Directive (WFD), the National Administrative Agreement (NAA) and the advisory report 21st-century water management are studied (Deltaprogramma 2015 - Werk aan de delta, 2015; “Kaderrichtlijn Water,” 2000; Lindeman & Verkasalo, 2005; Nationaal Bestuursakkoord Water, 2003; Nationaal Waterplan, 2015; Verdringingsreeks bij watertekort, 2019; “Waterwet,” 2018). The National Waterplan and the Deltaprogram are policy documents that are directly prescribed by the Waterlaw and thereby considered important. The WFD is an important European law that is also frequently emphasized by the Dutch Waterlaw. The NAA also sets some defining water managing standards that are taken over by the Water law. Finally the 21st century water management report is studied because it introduced a paradigm shift in the Dutch water management, from solely discharging water

to balancing it with water retention and storing. Thereby it might contain interesting insights into recently introduced values.

These laws and policies have all been analysed for the societal values they reflect. To do so, all text fragments that elaborate on the reason behind the policy have been labelled with the value that is reflected. Here, only reasons that relate to a societal benefit are included. Technical reasons are left out as these reflect values less clearly. This would require more interpretation and thereby predominantly add uncertainty to the analysis.

Values can be defined in many ways. To start with a coherent value set this research relies on Schwartz's values list. This list consists of 56 values, that stem from ten basic human values (Schwartz, 2012). His value theory is cross culturally validated (Schwartz et al., 2001) and is applied in two adjacent research fields, in environmental and in voting research (Dietz, Fitzgerald, & Shwom, 2005; Leimgruber, 2009; Mostert, 2018; Schwartz, Caprara, & Vecchione, 2010). Besides, Schwartz attributes some interesting characteristics to his values. Characteristics that are of interest to this study's goal to define a moral responsibility framework. They for example refer to desirable goals, serve as standards for good and bad, are ordered by importance and they transcend specific actions and situations (Schwartz, 2012).

Schwartz's theory only provides definitions for the ten basic human values. The more specific values are not elaborated in much detail. To structure the analysis, the values have been defined as shown in Table 2.1. These value interpretations have been based upon the underlying basic values defined by Schwartz (2012). Only for Accepting my portion in life a definition has been used that does not necessarily fit its corresponding basic human value. This because in relation to water management this value is believed to better fit within universalism than within tradition. Table 2.1 only shows the values that have actually been identified in the study.

Table 2.1: Schwartz values and their coding interpretation

Value	**Basic human value**	**Coding definition** statements that focus on...
A world of beauty	Universalism	The physical attractiveness of the environment
Accepting my portion in life	Universalism	The demand side of water management
Authority	Power	The leading role of the water authority
Capability	Achievement	Expertise and experience
Creativity	Self-direction	The need for creativity
Equality	Universalism	Equal treatment of citizen and/ or nature
Harmony	Universalism	Coherency between different disciplines
Healthy	Security	Citizen's health
Helpfulness	Benevolence	Subservient role of the water authority toward others
National Security	Security	Protecting national interests from the water
Pleasure	Hedonism	Water system use for leisure

Protecting the environment	Universalism	Protecting or improving nature quality
Reciprocation of favours	Security	Needed effort by both stakeholder and water authority
Respect for tradition	Tradition	Preserving historic value
Responsibility	Benevolence	The impact to non-stakeholders
Sense of belonging	Security	The connectedness between the water authority and citizen
Social order	Security	Impacts to social structures
Success	Achievement	Balancing results and effort
Unity with nature	Universalism	Balancing human and nature interests
Wealth	Power	Material possession

Both a quantitative and a qualitative assessment has been used to determine what values are most important to water management. First, the coded data, based on Schwartz's values, are quantitatively analysed. For each document, the five most important values are determined, based upon the number of text fragments representing the different values. Here it is assumed that important values are elaborated more. To determine the relative importance of the top five most frequently reflected values, their text fragments have been assessed qualitatively. Here the importance has been derived from the context in which the specific statements are expressed.

The overall importance of a value on national level is determined by averaging its ranks on the individual documents. These average scores are considered to be reflecting the value's relative importance on a national level.

Identifying regional values

To identify the regional values that are important to the regional water management, the values adopted by the elected political parties in the Vechtstromen board have been studied. To do so, their party lines have been analysed in the same way as for national law and policy. The top five most frequently stressed values have been selected and ordered on qualitative grounds. Here the ordering largely matches the quantitative results, since the party lines are more directly focused on communicating values.

Since the parties do not have an equal weight in the board, the overall value importance is determined by taking the weighted average of the value ranks. Here the weight per political party is defined by the number of board seats they represent. Table 2.2 shows this distribution and the corresponding weights.

Table 2.2: Party weights

Party	**Seats**	**Weight**
CDA	5	5/18
VVD	3	1/6
AWP	3	1/6
Water Natuurlijk	6	1/3
Secured Nature Seat	1	1/18

Value evaluation

To construct a framework that evaluates if a water manager should morally feel a responsibility for a problem, first the most important national and regional values, the values that are widely supported and therefore have a relatively high average rank score, are selected. For each significantly scoring value, the similarities and differences between the national policies and party lines have been studied. That what connects all views is used to define an evaluative question. These evaluative questions define a water managing interpretation of the value and define the tipping point at which a value is harmed. The text fragments have, therefore, been studied for tipping point defining concepts. These concepts are used to formulate evaluative questions. Values or value interpretations that are less broadly supported are included in a debated morality section of the framework. The debated morality follows a different assessment procedure, as will be discussed in the results section.

RESULTS

In this section, the results of the value analysis will be presented. First the values that are emphasized in the national law and policy documents will be discussed, then the regional values are considered and finally, an evaluative framework is constructed in the third paragraph. To clarify when values are discussed, all values are written in *Italics*.

National values

For each law and policy document, the most important values are identified. These results are discussed in this section. For each document first, the most frequently emphasized values are presented and qualitatively evaluated for their validity. Also their relative importance will be defined qualitatively. In general, it appeared that the quantitative measure, measuring value occurrence, was able to identify the most important values. Though, their relative importance does often not follow their quantitative score.

Water law

Rank	Value	Occurrence	Policy focus
1	National security	10%	Preventing individual casualties
2	Social order	13%	Facilitating vital societal functions
3	Protecting the environment	16%	Protecting the environment from irreversible impacts
4	Harmony	26%	Coherent management between different organizations and water management topics
5	Success	19%	Fulfilling goals effective and efficiently

Table 2.3: Values in the Water Law

In the introduction to the water law it is stressed that the law is designed to adhere to the government's responsibility to assure water conditions for a habitable country (which relates to *National security* and *Social order*) and to *Protect the environment*. Besides the introduction states that for an effective and efficient approach, a water law that facilitates an integrated approach combining water challenges with other spatial developments is necessary. Effective and efficient stress the importance of *Success* as a value to water management. Integral management on the other hand stems from a *Harmony* value. All five values that are identified by the quantitative analysis, as shown in Table 2.3, are thus stressed already in the most fundamental motivation for the water law. These values are therefore considered indeed to be the most important values underlying the water law.

The law's introduction as discussed above indicates that *Success* and *Harmony* are supportive to the other three values. Thereby these are considered the least important. Additionally, *National security* is likely to be of higher priority than *Social order* and *Environmental protection*. This because both the law's goals and the displacement series, these series provide the legal prioritization of water demand when there is a water shortage, prioritize these three values the same. In both documents the values are ordered in respectively, *National security*, *Environmental protection* and *Social order*. Besides the displacement series adds an essential nuance to the importance of *environmental protection*. It only considers irreversible nature impacts to be of high importance.

National water plan

Table 2.4: Values in the National water plan

Rank	Value	Occurrence	Policy focus
1	Social order	13%	Protecting vital functions and significant groups
2	Wealth	13%	Economic stability and development
3	Security	10%	Preventing individual casualties
4	Harmony	18%	Coherent management between different organizations and water management topics
5	Accepting my portion in life	11%	Water demand reduction

The national water plan describes the outlines, principles and general direction of the national water policy. Its main policy ambition stresses that the water system design should lay the basis for welfare and prosperity. Supportive to this main ambitions, the introduction explains that the cabinet strives for coherency in the development of the different water-related function and the importance of actions among water users is expressed. The latter entails that every stakeholder needs to take its responsibility to reduce the impacts of extreme events. Further on in the policy document, this is concretized mostly in supply level arrangements. From the policy it becomes clear that the most important values to water management to obtain welfare and prosperity are *National Security*, *Social order* and *Wealth*. The cabinets strive for coherency and stakeholder participation are considered expressions of respectively the values of *Harmony* and *Accepting my portion in life*. The five values identified

by the quantitative analysis are thus all stressed in the Water plan's general ambition statement.

As discussed above, the aim for coherence and stakeholder action is mostly framed supportive to the main ambition of welfare and prosperity. *Harmony* and *Accepting my portion in life* are therefore considered least important. They end up at a fourth and fifth place respectively. *Social order, Wealth* and *National security* are ranked respectively first, second and third. *Social order* and *Wealth* are emphasized to a similar extent. Yet, during drought, the National water plan prioritizes vital functions above economic use. This indicates that *Social order* is more important.

Delta program and decisions

Table 2.5: Values in the Delta program

Rank	Value	Occurrence	Policy focus
1	Wealth	23%	Economic protection, Competitive advantage
2	National security	16%	Protecting citizens and the economic value
3	Social order	14%	Additional protection of public utility functions, large groups and crucial economic value
4	Unity with nature	7%	Water-robust and climate proof spatial planning
5	Accepting my portion in life	14%	Reducing water demand and efficient water use

The Deltadecisions decide on the main approach towards water safety, freshwater supply and a climate and water robust spatial planning. The Delta program then elaborates further on how to translate these main approaches into concrete measures. The decision on water decides for "A new approach to protect the human being and the economy from flooding". Regarding freshwater availability it is decided for "A new approach to mitigate water shortages and optimally use freshwater for the economy and utility functions.". Finally the spatial adaptation decisions decides for "A new approach for a water robust and climate proof development of the built area.". Based upon the policy translation of these decisions, they are believed to reflect the values of *Wealth*, *National security*, *Social order* and *Unity with nature*. The *Unity with nature* value has therefore been added to the quantitatively obtained values, as it is fundamental to the decision on spatial adaptation. Finally *Accepting my portion* in life is a value that is substantially stressed in relation to freshwater supply. Therefore it is considered to be an important value.

In the introduction to the Deltadecisions *Wealth* is predominantly stressed and given more weight in wording than *National security* and *Social order*. Hence, these are considered to be respectively first, second and third most important. *Unity with nature* is considered fourth most important, because it is not stressed in the general motivation for the Deltadecisions. Though *Unity with nature* is considered more important than *Accepting my portion in life*, because it is fundamental to one of the Deltadecisions. Accepting my portion in life on the other hand is only supportive to the delta decision on freshwater.

Water Framework Directive

Table 2.6: Values in the Water Framework Directive

Rank	Value	Occurrence	Policy focus
1	Protecting the environment	28%	Protecting aquatic and terrestrial ecosystems and water rich nature from further degradation
2	National security	17%	Safe water quality
3	Social order	11%	Assuring drinking water supply
4	Harmony	28%	Policy coherence regarding functions, countries, hydrological subsystems

The Water Framework Directive (WFD) is a law that has been predominantly drafted to prevent nature from further degradation. Not surprisingly *Protecting the environment* comes out as the most reflected value, see Table 2.6. Besides, *National security* and *Social order* are expressed in the law. The WFD considers those important since water quality issues also impact the human being. It threatens one's safety and the public drinking water supply. Finally, *Harmony* is frequently expressed by the WFD. The issues addressed in this law can only be adequately solved if there is a strong coherence among countries, water functions, and hydrological sub-systems. Thereby, *Harmony* is a supportive value required to prevent further degradation. As it is a supportive value, it is considered the least important.

Remaining documents

Table 2.7: Values in remaining documents

Rank	Value	Occurrence	Policy focus
1	Unity with nature	41%	(1) Living with the water, (2) providing space to the water, (3) Multifunctional water use (4) retain store discharge
2	Responsibility	22%	(1) Don't pass on problems, not in time, not in space, not in responsibility and not financially

In the remaining documents, the National Administrative Agreement (NAA) and the 21st-century water management advisory report, two values are mostly reflected, *Unity with nature* and *Responsibility*, see Table 2.7. The NAA is a policy document that agrees upon the aims and responsibilities to get the water system future proof. Here living with the water, takes centre stage. It argues that "A country that lives with water, needs to provide space to water". This is seen as a translation of the *Unity with nature* value. Making room for the water is also the key message of the 21st-century water management report. It argues that future water management needs to provide space to water to be able to retain, store and gradually discharge the water.

Both documents also define *Responsibility* as an important value in water management. They both stress that water management may not pass on water management problems in any way. Not in time, not in space, not in responsibility and not in financial terms.

Regional values

In this paragraph, the identified regional values will be discussed per political party. In general, the quantitative measure appears to better reflect the value priority than it did for the national values. Possibly because the party lines are more directly about communicating what values the party stands for. Therefore, values that are indeed deemed most important are likely to be stressed more frequently. In general, the analysis shows that the national values are largely endorsed by the regional parties. All parties seem to emphasize a few specific national values and distinguish themselves by adding some unique regional values to it.

