Modelling expertise

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MODELLING EXPERTISE

EXPERTS AND EXPERTISE IN THE IMPLEMENTATION OF THE WATER FRAMEWORK DIRECTIVE IN THE NETHERLANDS

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof.ir. K.C.A.M. Luyben;
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op
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door

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No eye may see dispassionately. There is no comprehension at a glance. Only the recognition of damsel, horse or fly and the assumption of damsel, horse or fly (…).

Mervyn Peake

Gormenghast Trilogy, 1946, 1950, 1959, illustrated edition 2011, P95:, Vintage

Foreword

At the start of my research I drew a spiral (figure 1) to represent what I saw before me as a research process: spiraling around the main theme (the role of experts in policy making), I would look at it from different angles. After some time I would return to the same angle, but as Hundertwasser[1] says (box 1), you will not see the same thing because what you have seen from different angles the first time around will influence how you look at it the second time. The last phase of writing the thesis took a long time. Instead of being in a Hundertwasser spiral, I had ended up in an infinite orbit (figure 2) in a Thesis Repulsor Field[2], TRF, (Cham, 2010). The question of how to do justice to the whole and at the same time develop the interesting parts in detail, proved daunting.

Figure 1

"Wir gehen im Kreis,
aber wir kommen nie wieder an den Punkt zurück,
der Kreis schließt sich nicht,
wir kommen nur in die Nähe des Punktes,
wo wir gewesen sind." *Hundertwasser*

Box 1

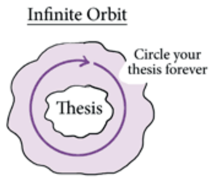

Figure 2

Having overcome the TRF and arrived here, there are many people to thank!

First and foremost, everyone who contributed to all the information I gathered: all the interviewees who were so generous in their time and in sharing what they know. Deltares, for kindly allowing me to observe internal meetings and to receive all the documentation. All the members of the WFDE project team that unreservedly accepted my presence and my notebook, while I could give little more than some cookies in return. Without you, I wouldn't have had much to write about!

Then, those who were there from the start. Loes, my wise coach when I was still working at the Waterboard Delfland, without whom I would never have started a PhD process at all. My dear supervisors who welcomed me in the department. Erik, thanks for having me as a roommate for so long and for patiently listening and reading, commenting, and listening and reading again. Nick, thanks for accepting an unusual topic and for having confidence that I would succeed.

Throughout the years, there were my many wonderful colleagues at the department - lots of PhD students, staff-members, our helpful secretaries - you made it fun to be here and even made me feel useful at times. I would like to thank you all personally, but I am afraid I would forget some. I hope to keep in touch with many of you! I enjoyed being part of the team, even though sometimes I talked with you so much, I had to go home to work.

The list is endless. My great colleagues in the Ribago network, some of whom have become great friends. The committee members, who so kindly agreed to read the whole thing, provide feedback and attend the ceremony. My friends and wider family, who supported and encouraged me even when I neglected them.

[1] http://www.hundertwasser.at/deutsch/werk/malerei/malerei_diespirale.php, retrieved 27-7-2017
[2] http://www.phdcomics.com/comics/archive.php?comicid=1354, retrieved August 5, 2014

The last couple of years, my health for quite some time completely blocked advancing the work. Therefore, a big thank you goes to all who helped my recovery: from the GP who put me on the special painkillers to my physiotherapists and my Pilates teacher, Sandra.

And always last but never least: my family, the best ‘gezinnetje’ there ever was. Mafalda, Merijn, Maurits, I love you.

Summary

In 2000, the Water Framework Directive (WFD) entered into force. This European Union directive aims to protect and restore water quality and ecology in all waters in Member States. To implement the new requirements of the WFD, the current status of the surface and ground waters in all member states were to be established. Furthermore, the effects of possible solutions were to be assessed to determine which measures were most cost-effective.

The WFD is an example of evidence based policy making, basing policy on the best possible evidence to make it more effective, which the EU and many countries over the world have embraced. The ideal image of the domain of expertise, where the evidence is produced, is that it is impartial, indifferent to any policy that may be developed based on it. In practice, however, the relation between the domains of policy and expertise is not unproblematic.