Water Natuurlijk

Table 2.8: Values Water Natuurlijk

Rank	Value	Occurrence	Policy focus
1	Protecting the environment	18%	(1) Nature recovery, (2) No negative impacts on nature
2	Responsibility	16%	(1) A party for everyone, (2) Don't pass on problems, not to others (this includes also non-human stakeholders) now and in the future, (3) Understand each other
3	National security	14%	(1) Protecting the human being and the biodiversity
4	Unity with nature	9%	(1) Water as starting point for spatial planning, (2) Building with nature, (3) Adaptation to climate
5	A world of beauty	8%	(1) Attractive living environment for human, animal and plants, (2) Better and future proof environment

The Water Natuurlijk party is formed by a collaboration between recreational, nature and environmental organizations. Not surprisingly, the party has a clear focus on nature recovery. It wants to prevent any action that causes further nature degradation. Water Natuurlijk hence profiles itself by adopting three national values, *Protecting the environment, National Security* and *Unity with nature*, see Table 2.8. *Protecting the environment* is adopted strongest. It shows up concerning all other values.

Besides the clear nature focus in nationally adopted values, the party adds *Responsibility* and *A world of beauty*. Water Natuurlijk wants to be *Responsible* by being a party for everyone. A party that does not pass on problems, not to other human beings, not to animals and not to future generations. Also here the inclusion of nature is striking. This all has to contribute to a beautiful world that forms an attractive environment for the human being, animals and plants.

CDA

Table 2.9: Values CDA

Rank	Value	Occurrence	Policy focus
1	Responsibility	14%	(1) Cherishing the relationship between generations, don't pass on problems to future generations, (2) care for the less fortunate, (3) view more than your own interest
2	Wealth	10%	(1) Assuring economic development by providing water to agriculture and industry
3	Harmony	10%	(1) Management does not stop at boarders, (2) Balancing human, earth and economy, (3)
4	Protecting the environment	7%	(1) Protecting the biodiversity and vegetation
5	Pleasure	7%	(1) Valuing recreational use

The CDA's party line mostly represents the five values presented in Table 2.9. Also qualitatively these five values seem most relevant. Three of these values, *Wealth, Harmony* and *Protecting the environment*, accentuate what national values CDA identifies with the most. Besides, *Responsibility* and *Pleasure*, are added. *Responsibility* underlies two of the party's core principles, stewardship, and solidarity. It is about caring for others. For the CDA taking care holds multiple dimensions: care for other interests than your own (solidarity), for the less fortunate (solidarity) and the relationship between generations (stewardship). The latter considers handing over a healthy financial situation, traditions, and nature. Finally, the party line emphasizes that they believe that water management should also support recreational purposes. This is considered as an interpretation of *Pleasure*.

VVD

Table 2.10: Values VVD

Rank	Value	Occurrence	Policy focus
1	Capability	13%	(1) Judging plans on urgency, feasibility and affordability (2) Low taxes due to innovation and smart collaboration (3) Searching win-win situations, (4) Sober and effective
2	National security	12%	(1) Safe from the water
3	Wealth	10%	(1) Protect economy, (2) Limit agriculture and other enterprises least as possible
4	Protecting the environment	10%	(1) Protect to benefit the human, animal and nature, but don't overdo it. More than sufficient is unnecessary
5	Harmony	10%	(1)

The VVD's party line relates to four national values, *National security, Wealth, Protecting the environment* and *Harmony*, see Table 2.10. In their party line, the VVD is clear about their priorities concerning national values. For them its safety (*National security*) over the economy (*Wealth*) over ecology (*Protecting the environment*). *Harmony* is again supportive to obtain these main values.

Next to these four national values, the VVD focusses on *Capability*. This value distinguishes the VVD from its fellow parties. The VVD strives for a sober and effective policy. They, therefore, define the water authority's task relatively narrow, focusing on the organization's core institutional responsibilities. Money that is spent on water should have a maximum effect on these core responsibilities.

The human empowering point of view adopted by the VVD is striking. Even Protecting the environment is primarily substantiated from a human benefit perspective. They, for example, seem to only want to protect the environment to a level at which the water system durably benefits the human being.

AWP

Table 2.11: Values AWP

Rank	Value	Occurrence	Policy focus
1	Protecting the environment	18%	(1) Sustainable and circularity are such important they will show up everywhere, (2) energy neutral organization, (3) Plastic garbage
2	Harmony	13%	(1) Structural collaboration regarding climate adaptation, (2) water as organizing principle
3	Responsibility	9%	(1) For the next generation's interests, (2) To all actors
4	National security	7%	(1) Flood protection has the highest priority
5	Reciprocation of favors	7%	(1) Polluter pays, (2) Who benefits pays

The AWP is a non-political party, a party that does not want to be guided by political interests but by finding the balance between all interests. It is thus not surprising that *Protecting the environment, Harmony and Responsibility* are important values to the AWP, see Table 2.11. All three relate in a certain way to including interests that otherwise are likely not to be included, at least in the view of this party.

Besides balancing all interests, the AWP also wants to balance the effort/costs. *Reciprocation of favours*, therefore, is an important value. In their policy line, this reciprocation is referred to mostly concerning financial management aspects. The polluter pays is a characterizing principle. Although this reciprocation is stressed in most policies and party lines, the AWP is the only one for which it can be included in the top five.

Secured nature seat

Table 2.12: Values Secured nature seat

Rank	Value	Occurrence	Policy focus
1	Knowledge	19%	(1) Improving knowledge is improving your skills, (2) Learn from and share knowledge with others, (3) Knowledge improves authority
2	Equality	15%	(1) Consider interest of different functions to be tantamount. Prevent conflict due to unequal weighing of interests. (2) Obtaining a water system with in which functions are present interdependently. To each other and to the water system itself.
3	Social order	14%	(1) Obtaining Social Support trough being a network organization stimulating citizen participation.
4	Capability	14%	(1) Knowledge, skills and objective view
5	Unity with nature	13%	(1) Adjusting to natural water system characteristics (2) Respecting the boundaries of the water system when serving functions

Contrary to the political parties, the secured nature seat is no eligible board seat. Instead this seat is assigned by nature conservation organisations. Consequently, the secured nature seat does not have a party line that defines its view on water management. Therefore, to identify the values that are important to the nature seat, a survey has been conducted. In this survey the nature seat representative has first been asked to choose the eight most important values from the Schwartz value list. For each value he is asked four questions to understand what the values mean to the respondent:

1. Why did you select this value?
2. Describe with a few key words what this value means to water management?
3. What ambition emerges from this value?
4. What water management principle emerges from this value?

Finally, to define the relative importance of the identified values, the respondent was asked to rank subsets of three values from most (score 3) to least (score 1) important. This has been done for all possible subsets of three values. Per value then the score has been summed. The value with the highest scores is considered most important. The subset way of scoring has been chosen because it assures more reliable results. When asking to rank all values in once, like Schwartz's survey does (Lindeman & Verkasalo, 2005), the respondent might not weigh each value to each other. The subset approach makes sure one does. This is done even more than once, therefore also consistency in the answers is accounted for.

From this survey it became clear that the secured nature seat mostly identifies with the national values *Unity with nature* and *Social order*, see Table 2.12. It is

interesting to see that *Protecting the environment* has not been identified by the respondent. This might, however, be explained by looking at the other values the nature seat deems important. Weighing each other's interests with equal respects and keeping an objective view on the matter is for example highlighted by the respondent as important water management skills. *Protecting the environment,* therefore, might be to narrow minded, where *Unity with nature* finds a more appropriate balance between the conflicting interests. Regarding *Social order* it is interesting to see the different focus that is given to it, compared to the national policy. To national policy *Social order* is mostly about facilitating vital functions and societal structures, the nature seat sees it as obtaining social support.

The nature seat adds *Knowledge, Equality* and *Capability* to the national values. *Knowledge* and *Capability* are assumed to be important to the nature seat because they likely are the most effective values to include nature in the decision making process. *Equality*, seems to emerge from a care for other interests. In the Vechtstromen area, nature is strongly interwoven with other water related functions. Adopting a narrow focus, solely focusing on nature interest, might be perceived counter effective in the decision making process.

From values to evaluation – the first framework element

An overview of the above discussed results is shown in Table 2.13. This table shows that the national values are largely endorsed regionally. Especially *National security, Protecting the environment* and *Harmony* are strongly emphasized by political parties. Contrary, *Social order* is hardly supported, but due to its high national relevance it is still considered an important value to the framework. *Accepting my portion in life* and *Success* are not stressed on a regional level and limitedly valued nationally, these have therefore not been translated into evaluative questions. Besides endorsing national values, each party adds its own value to distinguish themselves from the others. Here there is less agreement on what values to adopt.

Rank	Value	National policy	Water law	National Waterplan	Deltaprogram	Water Framework Directive	National administrative agreement	21st century water management	Vechtstromen Authority	Water Natuurlijk	CDA	VVD	AWP	Nature
1	Security	2,5	5	3	4	3			2,0	3		4	2	
2	Social stability	2,3	4	5	3	2			0,2					3
3	Wealth	1,5		4	5				1,3		3	3		
4	Protecting the environment	1,2	3			4			3,4	5	2	2	5	
5	Unity with nature	1,0			2		2	2	0,7	2				1
6	Harmony	0,8	2	2		1			1,9		4	1	4	
7	Accepting my portion in life	0,4		1	1									
8	Responsible	0,3					1	1	3,2	4	5		3	
9	Successful	0,2	1											
10	Competent								0,9			5		2
11	A world of beauty								0,3	1				
12	Pleasure								0,3		1			
13	Knowledge								0,3					5
14	Equality								0,2					4

Table 2.13: Overall value importance and overview

To construct an evaluative framework, the values that are broadly supported (values 1 to 6 and 8) and the values on which there is disagreement (values 7 and 9 to 15) are separated. The supported values have been translated into evaluative questions. The debated values are grouped as secondary values that define

moral responsibility less predominantly. This debated morality is considered by the eighth evaluative question. Also, nuance differences in the interpretation of the supported values have been added to this debated morality. The evaluative questions and the debated morality will be discussed in this section.

The evaluative framework is only designed for problems that are influenced by water authority controlled water system conditions.

Security: Irreversibility as boundary condition

National security concerns the protection of the human being, the economy, and nature. *National security* is, however, not about preventing all damages. It mostly emphasizes the prevention of irreversible impacts on items of significant interest. Even though irreversibility is factually only stressed in relation to nature there are more reasons to believe it applies more generally. No policy for example includes prevention of injuries, only deaths are aimed to be prevented. Apparently, there is a difference between injuries and death, which is the irreversibility of death. Besides, it is believed that the irreversibility condition also underlies the special attention that is given to cultural heritage. Even though cultural heritage does not stand out from the analysis, all parties mention it but not frequently enough, it is deemed important to water management. Plans to reach ambitions may often not harm cultural heritage. While the impact on other artefacts is not nearly as important. It is likely that, again, irreversibility is the crucial difference. New artefacts can be built, but the cultural-historical value of cultural heritage cannot be recreated. It is because of these three examples that it is believed that *National security* is largely about preventing irreversible damages to matters of significant interest.

1. Does the problem cause **irreversible** impacts to matters of **significant interest**?

Social Order: Assuring societal stability

Social order is largely about assuring societal stability. Within this value national water policy predominantly stresses two ambitions: maintaining vital functions and preventing group risks. From a National security point of view protection relates to individual persons. From a *Social order* point of view, however, it is recognized that a large number of deaths from a single event has more impact on social structures (Vergouwe, 2017). Thereby, this is considered to be more problematic than many single death cases. Maintaining vital functions is there to preserve a stable society also under crisis situations. Vital systems that are stressed in ambitions are drinking water systems, energy supply systems, vulnerable nature and water safety system.

To assess a problem on its importance to the value of *Social order*, the following evaluative question needs to be answered:

2. Does the problem **harm societal stability** by its effect on vital functions or on social structures?

Wealth: Assuring economic stability

Water is a vital element to the Dutch economy, the Delta program even calls it the source of our prosperity. The Netherlands has the largest port of Europe,

an intensive agricultural land use and has some important industrial companies that rely on water. This because the reliable and safe water system provides an attractive business climate to water related industries. The significant presence of water related industries, however, also introduces a dependency of the Dutch economic success to the water system conditions. Under extreme water conditions economic stability might be threatened. Both national policy and the regional parties therefore agree that water management should provide reliable water conditions that assure economic stability and thereby an attractive business climate for water related industries. That is what *Wealth* is about to water management.

Important to note here is that to water management *Wealth* is not about individual possessions. Contrary to what Schwartz considers it to be. No policy or party, firmly argues that water management is about assuring profits to individual people or companies. Though, profit-making companies are for sure an element of a stable economy. But they are not the goal itself.

3. Does the problem affect the economic stability, to such extend that the **business climate** becomes **unattractive** ?

Protecting the environment

Protecting the environment in water management holds a relatively straight forward definition. It literally is about providing the aquatic conditions, both water quality and quantity, to prevent further degradation of nature. Here preservation of natural ecosystems is mostly emphasized. This means that water management must assure that the whole of plants and animals and their mutual relationships within a specific nature area are preserved. Nature protection among this value differs from national security in that it is about all consequences of unnatural water conditions to natural ecosystems. Not merely about the irreversible consequences.

The interpretation of *Environmental Protection* differs per political party. Some, like Water Natuurlijk, believe that nature quality needs to be improved. Others, like the VVD, believe it is more about conserving today's quality level. As all parties and policy plans agree upon at least preventing further degradation this is seen as the tipping point where the value is substantially affected. From this analysis, the following question derives:

4. Does the problem **unnaturally** affect plants, animals and/or their mutual relationship?

Unity with nature: Use quality of the natural system

In water management *Unity with nature* translates into the ambition to create a water robust, climate proof water system in which there is space for water, nature and the human being. Multiple water management principles embody these ambitions, like, retaining storing discharging (RSD), greening and water as an ally. These principles are all in a way corrections to re-naturalize the human-modified water systems and its relation to the human being. By greening and RSD strategies, for example, a natural sponginess is reintroduced. Water as

an ally, on the other hand, re-establishes the natural understanding between the human being and its environment. From these principles, it is concluded that *Unity with nature* is about reintroducing natural characteristics that have been lost during centuries of water management.

Striking to see is that the ambition and principles are all in a way supportive to enhancing and sustainably protecting society. It seems that *Unity with nature* barely is an end goal itself. Here it differs from Protecting the environment, which is not necessarily about benefitting the human being. Even though it might do. From these insights the following evaluative question is derived:

5. Does the problem emerge from a lack of natural water system characteristics, caused by **historical** water managing **interventions**?

Harmony: Coherent water management

Harmony in water management relates to the coherency over different water related or spatial ambitions. The analysed policies and party lines stress that coherency needs to be sought both over the different water management disciplines and with external spatial ambitions. Coherency over the different water management disciplines is about harmonizing the management of water quantity, water quality and water safety issues in a way that their overall functioning is optimal. The coherency with external spatial ambitions relates to aligning water management with the spatial ambitions of provinces and municipalities. This results in the following evaluative question:

6. Is the problem a consequence of **unintended inconsistencies** within the water management practice or in relation to external spatial planning?

Responsibility: Don't pass on problems

Responsibility is about not passing on problems that are rooted in the regional water system, not in space, not in time, not in responsibility and not financially. The time dimension is especially stressed by the political parties. They profile themselves strongly with being responsible for future generations. A problem that to the water authority is not problematic enough, considering the evaluative questions above, might thus still be of water authority responsibility when it results in significant problems to others. This leads to the seventh evaluative question:

7. Does not acting on the problem, that originates in the regional water system, result in **significant problem for others**, now or in the future?

Debated morality – the second framework element

The seven questions presented above reflect a shared morality of national policy and regional politics. Regionally there are, however, also unshared values and within the shared values there are also interpretation differences. So far

only the shared interpretation on a value has been accounted for. To account for the unshared values and for the additional interpretations, the so-called debated morality, a different approach is used.

Since these values and interpretations are not broadly shared, they cannot be concluded to be generally defined by society as a whole. A problem that solely stresses these issues is therefore not considered problematic. This, however, changes when a problem affects multiple debated values. In such a situation a problem might gain enough political support to be considered as a water governance problem. Therefore, an eighth question is added to account for this situation.

8. Does the problem affect **multiple** debated morality values or interpretations?

Interpretation differences mostly appear regarding the *Protection of the Environment*. Evaluative question four only considers direct water condition impacts on nature. Though, some parties, like Water Natuurlijk and AWP, also advocate the need to become an energy-neutral organization, handle the great garbage patch or also want to improve nature instead of remaining the current quality level. These aspects are therefore considered debated morality considerations. Another example of an interpretation difference is VVD's view on *Wealth*. Where the others focus on macroeconomic impacts, the VVD also stresses the desire to limit the impact on individual enterprises. This again is considered as debated morality.

Accepting my portion in life, Competent, A world of beauty, Pleasure, Knowledge, Equality and *Reciprocation of favours* are debated values. Their definitions are not discussed separately. Since these values are largely stressed by single parties, their definitions can be obtained from the tables presented earlier on.

Use of questions – adding a third element

The above presented questions provide an evaluation framework that helps to determine if a water use related problem should be deemed problematic from a water managing perspective. Here the first seven questions evaluate if the problem harms the main water management goals. These are largely nationally defined, yet regional politics generally agrees upon these goals. If this is because they believe it is best or if they feel like they have no choice cannot be said. Besides agreement there is also debate on regional level. This debate predominantly relates to the secondary goals that need to be achieved supportive to the main goals.

To define the water managing perspective on drought, the first step is to identify the water user problems that occur during flood or drought situations. These problems need to be understood to such extent that it is possible to evaluate if the problems exceed any of the tipping points that are described by the evaluative questions. Each water user problem thus needs to be evaluated by all questions. The tipping points are highlighted by the bold letters in the questions. To be able to evaluate if , for example, a problem is a Security problem

it needs to be judged if the problem is irreversible and of significant interest.

Finally, the evaluative questions only define to which water user problems the water authority bears a responsibility. What precisely is this responsibility is not clarified by the questions. A problem is often constructed by mutual actions of both the water manager and the water user. If there would not have been use there would not have been a drought problem. The water authority responsibility is likely to often not regard to the full problem extend. In general it is considered that (partial) problems that result due to unreasonable or unthoughtful water use are of water user responsibility. Problems that despite reasonable and thoughtful water use occur due to the shortage of water, are believed to be also problematic to water management. Though, it is expected that most problems will relate to both responsibilities. Traditional forms of water use, like for the Vechtstromen region dairy farming and traditional nature types are considered reasonable water demanding functions (AdviescommissieWater, 2013). Yet, also these traditional users can use water unthoughtfully. Unreasonable water users are for example recently established water intensive companies located in drought sensitive areas. This approach to add nuance to the water managers responsibility is only a rough rule of thumb. In the end it is society that should define the precise responsibility trough democratic processes, not science.

DISCUSSION

In philosophy there are three normative ethical approaches, utilitarianism (Sinnott-Armstrong, 2019), deontology (Alexander & Moore, 2016) and virtue ethics (Hursthouse & Pettigrove, 2018). By identifying values, this study mostly emphasizes the virtue ethics approach. Some, however, stress that modern water management is largely utilitarian (Merchant, 1997), as it focusses on actions that provide the greatest good. This focus would best fit the western governance rationality, which considers striving for the greatest good as objective governance (Blatter & Ingram, 2001; Wolf, 2008). Herein, according to often cited IWRM definitions, the greatest good to water management is about maximizing economic and social welfare without compromising the environment (Agarwal et al., 2000). Even though the evaluative questions obtained in this research are obtained from a virtue perspective, they do not discard this utilitarian view on IWRM. Instead the first four evaluative questions provide a more in depth perspective on what is to be strived for in relation to welfare. The remaining values provide some nuances to the utilitarian perspective. They show that the ends do not always justify the means, which is largely believed by utilitarianism (Crimmins, 2019).

To validate the most striking results from the value analysis, the results have been discussed with the chairman of the daily and general board of the Vechtstromen water authority. He is believed to have a relatively complete and unbiased view on the believes of the general board. Four notable insights from the value analysis have been validated: The boards general agreement on national values and the strong emphasize on Environmental protection, Responsibility and Harmony by the political parties. The chairman largely confirmed the first conclusion. In the regional board it is mostly debated how to regionally implement the national policy. But the values that underly the general direction of the national policies are not extensively debated. Also

the strong emphasize on Harmony is confirmed. The chair mentioned that the Vechtstromen water authority is known for its focus on harmonizing the variety of spatial and water managing ambitions. The focus on Environmental protection and Responsibility is less strongly confirmed. The chair approved that there is a relatively great mutual understanding regarding the interests of nature and agriculture. Thereby there is no true clash between those interests. Though when summing the agriculture and nature focussed board members the nature focus is likely not so dominant. Finally the chairman confirmed that the board tends to be sensitive to not pass on problems to others. Yet, he still believes that some opportunistic decisions are made. It can thus be concluded that Environmental protection and Responsibility are predominantly emphasized on paper, but less dominantly expressed in the board's actions. It is unsure if this undermines the conclusions of this research. The citizen likely vote based upon what's written in the party lines, therefore the importance of these values to the citizen can still be valid.

To provide an as unambiguous framework as possible, the identified values have been translated to more specific evaluative questions. By this it is prevented that values are interpreted in a way that does not fit the water management context. It can however be discussed if the questions still reflect values, or if the questions specify values too such extend that their characteristics vade. Values are, for example, defined in abstract way since they then apply generally enough to transcend specific actions and situations (Schwartz, 2012). It has been tried to specify the values to the water managing context without nullifying the value characteristics. Though, compromising is unavoidable. It is, therefore, possible that some situations might not be evaluated problematic by an evaluative question, but are problematic when considering the value's more general meaning. In such situation one should not be blindfolded by the evaluative questions. When it is certain that the judgement is still in line with the water management's view on the value, such a situation can still be considered problematic.

The possibility to deviate from the evaluative questions touches a limitation of the presented work. The evaluative questions have been defined solely on the actual substance that the documents themselves provided, by translating the coded statements into an evaluative question. The value labels that have been attached to the statements on the other hand are predominantly guided by researcher's interpretation. An interpretation that has been limited by the predefined values list. Which despite its size is likely to be incomplete. It might well be possible that statements originate from values that are not included in the predefined list. Because of this incompleteness, values might have been wrongly linked to values that where on the list. When one deviates from the evaluative question and judges on the basis of a more general value interpretation, it must be sure that that this value is indeed important to water management. Which for now cannot be approved or rejected.

It is important to consider and use the obtained framework in the right way, with the right purpose. The framework, for example, is no replacement of the law, policy or of political views. It purely is an abstraction that defines the main objectives of water management on the basis of the shared values that underlie law, policy and politics. These by values determined objectives allow to quickly assess if water user's problems is problematic to water management. Not even all objectives are considered, it only reflects the objectives that stem from the core moral values that underlie water management. Problems that

are positively evaluated by any of the questions should be deemed problematic by the responsible water managing agent. Yet, problems that are rejected are not excluded to all lengths. It might well be that they are problematic through other mechanisms. Thereby the framework mostly forms a first rough problem evaluation, to scale down a problematic water related problem to manageable proportions. Also the framework does not provide any insights in what solutions are to be defined. In defining solutions it is likely that additional values enter our judgement on what's good and bad.

Although the framework has been defined based upon the Vechtstromen water authority case, it applies more generally when treated with care. The regionality of the framework lies mostly in the political values of the regional political parties. Yet, their regionality can be debated. The political parties that have been studied also operate in other Dutch water districts. Their plans might be different per district, but the values that underlie their views are likely to be similar. Some, like for example the AWP, do not even have a regional specific policy line. When political parties and their representation in the water authority's board are similar, the framework still holds.

Future research can help to better understand the applicability and limitations of the obtained framework. First it is interesting to study the validity of the framework, both for the Vechtstromen case as well as for a more general applicability. Also it might be interesting to better understand how this moral responsibility relates to the legal responsibility, are there truly significant differences? Finally, applying the framework to a test case can provide interesting insights in how the framework needs to be used and where optimization is required to provide more guidance.

CONCLUSION

Integrated water resource management is about unifying and balancing views. But when water management fails in doing so, is understood rather poorly. This article presented a values based moral responsibility framework that allows to evaluate when a water system state fails to sufficiently facilitate water users and thereby fails to balance the different water user views. This balance is believed to be harmed when water user problems occur for which water management should feel a responsibility. To define the moral responsibility, national law and policy and regional political party lines have been analysed and coded for the moral values they reflect. From this data the most important water managing values are determined and ranked based upon both qualitative and quantitative argumentation. Then, the coded value reflecting text fragments have been used to define evaluative questions that assess if a value is harmed by the water system conditions and thus if regional water management fails or not.

The resulting framework consists of three elements. First, there are seven core values that reflect the water management's most fundamental moral responsibility. These are, respectively *Security, Social Order, Wealth, Protecting the Environment, Unity with Nature, Harmony* and *Responsibility*. The importance of these values is generally supported on both national and regional scale. For these values, evaluative questions have been formulated that provide the value with a more water management specific meaning. They describe when water management should consider the corresponding value to

be harmed. Herein, irreversibility, social stability, economic stability, unnatural problem extent, historical interventions, unintended inconsistencies and significant problems to others are key concepts that need to be understood to evaluate if one of the tipping points has been exceeded. One should however not be blindfolded by these questions, problems can also bear a water managing responsibility on the basis of the more general value interpretation. Here, however, the methodological limitations as described in the discussion should be kept in mind.

An eighth question, that reflects the debated morality, forms the second element of the framework. Here the impact to unshared values is emphasized. Based upon a coalition forming principle it is believed that when a single problem affects multiple unshared values, enough consensus can be reached to declare a problem to be of water managing responsibility. This debated morality mostly comprises the regional water managing discussions on what secondary ambitions need to be added to the main objectives.

The first two elements only describe towards what problems water management bears a responsibility. Yet, what precisely is this responsibility is not clarified. The framework's third element, therefore, provides a rule of thumb to provide more clarity on what precisely is of water managing responsibility.

Finally one must understand that the framework is no replacement of the law, policy or of political debate. It is a reflection of the fundamental morality of regional water management, designed to scale a complex water related problem down to manageable proportions.