Expertise is not something absolute but relative to a specific field and to other actors. One can be an expert in one field and not another, and in any field one can be an expert compared to one actor and an amateur to another, or something in between. Most of the experts in this thesis, work at (applied) research institutes, consultancies or water authorities.

A possible means of supplying expertise to the policy domain is through decision support systems (DSSs). These software products support decision makers by providing insights in the effects of possible decisions. They generally include one or more models and allow decision makers to compare various policies or measures.

As the effectiveness of DSSs for evidence-based policy is uncertain, this thesis has two aims. The first is a deeper understanding of the concept of evidence based policy making, more specifically the relation between the policy and expertise domains and the role of DSSs as an intermediary between the two. As the analysis initially applied in this thesis appeared unable to explain certain observations, the second aim was formulated: assessing the contribution of a different approach, Actor-Network-Theory, to policy analysis and policy support tools.

Central to the thesis is the implementation of the Water Framework Directive in the Netherlands and the development of a DSS called the WFD Explorer (WFDE). This thesis is based on policy documents, project documents, 42 interviews, and observations of 30 meetings regarding the development of the WFDE. The material was mostly analysed using Atlas.ti, a software tool to assist qualitative data analysis (see chapter 2).

To start with policy, the thesis discusses the implementation of the WFD in the Netherlands (chapter 3). While on paper the planning process for implementing the WFD promoted both cross-level and cross-sectoral integration, in practice cross-sectoral integration was limited. Conflicting interests between sectors, specifically the agricultural and the water management sectors, were insufficiently addressed at the national and European level. At the regional level, the water authorities had no authority over other sectors, nor did they have good counterparts - such as regional agricultural authorities - to cooperate with. Nearly all WFD measures were taken by regional and national water management authorities. Other than through some local voluntary measures, agricultural practices have not been affected by the implementation of the WFD in the Netherlands.

The WFD introduced a number of new requirements to water quality and ecology management, with new concepts as well as new standards to adhere to. The operationalisation of these concepts and standards was done by experts from various research institutes, consultancies and water management authorities, in parallel with the first round of WFD planning. The technical aspects of the WFD implementation overshadowed debates on the views of the various stakeholders on what would actually be the desirable state of the waters and what they would be willing to do to achieve this. The technical approach to implementing the WFD corresponds with a major role of experts and their expertise, and a limited role of the non-governmental stakeholders in the WFD implementation, who were not always capable of keeping up with the technical debates and the number of meetings.

To examine the role of expertise in more detail, the focus of the thesis shifted to the development of the WFDE (chapter 4). At the start of the development, the intended support by the WFDE was twofold: providing direct input on the expected effects of measures during meetings of stakeholders and acting as a joint knowledge base for the regional water authorities. After an evaluation in 2009, the WFDE was completely redesigned. The result in 2013 was not a tool supporting policy planners in their meetings with various stakeholders, nor a joint knowledge base, but an expert-tool that calculated the effects of measures.

The description of the development process demonstrated the ever-increasing focus on the technical aspects of the WFDE. Furthermore, it elaborated how the involvement of many stakeholders was related to the important roles of other software instruments the WFDE was connected to. The team of experts developing the second version of the WFDE (WFDE-2) worked well together, but the management of the project was hindered by issues such as the uncertainty of financing and the lack of knowledge, as well as a lack of consensus regarding what was relevant for ecological modelling.

The development process from the start, late 2004 until October 2009, was further analysed to discover how the development process of a DSS affects the users' perception of the validity and usefulness of the DSS (chapter 5). In this context, useful information means information that would "improve environmental decision-making by expanding alternatives, clarifying choice and enabling decision-makers to achieve desired outcomes" (McNie 2007 p1), and validity means the ability of a model to represent reality correctly.

The analysis showed the complexity of balancing the various elements of developing a successful DSS. The developers had to navigate various tensions in the process. That different groups of users have different perceptions of usefulness may come as no surprise, but the case also demonstrates that different groups of experts have different notions of validity. For some, representing causal relations was essential, while others accepted statistical methods. During the development of the first version of the WFDE, the developers involved users, tried to provide useful and valid information, and considered user-friendliness, at least for the originally intended target group. The developers were clearly aware of what is conducive to a successful development process, but this is no guarantee to success.