3

THE PROBLEM OF DROUGHT

A WATER MANAGING PERSPECTIVE

ABSTRACT

Dutch water management increasingly focusses on balancing wet and dry seasons. But as the problem of drought is not clearly defined from a water managing perspective, balancing flood and drought management is hardly possible. This paper, therefore, defines the problem of drought for water management. Here a water managing drought problem is defined as a water user drought problem towards which water management should feel a responsibility. Herein the case of the Vechtstromen regional water authority is considered. Hence, three important water users in the Vechtstromen region, dairy farming, raised bogs and wet heathlands, are studied to understand what problems they experience. Then the water authorities' responsibility towards these problems is evaluated by a specially developed moral responsibility framework. From this assessment all identified water user drought problems appear to be of some water managing responsibility, yet not to their full extent. Dairy farming drought problems are problematic to water management when they result in insufficient protein self-sufficiency or when they induce the risk for large scale bankruptcy. Nature problems are mostly problematic to water management when they are human induced.

INTRODUCTION

Drought is a creeping (Wilhite & Glantz, 1985) and detrimental natural hazard (Mishra & Singh, 2010), and it is only getting worse (Bressers, Bressers, & Larrue, 2016). As global temperatures rise and thereby the climatic extremes intensify new and more severe drought problems occur (Trenberth, 2011). Around the globe, these changes can already be observed. In Europe traditionally it was mostly the Mediterranean region that suffered from droughts. But in the past decades, drought has also found its way to the northwest of the continent (Stein et al., 2016). A part of Europe in which water management used to focus on managing the abundance of water.

To efficiently deal with droughts, and its relation to flood management, water managing institutions in northwest Europe need to shift their focus from discharging water to balancing it with water retention for drier seasons (Ritzema & Van loon-Steensma, 2017). But as drought is a relatively new phenomenon to northwest European water management, water managers tend to have no clear view on when drought becomes problematic for them as water managing agent. This makes balancing flood and drought management difficult. This is one of the reasons why, for example, in the Netherlands water management is still predominantly flood oriented. As only the point of problematic flooding is clearly defined by law ("Waterwet," 2018) and policy (Nationaal Bestuursakkoord Water, 2003), Dutch water management focusses on staying away from this problematic point. Partly due to a lack of drought definition this movement is hardly limited by drought interests. To define the range between which the water system conditions are acceptable, it needs to be better understood when drought becomes problematic to water management.

Despite the abundant literature and state of the art tools regarding the impacts of droughts on for example nature (Besse-Lototskaya, Geertsema, Griffioen, van der Veen, & Verdonschot, 2011; Witte et al., 2018) and agriculture (Knotters et al., 2018; van Bakel & Hoving, 2017), the problem of drought from a water manager's perspective is not defined. All drought impact studies focus on the impact on end-users of the water system. A water manager, however, is no end-user and problems are therefore different to them. It can, for example, be questioned if and to what extent agricultural yield losses are problematic to water management. The same holds for nature. Are impacts on nature quality problematic to water management or are they only problematic to nature managers? Since the water managing responsibility fundamentally differs from an end user's responsibility, the problems stated by literature are not necessarily water managing problems.

This paper aims to define the problem of drought from a water managing perspective. Adopting a water managing view on drought impacts have not been explicitly done before by science. Thereby this study is the first that defines the problem of drought to water managers. To do so, first the impact of droughts on water users will be identified. Then, the problem of drought from a water managing perspective will be determined by defining the water managers responsibility towards the water user problems. This responsibility is evaluated by a values based responsibility framework that has been specifically constructed for this research. Thereby, this research is a first test for the responsibility framework. It will thus also provide useful insights in the usability and usefulness of this framework.

As the problem of drought is partly defined by regional circumstances the case of the Vechtstromen regional water authority has been studied. The Vechtstromen region is one of the driest regions in the Netherlands. It is a region that predominantly depends on rain- and groundwater, since it lacks the possibility of water intake. Due to the lack of correcting measures by water intake the Vechtstromen case provides relatively undisturbed insights in the problem of drought.

METHOD

Integrated water resource management is often defined as the strive for maximum economic and social welfare without compromising the environment (Agarwal et al., 2000; Groenfeldt & Schmidt, 2013). Economic and social welfare are, however, mostly related indirectly to the water system conditions. It are the water users, like farmers, industries and drinking water companies, that provide welfare. Water manager´s should thus aim to facilitate these functions as good as possible. Not all water use is, however, seen as equally important to facilitate. For which water user problems a water manager should feel responsible, and in what way, should be carefully considered. Hence, a water manager´s drought problem is defined as a water user´s problem for which the water manager should feel a responsibility. This definition introduces two questions: what drought problems do water users experience? And which of these problems must be deemed problematic by a water authority due to their responsibility towards water users? This research´s methodology is designed to address these two issues.

WATER USER DROUGHT PROBLEMS - conducting interviews

There are many water users affected by a drought event. Yet, because of time limitations, only three have been studied: dairy farming, raised bog and wet heathlands. Those water users are chosen because of their significant meaning to the Vechtstromen area. Dairy farming covers 79% of the agricultural land use in the Vechtstromen area. This makes it the largest land user of the region. Raised bog and wet heathlands are two drought-sensitive (Besse-Lototskaya et al., 2011) highly valued nature types. Due to their scarcity, they are greatly cherished by the region.

The problems that these nature types and dairy farming experience during drought are identified by interviews with three dairy farmers and two nature conservers. The three interviewed farmers strongly differ in their geographical circumstances. One is located on a relatively high elevation with mostly sandy soil types, one is located high with mostly organic soil and one is located along the river Dinkel with both organic and sandy soils. Because of their different circumstances, chances are greatest to identify all dairy farming problems that might occur. Regarding nature, two nature conservers with different expertise, one ecologist and one hydrologist are interviewed. Due to their different expertise, it is expected that a broader set of problems is obtained.

Semi-structured interviews were held that aimed to identify and understand

problems in a way that the water authority's responsibility can be assessed. As the latter mostly regards problem impacts that are rooted in the water system, the interviews focused on understanding the problem, its cause and its impact on the water user and society. For the problem identification, last 2018's drought has been addressed. This drought was relatively extreme and its impact is still fresh in the respondent's minds.

From the interviews, flow diagrams have been constructed that show how the water user and society in general are affected by drought conditions. These graphs have been produced to structure the identified problems that are obtained from the interview. Many of those problems appeared to be consequences of other problems. The graphs provide clarity on what are problems and what are consequences or impacts as result of this drought problem.

WATER AUTHORITY RESPONSIBILITY - A moral responsbility framework

A values based evaluative framework, that reflects the water authority's moral responsibility, is used to evaluate if the water user drought problems are problematic to the water authority. This because the moral responsibility framework accounts for both the nationally and regionally defined responsibility in a single assessment, by concentrating on the values that underlie national law and policy and regional political views. Thereby, the framework reflects a complex issue as responsibility in a relatively simple and clear way. This is required to assess the variety of complex drought problems in a structured and transparent way.

The framework identified seven values that predominantly shape the water management perspective: security, social stability, wealth, protecting the environment, unity with nature, harmony and responsibility. For all seven values, an evaluative question is defined that assesses if water management should morally feel a responsibility for certain drought problem impacts to the water user or society. Herein the values are given a more water management specific definition.

1. **Security:** Does the problem cause *irreversible* impacts to matters of significant interest?

2. **Social order:** Does the problem harm *societal stability* by its effect on vital functions or on social structures?

3. **Wealth:** Does the problem affect economic stability to such extend that the *business climate* becomes *unattractive*?

4. **Protecting the environment:** Does the problem *unnaturally* affect plants, animals and/or their mutual relationship?

5. **Unity with nature:** Does the problem emerge from a lack of natural water system characteristics, caused by *historical* water managing *interventions*?

6. **Harmony:** Is the problem a consequence of *unintended inconsistencies* within the water management practice or with external spatial planning?

7. **Responsibility:** Does not acting on the problem, that originates in the regional water system, result in a *significant problem for others*, now or in the future?

Besides, the framework includes a debated morality in which value differences between regional political parties are located. These values are not significant enough to define a moral responsibility on their own. Yet, it emphasized that a problem's impact can affect multiple values simultaneously. When multiple debated values are affected, it is believed that there is sufficient support to declare the impact problematic to water management. The values that are debated are successful, capable, a world of beauty, pleasure, knowledge, equality, and reciprocation of favours.

Finally, the framework leaves room to deviate from the evaluative question if a problem is negatively evaluated but still clearly harms the value that is reflected by the question. To define an unambiguous framework evaluative questions have been formulated that specify a value in relation to its water managing context. Yet, it might be possible that this question is made too specific and thereby rules out some problems that from a more general value perspective are to be considered problematic. In this case a problem can still be defined as problematic even though the evaluative question is negatively answered. Then, however, it needs to be certain that the wider value interpretation still corresponds with the water management perspective.

Water authority drought problem - Applying the responsiblity framework

The evaluative questions presented above were used to evaluate if a water user's problem is problematic to the water authority. To do so, each problem that is identified by the interviews with water user's has been evaluated by all evaluative questions. Here for each question it is considered if the problem's impact to the water user itself or to society exceeds the tipping points that are reflected in the evaluative questions. These tipping points are the Italic parts within the evaluative questions. In relation to Security, for example, for all problems it has been studied if there are irreversible impacts of significant interest. The required information to assess the tipping points are obtained from the interviews with water users as discussed above. Thereby, it must be noted that it is more the perceived impacts that are assessed, not necessarily the objective impacts. Yet, it can be argued that perceived impacts might be also relevant to a democratically accountable water managing organization next to objectively supported facts.

The evaluative questions that predominantly shape the responsibility framework, only define towards what water user problems water management bears a moral responsibility. What precisely is this responsibility is not defined by the evaluative questions. Though, the framework provides a first suggestion on how to define the responsibility more specifically. For this, the applied

framework considers a problem to be a social construct between multiple actors. A problem is thus often mutually created. Hence, to define the problem of drought from a water managing perspective more precisely the following rule of thumb is used. Problems that result due to unreasonable or unthoughtful water use are of water user responsibility. Problems that despite reasonable and thoughtful water use occur due to the shortage of water, are believed to be also of water managing responsibility. Though, it is expected that most problems will relate to both responsibilities, here further specification of the problem mostly requires a political debate. As there is no room in this research to facilitate a political debate, this study follows the argumentation provided by the interviewees and provides clarity on the assumptions that implicitly follow from this argumentation.

RESULTS

WATER USER PROBLEMS

This section discusses the problems that are experienced by dairy farmers and nature. From the interviews, it became clear that the available measures to mitigate drought problems fundamentally differ for the two considered forms of water use. In dairy farming practice, seasonal drought impacts can be mitigated relatively well by delaying the problems hoping for a water-rich winter. Only when droughts occur in consecutive years, farmers run out of options. For nature this is different. There hardly are mitigating measures during the drought season, because nature is less one dimensional. What is good for one vegetation or species type, might harm others. Problems, therefore, can only be solved by providing the required water conditions. This makes that a single drought season already causes problems to nature. Yet more structural drought also forms the greatest threat to nature.

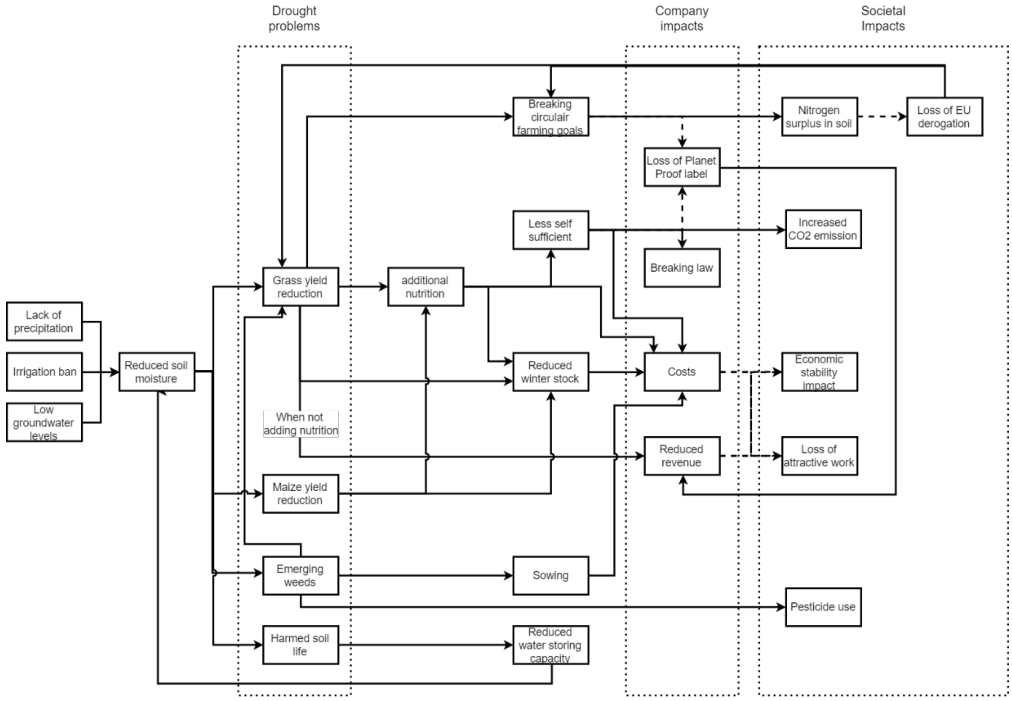


Figure 3.1: Drought impact to dairy farms (dotted arrows are structural drought links)

Dairy farming

The dairy farmers identified four drought problems that directly or indirectly affect their company and society in general, see Figure 3.1. These are grass yield reduction, maize yield reduction, weeds and harmed soil life. These four problems are acknowledged by all three interviewed farmers. Geographical circumstances apparently do not affect the type of problems, only the extent to which it occurs differs.

Reduced grass yield and nutritional value

An appropriate diet is crucial for a cow to produce milk efficiently. Herein grass takes centre stage. It is the primary source of nutrition, providing the required proteins. When soil moisture runs low, the yielded nutritional value reduces significantly. Three processes cause to reduce this yield: reduced growth, reduced nitrogen uptake, and the plant's survival drift.

Firstly, grass growth is reduced due to a lack of soil moisture. Out of the five harvesting cycles in a normal year, last year's drought only provided three of which one was already heavily affected. Thereby, the yield in tonnes of dry grass reduced about 50%. On top of this reduction in mass, the obtained grass yield contained significantly fewer proteins. Proteins are a result of nitrogen that is conversed by the grass. This nitrogen is taken up with the water from the soil. When the water uptake reduces due to drought, also the nitrogen that is absorbed reduces. Thereby, fewer proteins can be produced by the grass. Finally, the nutritional value is affected by the grass' survival drift. During droughts, grass switches from a vegetative to a generative state. Generatively grown grass has more seeds and fewer leaves. As seeds are chewy, they are less easily digestible for the cow limiting the protein absorption.

The reduced grass yield and protein levels strongly affect the farm's business operations. When the reduced nutrition is not compensated revenues are affected. Dairy farmers get paid for the amount of fat, proteins, and lactose that is in their milk. When the low protein levels in the grass are not compensated by additional nutrition, the milk's protein content will decrease and thereby also the revenue gained from it. That is why in practice farmers chose to provide additional nutrition to the cows. Yet, this correction introduces consequences of its own. Instead of reduced revenues, it results in costs, insufficient protein self-sufficiency and the loss of sustainability labels, as will be clarified now.

The reduced grass yield adds substantial costs to the business operations. Firstly additional nutrition introduces costs, both directly and indirectly. Costs are directly affected when silage grass is fed instead of fresh grass. Silage grass, grown on home soil, is about two times as expensive as fresh grass consumed directly from the field. Providing home-grown silage grass is, however, not always possible. It might compromise too much on the winter stock, or it might not even be in stock at all. In such case, the farmer needs to purchase additional nutrition elsewhere. This costs even more. The winter stock is also directly reduced by yield reduction. This might introduce the need to purchase additional nutrition in a longer-term.

Providing the cows with additional nutrition produced elsewhere might even become unlawful at some point. Within a few years, dairy farmers are obliged to produce 65% of the proteins fed to their cows on home grounds. In 2018's drought all three farmers were not able to reach this 65% since their yield was heavily affected. Although it is unclear what the consequence of this illegally low

self-sufficiency will be, it is considered a problem itself.

Finally, drought might threaten the farmer's sustainability labels. All three farmers possess a Planet Proof label from their purchaser. Droughts might cause farmers to lose their label as they might not fit the requirements anymore. One of the Planet Proof requirements, for example, sets a standard for the farm's self-sufficiency. This standard is even higher than the legal norm. The label might also be lost because the company is not able to be sufficiently circular concerning for example nitrogen and phosphate. When for example a farmer injects manure into the soil, a certain amount of nitrogen is injected. For farming to be circular, this nitrogen needs to be absorbed by the plants, otherwise, it will wash into the groundwater system. Droughts, however, reduce the nitrogen uptake and thereby affect the injection's circularity. When the nitrogen and phosphate cycles are too much outbalanced, farmers might not fit the Planet Proof criteria anymore. Losing the sustainability label in itself is seen as a problem, but it also reduces the revenue since the purchaser pays more for milk that is produced Planet Proof.

Besides company impacts, drought problems also affect society. From the interviews, four important societal impacts of reduced grass yields have been identified. Some that occur every drought, others that occur when drought becomes more structural.

Dairy farms are considered of importance to the Vechtstromen economy. That's why they are included in this study in the first place. Not only because there are many, but also because for each company multiple regional companies are benefitting. The loss of a single farm, therefore, impacts a larger network of business. When farms disappear on a larger scale the regional macro economy is believed to be affected substantially. Large scale bankruptcy is not unlikely. The company impacts show that the dairy farm's profit is affected in multiple ways, either by adding costs or by reducing the revenue. For a sector in which the margins in a normal situation are already under pressure (Remmelink et al., 2018), drought impacts might cause bankruptcy. On the basis of the interviews drought is consequently believed to be a phenomenon that might cause large scale bankruptcy when it happens in a few consecutive years.

Besides the macro economic impacts, the possibility of large scale bankruptcy has a more social impact. To practically schooled people the dairy farming sector provides attractive job opportunities. Practical jobs that in the Netherlands are less and less available, as the Dutch economy is becoming more service focused. When droughts becomes structural and thereby dairy farms might disappear, practical farming jobs might be lost on considerable scale.

CO_2 emissions will also increase because of droughts. When farmers need to provide additional nutrition from elsewhere the CO_2 emission that is involved will increase. Nutrition from home soil produces limited CO_2 emission, as it does not require long transportation distances. However, imported nutrition often includes soy from Brazil or Argentina. Their transportation to the Netherlands significantly increases the carbon footprint.

Lastly, drought will pollute the water system and threaten the Dutch nitrogen derogation. As discussed among the company impacts, drought might break nitrogen cycles. This also affects society as the nitrogen surplus will wash away. It will end up in the groundwater system and eventually also in the surface water. To limit this effect, the EU has regulated the amount of nitrogen that may be injected. But because of the high efficiency in Dutch grass production, the Netherlands has a derogation that allows them to inject more nitrogen. When

this efficiency reduces and the additional nitrogen ends up in the water systems, the grounds for this derogation fades.

Reduced maize yield and nutritional value

Maize is a second important type of nutrition for a cow's diet, providing the necessary amounts of farina. Although maize originally is a tropical plant its growth was largely affected during the 2018 drought. Yields reduced both in terms of mass, about 33% reduction, and nutrition, about 25% reduction. Hence, combined nutritional yield reduced about 50%. These reductions are caused by a limited amount of soil moisture availability. Mass reductions are a result of shortages along the full growing period. The reduction in farina mostly stems from a water shortage during the growth phase of the cob.

The yield reduction mostly affects the company in terms of direct and indirect costs. Since the maize contains fewer farina per kilogram, more kilograms need to be fed to provide sufficient nutrition. This additional demand can either be taken from the winter stock or it needs to be bought from elsewhere. When it needs to be bought it results in direct costs. When it is taken from the winter stock it might cost money in the long term, when there is a shortage in winter. Such a shortage is likely since the yield has reduced by 50%.

Although, just as for grass, nutrition needs to be compensated by obtaining nutrition from elsewhere., it does not result in unlawful practices and Planet Proof label problems. This because self-sufficiency standards only apply to proteins.

The societal impacts due to the additional costs are similar to the grass problem. In case of structural drought, the additional costs might be too high and contribute to bankruptcy. Thereby, it might affect economic stability and job attractiveness. Also, the carbon footprint is again expected to increase. This, however, is expected to increase less heavily than for grass. Maize is imported often from more nearby countries and it is less bulky than the grass amounts.

Weeds displace grass

As grass growth reduces due to lacking soil moisture, weeds come up. Weeds are generally able to grow better under dry circumstances than grass. This because their roots reach deeper into the soil. Thereby, they can better absorb water through capillary rise and displace the grasses. This displacement is problematic because weeds are not consumed by cows. Valuable nutritional grass space is thus taken by vegetation that does not provide nutrition to the cow.

As grass displacement directly influences the field's nutritional values, the same company impacts apply as for the reduced grass yield. Yet, there are also direct financial consequences. To undo grass displacement the fields have to be sowed again. This costs about €1000,- per hectare.

To get rid of the weeds, farmers may also extirpate weeds by using pesticides. The pesticides will wash into the groundwater and eventually end up in the open waters. This harms the water quality, influencing aquatic nature and recreation.

Harmed soil life

Organic material is important to the fertility and water-retaining capacity of the soil layer. In a soil layer, the organic material gradually decomposes. New material is provided by, among others, an active soil life. During droughts soil life activity, however, reduces. Hence, less organic matter is formed. The

decline of organic material can have substantial impacts on the water-retaining capacity. 1% increase in organic material increases the water-retaining capacity by 6,8 mm for a sandy soil (de Lijster et al., 2016). The other way around holds also true.

Harming the soil life does not have a direct impact on the company or society. Yet, since it decreases the soil's water storing capacity, it intensifies drought on the most fundamental level. It introduces a loop that affects all company and societal impacts discussed above.

Raised bog

Bogs are a type of wet nature that consists of a large stack of organic plant material formed by mostly death sphagnum. Due to the wet and nutrient-poor conditions, the organic material does not decompose as it would do otherwise and forms a wet organic layer. This layer forms the ideal conditions for new sphagnum to grow. This way bogs are naturally able to sustain themselves in the relatively wet Dutch climate.

From the interviews held among two nature conservers, the impact of drought has been mapped as presented in Figure 3.2. The problem of drought is that the bogs, which normally is a large sponge, dry up. This problem results in multiple consequences to the vegetation and species. Some of these consequences on their turn amplify the initial problem, thereby the nature system ends up in a negative problem spiral.

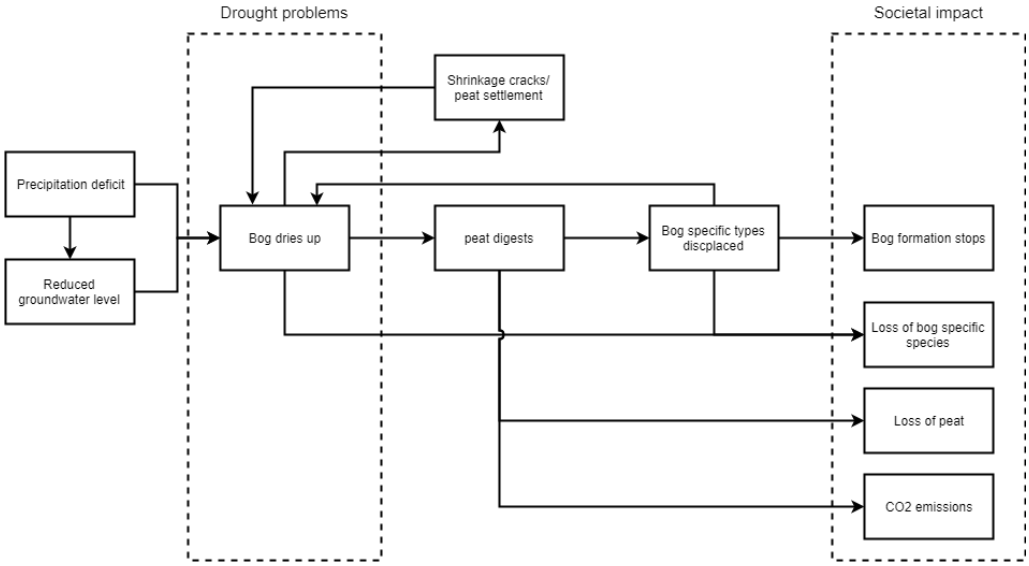


Figure 3.2: Drought impact to Raised bogs

Bog dries up

A naturally functioning bog system can independently regulate its water conditions. Yet, peat mining activities and conflicting agricultural interests have damaged the Dutch bogs to such extent that this natural water management characteristic got lost. This makes the Dutch recovering bog systems more sensitive to drought conditions. Droughts can affect recovering bog systems in two ways, by a precipitation deficit, and by an insufficient groundwater level. Precipitation deficits are mostly problematic because historic mining activities

harmed the natural capacity to sufficiently retain water to survive periods of meteorological drought. This introduces a problem intensifying loop. Besides sufficient precipitation, bogs exist by the grace of a constantly wet subsurface. This wet subsurface prevents water infiltration from the bogs to the groundwater layer. However, drained surrounding agricultural lands lower the bog's groundwater levels. Hence, bogs also run dry through groundwater infiltration. Drying by hydrological and meteorological drought causes the bog to settle and crack, reducing the water storing capacity even further.

Drying of bogs results in multiple societal problems, like a haltered bog formation process and the loss of bog specific species and vegetation. These impacts on bogs are mostly of societal impact because of the bog's intrinsic value. Due to the peat mining bogs have become scarce nature types. That's why society tends to value it. Besides they contain unique nature values, in terms of both flora and fauna. The sphagnums are highly appreciated vegetation types and bogs accommodate some valued specialist species, like specific dragon- and butterflies.

Bog specific vegetation disappears by both direct and indirect effects. When the bog runs dry, the top layer digests. This a direct effect. Digestion, however, also causes an indirect effect. When the peat digests nutrients are released. These nutrients cause other nutrient-rich plants, like pipe straw, to grow. These plants displace the sphagnum. This displacement also hinders the bog formation process and it intensifies the drought impacts by increasing the bog's evaporation. That is why nature conservers put lots of effort into removing pipe straws from the bog. Digesting bog in itself is considered problematic due to its intrinsic value. Besides, it is also problematic because it emit large amounts of CO_2.

Specialist species are harmed directly by the drying of the bog. Most of the specialist species depend on wet conditions. Some birds, like the golden plovers, have already disappeared. Due to the drier conditions, they were not able to hatch their eggs anymore. Also some less mobile dragonflies and butterflies, like the Alcon Blue butterfly, are under threat. Since bogs are located fragmented across the country these species are not able to reach other bogs to survive. Thereby, they will disappear relatively quickly. Species will also be affected when sphagnum is displaced by more nutrient-rich plants. In such a case, the biotic conditions do not suit these specialists anymore.

Wet heathland

Wet heathland is a kind of collective name for nature types in which the moisty heather plants are predominantly present. Contrary to raised bogs that function more or less in isolation, wet heathlands are a nature type that forms an important part to a larger nature gradient. It occurs either high in the gradient on an impermeable layer fed by the rain, or lower in the gradient where it is predominantly provided with groundwater. In spring wet conditions are essential, as this is the critical season for heathers to grow and for specialist species to reproduce.

Drought can be caused by a lack of precipitation, insufficient groundwater levels or both. From the interviews, the impact of these drought mechanisms has been derived and represented in the scheme of Figure 3.3. Three direct problems from drought circumstances have been derived, ponds dry up, heathers wilt and groundwater buffering stays behind. Those all affect the type-specific vegetation and species in their way.

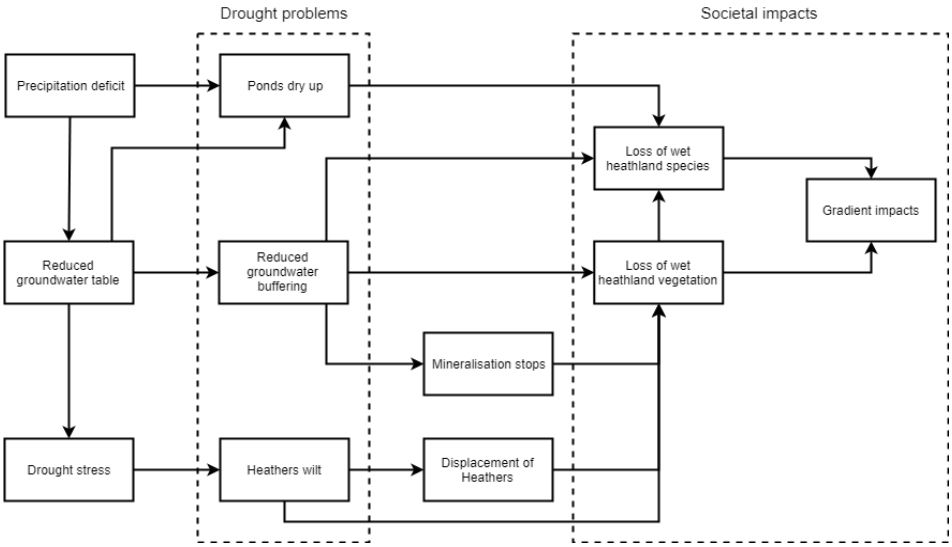


Figure 3.3: Drought impact to wet heathlands

Ponds run dry

Ponds falling dry was one of the first visible signs of 2018's drought. Depending on their location in the gradient ponds run dry either by a lack of precipitation or by a lack of groundwater replenishment. Rainfed ponds fell dry first and after a while also groundwater-dependent ponds disappeared. When the latter falls dry, largely depends on how much the groundwater tables recovered during the winter season. That is why this problem is expected to be more severe during 2019's drought. Groundwater levels have not recovered during winter season.

A single pond that falls dry is not directly problematic. However, when near ponds collectively dry up in spring multiple species, like butterflies and fireflies, are having problems reproducing. As the pools dry these species are for example not able to depose their eggs on the aquatic vegetation. This causes direct problems to the reproduction of the specific butter- and fireflies. Besides, also gradient species that depend on the ponds are likely to be affected.

Insufficient groundwater buffering

Groundwater buffering relates to the capacity to prevent acidification of the soil by, among others, precipitation. When in winter the groundwater levels do not recover the soil becomes more acid, which many plants and species cannot survive. Even more, when the soil becomes too acidic, toxic chemicals can be formed. This process is normally stopped by the minerals that are provided due to groundwater buffering.

Heather plants can grow under relatively acidic circumstances. That is why they can also form under rainfed conditions. Yet, also for heather plants, there is a limitation to this capacity, a pH of 6 is the maximum (BIJ12, 2019). When the soil becomes more acid plants stop to grow and species that are specific to this nature type are affected. Both are also affected when the soil's mineral content reduces.

Insufficient groundwater in spring

In wet heathland nature spring is the critical season. It is in the spring period that most species and plants reproduce and lay the foundation for the upcoming year. Off course this is not only the case for wet heathlands, but to this nature

type spring is even more relevant. Wet heathland is an aquatic nature type that houses plants and species with relatively high water demands in spring season. Besides some specialist species only life for about a year. When they fail to reproduce, the species' survival can be threatened.

Drought stress

Although wet heathland is an aquatic nature type, it does not necessarily need to be wet all the time like bogs do. During summer groundwater levels may gradually reduce up to 120cm below the surface for a certain amount of days. However, when during drought groundwater levels reduce more quickly or deeper nature is still affected.

In such a drought situation the vegetation experiences drought stress. A period in which the plant cannot reach any water anymore. When this stress persists for too long the heathers wilt and thus nature value is temporarily lost. Also, more structural damage occurs when more drought-resistant vegetation displaces the heathers. Recovering the heathlands in such a situation requires a significant amount of extra work from the nature conservers.

Water managing drought problems

To assess which problem impacts are problematic from a water managing perspective and the reason behind this, the identified problem impacts have been evaluated by the moral responsibility framework as discussed in the methodology paragraph. To do so, for all company and societal impacts of drought, as shown in, Figures 3.1, 3.2 and 3.3, it has been evaluated if the problem impact exceeds the tipping points that are described by the eight evaluative questions from the responsibility framework. This has been judged on the information that is obtained from the interviews with the water users. The results of this assessment are presented in Table 3.1 and Table 3.2. In these tables all assessed impacts are presented horizontally and the values that are reflected by the evaluative questions are placed vertically. Where an impact is believed to exceed the values tipping point the corresponding box has been marked black.

Dairy farming

Table 3.1: Water authority responsibility towards dairy farm impacts (black marked boxes indicate a responsibility)

Value	Dairy farming drought impacts								
	Costs	Sustainability Label	Unlawfull	Reduced revenue	Increased CO_2 emission	Loss of practical work	Economic stability	Nitrogen surplus	Pesticides
Security									
Social order						■			
Wealth							■		
Protecting the environment								■	
Unity with nature									
Harmony									
Responsibility	■		■	■					
Debated morality									

Multiple dairy farming impacts appear to be in some way problematic to the water authority, see Table 3.1. These are, Costs, unlawfulness, Reduced Revenue, Loss of practical work, Economic stability and Nitrogen surpluses. The Nitrogen surplus and unlawfulness are related to incidental drought. The rest becomes problematic in case of consecutive dry years.

Regarding incidental droughts, the interviewees indicated that human injected nitrogen surpluses are formed when grass growth reduces due to water shortage. As these surpluses wash into the ground and surface water, plants and animals are negatively affected due to the nitrogen's negative influence on the soil and water quality. Besides, the impacts on plants and animals are considered unnatural, since the nitrogen surpluses are injected by humans. Thereby, according to the responsibility framework, the tipping point of environmental protection is crossed and the problem is considered problematic to the water authority. Even though it is the farmer who injects the nitrogen, he is thus not considered to be responsible on his own. As farmers need to inject their lands before they can foresee droughts, they cannot be fully blamed for injecting regular amounts assuming average meteorological conditions. Only the amounts that they inject can be debated, as will be discussed later. After injection, it is the water conditions, that are partly controlled by the water authority, that influence the surplus. Thereby, the water authority needs to feel a responsibility to provide water system conditions for which the surplus can be reduced as much as possible.

Regarding the problem of illegally low self-sufficiency levels, the interviews did not provide an indication that any of the tipping points described by the evaluative questions are crossed. Yet, because it causes law breaking situations it is still believed that this problem harms the more general intentions of the Responsibility value. Herein it is assumed that the legalized level already accounts for natural fluctuation. Hence, falling below the legal requirements are either a result of an inadequate balance between the amount of grassland and the number of cows or of failing water management. Since the latter is partly controlled by the water authority, they should consider unlawful self-sufficiency levels, that result from the water managing practices, problematic.

From a Responsibility perspective another water managing drought problem is defined that relates to more structural drought. When for a few consecutive years profits are affected on a large scale, large scale bankruptcy and loss of practical jobs are assumed plausible by the interviewees. They believe this will have significant impacts on the attractiveness of the agricultural business climate and on the social stability of the region. The latter is believed so because a large group will become unemployed or has to switch to less attractive work. These possible long term impacts are problematic to the water authority, considering the evaluation of respectively Wealth and a Social order. Not acting on cost increases and reducing revenues will thus possibly lead to significant future dairy farming problems for which the water authority should feel a responsibility. Hence, from a responsibility value, the water authority bears a moral responsibility to provide water systems conditions for which the large scale profit decreases are manageable on the longer term.

Some negatively answered questions might need a further explanation of why they are not considered water authority problems. The consequences of pesticides are similar to those of a nitrogen surplus. Though, there is a fundamental difference. When injecting nitrogen, farmers do not necessarily choose to inject a surplus that washes into the water system as they do not know

if it will be a normal or a dry season. Here it is assumed that the EU policy on nitrogen use reflects a widespread view on morally acceptable nitrogen use. Thereby, when farmers adhere to the EU regulations it is not considered fully their own responsibility when nitrogen washes into the water system. For corrective pesticide use to eliminate weeds, this differs. Traditional chemical pesticides always wash into the water system, when using thse pesticides a farmer thus implicitly choses to pollute the water system. It is also a farmer's choice on how to deal with the weeds. There are other ways to deal with weeds, like re-seeding or using non chemical alternatives. Because of this deliberate choice to use pesticides the farmer is considered to be fully responsible for this impact. Pesticide use is thus rejected as a water managing responsbility because it believed to be a form of untoughtfull management. Herein it is assumed that pesticides are used in corrective sense, this is the only pesticide use that was mentioned during the interviews. The rejection of this impact in this context does, however, not mean that pesticides in the waterbodies are not at all problematic to the water authority. From other water user perspectives polluted water might cause problems towards which the water authority should feel a responsibility.

One could also argue, that all problems occur due to an imbalance between retaining and discharging water and should therefore be seen as problematic to the Harmony value. Yet, the lack of harmony has been a deliberate strategy mostly demanded by the farmers themselves. As the created imbalance was not unintended the problems that result from it for dairy farmers are not necessarily of water managing responsibility. Herein it is assumed that water management has sufficiently informed the farmers on the consequences of their demands, this can be debated. For the same reason, it also does not adhere to the Unity with nature value, as this requires the water authority to cause the unnatural water system characteristics. In this case, the farmers demand the interventions and are therefore considered the ones causing it.

Finally, the increasing CO_2 emissions are also rejected as water authority problem. One of the interviewed farmers mentioned that farmers have the opportunity to reduce this impact themselves, by feeding local residual products from food processing industries like of beer production. From the interviews it thus became clear that the CO_2 emission is a problem that is induced by farming choices, not by water conditions. Assuming that there are enough of these residual products, water management should not feel a responsibility towards dairy farmers for the increasing CO_2 emissions.

The company and societal drought impacts that are judged problematic all relate to one or more of the direct drought problems shown in Figure 3.1. Hence, reduced grass yields, reduced maize yields, weeds and harmed soil life are all four considered to be water authority drought problems. They are however not problematic to their full extent. Reduced grass yield is problematic when it reaches a point at which the protein self-sufficiency runs too low or when profit losses cause potential large scale bankruptcy in the longer term. The latter also holds for reduced maize yields and emerging weeds. The harmed soil life is problematic by its inducing effect on the other three drought problems. Thereby, it becomes problematic when it induces the other drought problems to the just described levels.

Wet heathlands and Raised bogs

Value	Nature drought impacts						
	Loss of wet heathland specific species	Loss of wet heathland specific vegetation	Gradient impacts	Los of bog specific species	Bog formation stops	Peat loss	CO_2 Emissions
Security						■	
Social order							
Wealth							
Protecting the environment	■	■	■	■	■	■	■
Unity with nature	■	■	■	■	■	■	■
Harmony							
Responsibility							
Debated morality							

Table 3.2: Water authority responsibility towards nature impacts (black marked boxes indicate a responsibility)

In both interviews with the nature conservers it became clear that peat develops extremely slowly. When a layer digests the bog's recovery is set back by multiple decades. Due to this long recovery time, it is assumed to be relatively irreversible. Considering peat digestion as irreversible is also required to be able to let the systems recover into fully naturally functioning bogs. Assuming there is a general consensus on the wish to re-naturalise bog systems, the problem needs to be considered as irreversible. Also, the bogs are considered of significant interest, because of their high protection status by the EU. This is assumed to reflect a widespread societal interest in raised bog nature types. Thereby, peat loss meets both evaluative criteria for the Security evaluation. From their moral responsibility towards bogs as water users, water management should thus consider peat digestion to be problematic.

Some of the other impacts, presented in Table 2, might also feel like they are irreversible, the loss of species or vegetation for example. Yet, it is possible to reintroduce those to the natural systems when the systems are ordered in a sufficiently robust way. This is considered as a responsibility for nature conservers. Besides, bog management in the Vechtstromen region is not species focused and the threatened species also hardly fulfil a bigger ecological role in this region. Unlike, for example, when bees would disappear, which would have a snowball effect on a larger ecosystem (Byrne & Fitzpatrick, 2009). As the interviewed nature conservers tend to agree with the conservation focus, it is assumed that this reflects a more widely supported view on the boundaries of nature conservation. This because nature conservers are believed to be relatively ambitious towards the environment, if they rule out certain aspects it is assumed a majority will agree. The lack of species focus and the limited ecological consequences makes that this type of drought impact is not considered to be of significant enough interest to harm the Security value.

From an environmental protection point of view, most impacts are considered to be in a way problematic to water management. Both nature conservers stressed that drought impacts on nature are induced by the drained surrounding agricultural lands. Thereby, flora and fauna are affected to unnatural extend. In the Vechtstromen area, this effect is especially relevant because agriculture and nature are strongly intertwined. This increases the influence of agricultural

groundwater levels on the natural systems. This is mostly relevant to the raised bog systems. Since nature is affected to unnatural extend the tipping point for environmental protection is exceeded. The water authority should therefore consider it problematic when species and vegetation are affected by the impact of surrounding drainage.

The same reasoning also positively evaluates the Unity with Nature evaluation. Since the problems are predominantly the result of surrounding agricultural practices, the nature systems have lost some significant natural characteristics. The natural sponginess of bog systems, for example, got lost due to centuries of bog drainage for peat extractions. The lack of sponginess now is one of the main reasons why the bogs run dry. As natural characteristics got lost and this intensifies drought problems, Unity with Nature is lacking. From a Unity with Nature view, the impact to species and vegetation is therefore evaluated as problematic to the water authority.

It might seem like there also is a lack of harmony between nature and agricultural lands. Yet, this is assumed to be a deliberate water managing choice. This because both nature and agricultural interests are represented in the board. Hence it is assumed that in the decision making process the impact of certain policy to both land uses are expressed to each other and a well-advised decision has been made. The water authority thus deliberately chooses to balance nature and agriculture in such a way that nature among normal conditions meets its minimum requirements. Thereby, it is also a choice that under drought conditions nature is impacted. Hence, there are no unintended consequences caused by an unharmonized policy. The impacts have thus not been negatively assessed on the Harmony evaluation criteria.

All societal drought impacts are in a certain way of water authority responsibility. This means that all underlying drought problems that have been identified during the interviews are also to certain extend problematic to the water authority. For wet heathland, the water authority should feel a responsibility towards these drought problems when they result from insignificant groundwater levels. As these groundwater levels are affected to an unnatural extent, by the draining of agricultural lands. Where problems occur solely due to a precipitation deficit, it is generally considered a natural impact that is not of water authority responsibility. Here bogs form the only exception, for this nature type the water authority should also consider precipitation deficits to be problematic. Natural bogs are largely self-reliant, regulating precipitation shortages and surpluses themselves. Yet, as this characteristic got lost due to historic water management interventions, the water authority should also feel a responsibility for the consequences of precipitation deficits. Even though they cannot do much about it, other than fully contribute to recovering the systems to a natural state.

DISCUSSION

The application of the moral responsibility framework in this research proved that the framework provides a useful and guiding tool to assess complex water problems. The value based evaluative questions provided clarity in the information need and in the considerations that need to be made to assess the water managing responsibility. Thereby, the framework was able to structure the problem defining process and gave clear insights in why certain impacts are

problematic to water management.

There are however also some critical remarks that need to be made. Mostly because the applied methodology comes with some limitations to the completeness and validity of the presented results. These limitations must be understood and treated with care.

Firstly, while answering the questions provided by the responsibility framework, it became clear that too much assumptions had to be made. Assumptions were especially required regarding problems that are strongly mutually constructed. These problems required the use of the framework's rule of thumb, but from the interviews a too one sided view had been obtained to fairly apply the framework. To assess strong mutually constructed problems, it is recommended to obtain the detailed problem insights from a discussion panel with mixed interests. Instead of from interviews with the water user only.

Secondly, the analysis presented in this paper showed that water management should consider dairy farming profit losses as problematic when they cause large scale bankruptcy. Not because of the impact to the individual farms, but because the large economic and social impact. To validate these perceived impacts literature has been studied. There are no studies performed that solely focus on Vechtstromen region, but there is a research that studied the general economic and societal importance of the high sandy regions to the country. This report indeed argues that the agricultural sector has an important role to the economy and to the social structure of the region (Michon & van Liere, 2012). Yet, even though the dairy farming is relevant to the economy it is not necessarily said that large scale bankruptcy of farms will automatically lead to macro-economic impacts. The lands are likely to be taken over by other companies that on their turn will grow and compensate. Macroeconomic fluctuations can thus be less extensive than expected by the interviewees. Yet, the attractiveness of the business climate is likely to be harmed due to the drought impacts (Michon & van Liere, 2012). Also the social impacts on job availability are considered plausible. Even when the lands will be taken over by other farming companies, the scale up efficiency gains will likely result in job losses. Hence, the social impact is believed to be still there regardless of the macro-economic effects. The water managing drought problems that are identified are therefore in anyway problematic. Only the argumentation, if it is because of the economic impact or because of the social impact, is uncertain.

Thirdly, when comparing the dairy farming drought problem graph, Figure 3.1, with the two nature graphs, Figures 3.2 and 3.3, the nature graphs seem to be less complex. This might be confusing as dairy farming is more one dimensional than nature. At the same time that is one of the reasons why the graphs differ in complexity, next to the correcting actions of dairy farmers as discussed in the results paragraph. While constructing the nature graphs the processes are abstracted to the level of species and vegetation in general. In reality, however, impacts might substantially differ per type. It was assumed that this type specification was not necessary as the responsibility framework stresses moral principles that apply to impacts to all types. The graphs would have become overly complex. The results appear to support this initial assumption. Almost all impacts are evaluated as problematic to water management because of the way they are induced by human interference, not because of their precise societal impact. Thereby, no specific insight is needed regarding the precise impact to all species and vegetation.

Fourthly, this research only partly describes the problem of drought to water

management. The analysis has only focused on dairy farming, raised bogs and wet heathlands as water users. These are considered of relatively high importance in relation to drought, either because of their large scale as is the case for the dairy farming or because of their sensitivity to drought as is the case for the two nature types. There are however plenty of other water users that have not been included in the research scope. It can well be that one of these water users experience droughts sooner than the studied water users. Operationalizing the identified problems might, therefore, not provide all the critical information that is required for water managing decision making. In 2019's drought, the Vechtstromen water authority for example declared irrigation bans because large scale fish mortality was lurking due to the declining water quality. When only the problems that are identified in this study are operationalized, the water authority would not be provided with information on this problematic drought impact. Also some impacts that have been negatively assessed in this research might become problematic to water management when considering other water users. This research for example concluded that the water authority should not feel a responsible towards the dairy farmer for his pesticide use. However, when considering the aquatic life as water user, it might well be concluded that the water authority bears a responsibility towards the aquatic life for the pesticides in the water. An important first step to take in future research is to obtain a more complete problem overview by studying the problem of drought related to other water users.

Finally, one should bear in mind that this research only roughly defined the water managing drought problems. What precisely is problematic is only defined by a primitive rule of thumb. For the transcending aim of this research, operationalizing a too dry state, this information level suffices. An operationalized definition only requires an understanding regarding what problems information should be provided. One must, however, not want to use these problem definitions to guide water managing response. This response requires a more detailed problem specification that is not believed to be defined by science. Instead, this is up to water managing governments that reflect the interests of the regional water users.

CONCLUSION

In this study the drought problem has been defined from a water managing perspective. A water managing drought problem is conceptualized as a water user drought problem towards which water management should feel a responsibility. This conceptualisation has been chosen because water management mostly provides value by facilitating water use. Hence, to define the problem of drought, water user drought problems and impacts are identified. Here the study has focussed on three important water users, dairy farmers, raised bogs and wet heathlands. Their drought problems have been obtained by conducting interviews with three dairy farmers and two nature conservers. A moral responsibility framework, that was constructed in light of this research, is then used to assess towards which drought impacts water management should feel a responsibility to the water user. The research focussed on the case of the Vechtstromen water authority. This water authority is responsible for one of driest regions in the Netherlands.

To dairy farming, four drought problems occur: a reduced grass yield, a reduced maize yield, emerging weeds and finally the soil life is harmed. These four problems in the end result in multiple company and society impacts. On a company level the drought problems affect the profit, threaten the sustainability labels and cause unlawful protein self-sufficiency levels. On a societal level the drought problems result in increased CO_2 levels, nitrogen surpluses, washed pesticides, economic impacts and the loss of attractive practical work. The last two are only likely in case of consecutive dry years.

A water manager should mostly consider the unlawfulness, nitrogen surpluses and the profit losses as problematic. Yet, not to their full extend. Unlawfulness is only problematic when the dairy farms have ample grassland to be sufficiently self-sufficient under regular conditions. Nitrogen surpluses are problematic to water management when regular amounts of nitrogen have been injected in spring. Finally profit losses become problematic to water management when they risk large scale bankruptcy of dairy farms. Not because of the water managers responsibility towards individual farms, but because of their responsibility towards economy and societal stability. Since the three problematic all relate to one or more of the underlying drought problems, all four drought problems are to certain extend problematic to water management.

Bogs and wet heathlands have to cope with respectively one and three drought problems. To bogs, the drying of the bog layer is the only drought problem. This problem, however, causes multiple serious societal impacts. It causes the peat to digest which in itself is already considered a problematic impact. Besides, the peat digestion stops the bog recovery process and it results in some considerable amounts of CO_2 emissions. Finally, some specialist species that depend on the bog's wet circumstances might get lost because of the drying. Wet heathlands are affected by three drought problems, ponds dry up, groundwater buffering reduces and heather plants wilt. These drought problems potentially cause specialist species and vegetation to disappear. This in itself is considered as a societal impact because of the intrinsic value of the wet heathland nature type. Yet, it also has its effect on the larger nature gradient in which the wet heathland plays a role.

All impacts are considered to be in some way problematic to water management. This partly because of their impact, but mostly due to the way these impacts occur. Drought to nature is largely induced by the drainage of the surrounding agricultural lands. Thereby, groundwater levels are affected which harms the nature. The induced extent of the drought problems must be considered problematic by water management.

For the nature conclusions to hold more generally, it is important that the nature impacts stem from the surrounding human activities. For the dairy farming problems to hold more generally, it is important that the economic and social role of the dairy farming sector to the area considered should be significant. Besides, when applying the above presented conclusions one should keep in mind that this research only partly defined the drought problem to water management. There are many water users of which only three have been studied. Even though these three have a special relation to drought, they do not form a complete view on the drought problem to water management. This is an interesting topic to be studied by future research. Finally, it must be understood that the drought problem is only roughly defined. The problems are thus not sufficient to guide water managing responses. The further detailing of the water managing drought problem is believed not to be defined by science but by the citizen representative governments of the water managing institutions.


4

CONCLUSION

As the climate changes, water abundant countries like the Netherlands tend to shift their focus from managing floods to balancing wet and dry seasons. To be able to balance wet and dry seasons it is important for water management to understand when it is too wet and when it is too dry. Within water abundant countries, like the Netherlands, the first is believed to be defined relatively clearly, the latter is not. This research, that consists of two phases, aims to provide more clarity on when it is too dry by defining and operationalizing problematic drought from a water managing perspective. This report presented the first step towards such operationalized definition, by studying what the problem of drought is for water management. For this, the case of the Vechtstromen regional water authority has been studied, which is one of the driest regions in the Netherlands.

Since Dutch regional water management is mostly about facilitating water use, a water managing drought problem is defined as a water user drought problem for which the regional water authority should feel responsible. From this conceptualisation, three research questions have been formulated:

1. What problems do water users experience during drought and what are their consequences?
2. Towards what water user problems should water management feel a responsibility?
3. What is the problem of drought from a water management perspective, considering their responsibility towards water users?

This concluding chapter provides a brief overview on the answers to these three research questions.

RQ1 - Water user problems

Three water users have been studied, dairy farmers, raised bogs and wet heathlands. To identify dairy farming problems three dairy farmers have been interviewed. The drought problems to raised bogs and wet heathlands have been obtained by interviewing two nature conservers. From the interviews many drought problems are identified. Most of these problems are causally linked. To coherently distinct causes, problems and effects, the identified consequences of drought have been structured in a flow chart. Drought consequences that directly result from the water conditions are considered drought problems. Less direct consequences that impact the dairy farmer or society are seen as relevant impacts for which the water managing responsibility needs to be assessed.

Figure 4.1, presents the resulting flow chart for dairy farms. This figure shows that there are four drought problems, reduced grass yield, reduced maize yield, emerging weeds and a harmed soil life. Through a complex process that is shown in the figure, these problems affect the farm´s business operation by affecting sustainability labels, by reducing protein self-sufficiency below legal requirements and by limiting the profits. Society is ultimately affected by increased nitrogen surpluses, potential loss of EU nitrogen derogation,

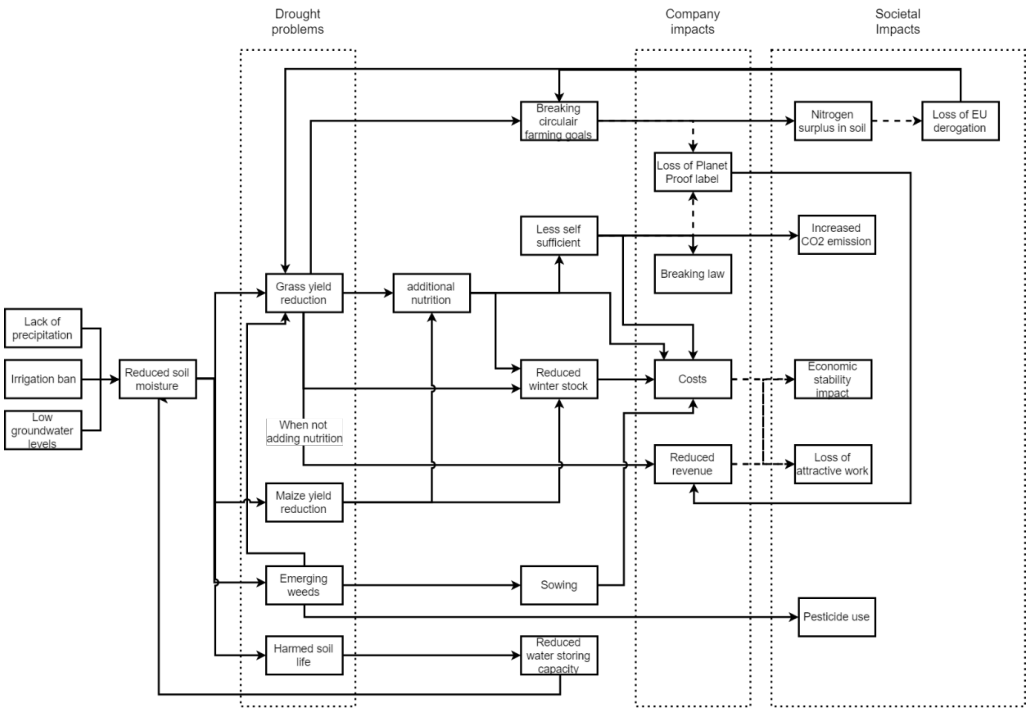


Figure 4.1: Drought impact to dairy farms (dotted arrows are structural drought links)

increased CO_2 emissions, washing pesticides and in case of consecutive dry years economic stability and job availability can be negatively affected.

Figure 4.2 presents the identified problems and societal impacts related to raised bogs. Raised bogs appear to have only one direct drought problem, the drying of the bog. When groundwaters run low or precipitation remains for too long, the recovering bog systems are not able to stay sufficiently wet for the peat to survive. Multiple societal impacts occur because of the drying of the bog. First the peat digests. This in itself is considered problematic because of the intrinsic value of the bogs. Yet, it also stops the bog recovery process and causes large CO_2 emissions. Finally, some specialist species, that depend on the bogs natural circumstances, might get lost because of the drier conditions.

Figure 4.2: Drought impact to Raised bogs

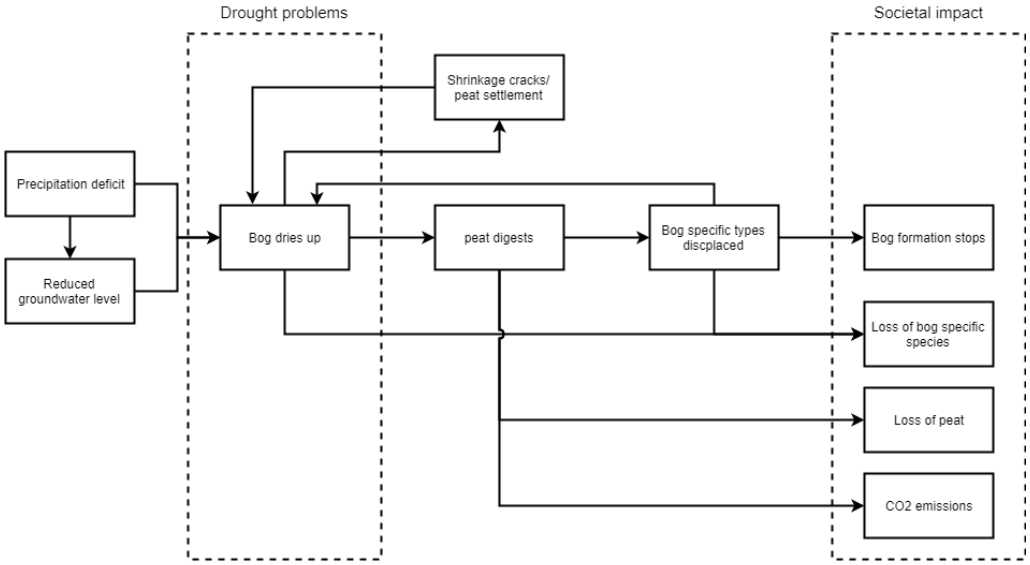
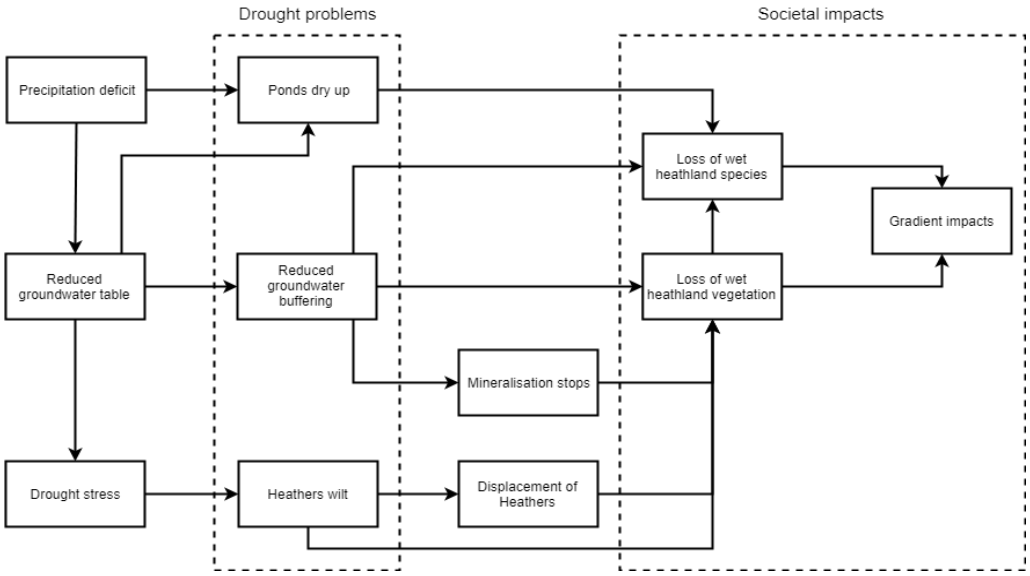


Figure 4.3 shows the problems and impacts related to wet heathlands. Three drought problems have been identified for this nature type, drying ponds, reduced groundwater buffering and the wilting of heather plants. All three drought problems direct or indirectly result in the potential loss of wet heathland specific species and vegetation. Also the impacts to wet heathland nature types affect other nature types because of the gradient function.

Figure 4.3: Drought impact to Wet Heathlands



The above presented impacts are impacts to three of the most important water users, in relation to drought. Yet, there are many other water users that have not been included in the research scope. The drought definition that is defined in this research is therefore only a partial definition of the problem. This limitation must be taken into consideration when using the presented work.

RQ2 – Water managing responsibility

To be able to assess if a water managing agent must feel a responsibility towards a certain water user problem, a value-based moral responsibility framework has been defined. For this, the most important values that underlie national law and policy and the regional political views are determined and given a water management specific definition. These have then been translated into a responsibility framework. The resulting framework consists of three elements. The first element defines seven values and evaluative questions that for each core value comprise a tipping point for which the value should be considered as affected. These questions are:

1. **Security:** Does the problem cause *irreversible* impacts to matters of significant interest?

2. **Social order:** Does the problem harm *societal stability* by its effect on vital functions or on social structures?

3. **Wealth:** Does the problem affect economic stability to such extend that the *business climate* becomes *unattractive*?

4. **Protecting the environment:** Does the problem *unnaturally* affect plants, animals and/or their mutual relationship?

5. **Unity with nature:** Does the problem emerge from a lack of natural water system characteristics, caused by *historical* water managing *interventions*?

6. **Harmony:** Is the problem a consequence of *unintended inconsistencies* within the water management practice or with external spatial planning?

7. **Responsibility:** Does not acting on the problem, that originates in the regional water system, result in a *significant problem for others*, now or in the future?

The seven evaluative questions reflect the seven values for which there is a general consensus on their importance to water management. Most political parties however also adopt values by which they distinguish themselves from the other parties. These values are not supported generally enough to be among the seven general evaluative questions. They are, however, still of importance to the moral responsibility. By including a debated morality, the framework's second element accounts for the regional debate on what other values need

to be adopted by water management. Here it is believed that when a single problem affects multiple debated values, a problem can still be considered to be of water managing responsibility. This debated morality mostly comprises the regional discussions on what secondary ambitions need to be added to the main objectives.

The first two elements only describe towards what problems water management bears a responsibility. Yet, what precisely is this responsibility is not clarified. The framework's third element, therefore, provides a rule of thumb to provide more clarity on what precisely is of water managing responsibility.

RQ3 – Water managing drought problems

The problem of drought to water management has been determined by applying the moral responsibility framework to the identified water user problems. For this the drought problem impacts have been assessed by the framework. All problems that cause an impact for which water manager's should feel a responsibility are considered as water managing drought problems.

From a moral responsibility perspective water management should consider the insufficient protein self-sufficiency levels and the reduced profits to be problematic. Though not to their full extend. Insufficient protein self-sufficiency is only considered to be a problem to water management when the farmer has a sufficient amount of grassland to grow proteins to feed the cows. The reduced profits are problematic because they might cause large scale bankruptcy that affects the economic stability and job availability. Hence, the value of wealth and social order are potentially harmed. Profit losses are thus considered problematic to water management when they are wide spread and significant enough to cause bankruptcy over a few consecutive drought years.

From an environmental protection perspective, the nitrogen surpluses that wash into the ground and surface waters are to be considered as problematic by water management. Even though it is the farmer who injects the nitrogen, he is not considered to be responsible on his own. As farmers need to inject their lands before they can foresee droughts, they cannot be fully blamed for injecting regular amounts assuming a normal summer. After injection, it is the water conditions, that are largely controlled by the water authority, that influence the surplus. Thereby, the water authority should feel a responsibility to provide water system conditions for which the surplus can be reduced as much as possible.

The above impacts all relate to one or more of the underlying drought problems. Reduced grass yields, reduced maize yields, emerging weeds and harmed soil life are therefore all water managing drought problems. The extent to which they are problematic depends on what impacts they cause for which the water managers are responsible.

Regarding the two nature types, all impacts are evaluated as problematic to water management. This because all problems and thereby their impacts are induced by water managing choices. Thereby the Unity with nature and Protecting the environment values are harmed. The role of water management towards these issues is also of special importance due to the limited options for nature conservers to mitigate drought impacts. Nature conservers can only preventively order nature in a robust way and removing vegetation that

displaces the desired vegetation. Yet, during a drought event there are no true mitigating possibilities. Impacts, can consequently only be decreased by water management.

Just as for dairy farming, all nature impacts that are assessed to be in some way problematic to water managers relate to one or more of the underlying drought problems. Drying of bogs, ponds that run dry, reducing groundwater buffering and wilting heathers are therefore all water managing drought problems. Here again the extent to which they are problematic is defined by their societal impact.

From problems to operationalisation input

As discussed this report only presented the first step towards an operationalisation of drought from a water managing perspective. This first part aimed to define a clear understanding on what drought problems need to be operationalised and on how to evaluate their problem extent. To provide a brief overview for the operationalisation phase, these insights have been summarized in terms of operationalisation input. The problems that need to be reflected, the variable that defines the problem's extend and the point at which a problem is considered fully problematic are presented in Table 4.1.

Table 4.1: Operationalisation input

Drought problem	Problem extent defined by	Fully problematic when
Reduced grass yield	Effect on profit	Risk of large scale bankruptcy
	Protein self-sufficiency	Self-sufficiency below legal requirement
	Nitrogen surplus	tbd
Reduced maize yield	Effect on profit	Risk of large scale bankruptcy
Emerging weeds	Effect on profit	Risk of large scale bankruptcy
Harmed soil life	Effect on profit	Risk of large scale bankruptcy
	Protein self-sufficiency	Self-sufficiency below legal requirement
Bog drying	Years of setback in bog development	tbd
	Human induced decline in specialist species	Loss of specialist species
Ponds dry up	Human induced decline in specialist species	Loss of specialist species
Reduced groundwater buffering	PH values	PH above 6
Heathers wilt	Percentage of displaced wet heathers	Irreversible loss of wet heathers

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