To develop a deeper understanding of the relation between expertise and policy actor-network-theory (ANT) was applied from chapter 6 onwards. The entire nine years of developing the WFDE was analysed to determine how the WFDE targets shifted over time and why the tool is so different from what was originally planned. This analysis was centred around one of the sayings by the Janus heads, from Latour's book Science in Action: "once the machine works people will be convinced / the machine will work when all the relevant people are convinced" (Latour 1987 p10). The developers clearly wanted to make the best possible "machine". However, not all actors defined quality in the same way, so what worked for the developers did not always work for other actors.

The continuous interactions between stakeholders, documents, the WFDE itself, other instruments, etcetera, resulted in a redefinition of what the WFDE should do and for whom. The chapter demonstrates how the WFDE managed to convince some actors by enrolling new groups of actors and shifting the targets in the development process of the WFDE. Examining how the actors were connected demonstrates that they were connected through their discipline - for instance ecology - , or through specific projects, or previous employment. These relations can be stronger than the formal arrangements set on paper.

Some changes in the objectives of WFDE development were deliberate, justified by the developers as a result of new insights, a lack of accepted expertise or funding, or the acknowledgment of specific groups of users, such as waterboards' specialists. The resulting focus on technical issues, instead of the policy planning process the WFDE was intended to support, was not recognised. In addition, the various other information systems the WFDE was connected to necessitated certain properties of the WFDE, such as data formats, process structures and algorithms. In terms of ANT, the WFDE is an effect of the actor-network; both human and non-human actors shaped the WFDE.

Next, the issue of harmonisation is discussed as it is a concern for both policy and expertise, and was a concern for the WFD and the WFDE (chapter 7). Harmonisation can be defined as the process towards standardisation, or to make things comparable, while still allowing differences. The latter allows policy enforcers in the EU to assess member countries' compliance and organise bench-marking processes to stimulate the uptake of best practices, while member countries retain their autonomy in policy development. In the expertise domain, the search for the best possible representation of reality drives standardisation: standard methods for monitoring water ecology, assessing water quality and so on. Within the EU, harmonisation calls for collaboration between countries as well as within countries. In this thesis the focus is on the Netherlands.

The implementation of the WFD harmonised the practices of Dutch water quality and ecology management by imposing a new vocabulary and specific practices. The existing practices, concepts and tools were, however, not completely overturned. They also shape how the WFD is implemented in the Netherlands. The language, concepts and standards from the WFD were incorporated into procedures, tools and instruments, for example the WFDE. Some of the properties of the WFDE can be explained by the WFD; the instrument is an effect of the WFD, therefore the WFD was an actor in the development of the WFDE.

Through the WFDE, predictions based on modelling would replace the existing practice of expert judgement. Many interviewees argued that modelling was better, because of the inherent standardisation which would allow replication and retracing the logic of the results. In practice there were long debates on what was seen as relevant to include in the models. The boundaries of a problem and what factors to take into account cannot be established objectively. Similarly the issue of what are valid methods to assess the problem, and possible measures to address it, was not agreed on easily. Disagreements regarding relevance and validity were reasons for some actors to seek other instruments than the WFDE to assess measures to reach the WFD objectives.

The original purpose of the WFDE was the use by policy makers to inform stakeholder meetings and in that way allow the participants to select and interpret information, enabling them to assess the effectiveness of measures to satisfy their goals. However, it became an expert instrument, not only in the development but also in the use. The prerogative of experts to provide and interpret information for policy remained and consequently the information gap persisted.

Evidence based policy making suggests that the evidence base is developed separately from the policy, but the case of the WFD implementation in the Netherlands shows that policy shapes expertise and the other way around. In struggling with WFD's complexity, policy and expertise were often so intimately entwined that they were impossible to separate. Evidence based policy making is a difficult balancing act. It is necessary to produce the type of evidence that is useful for policy developers, so policy considerations can have legitimate influence on the evidence. However, the evidence also has to comply with scientific standards: it needs to be scientifically sound, and demonstrate that it is, to maintain its credibility.

DSSs or other information systems to support policy makers can be a means to provide evidence to policy. Models can provide insights in complex systems, but the chosen problem definition, boundaries, assumptions, the algorithms and data applied all shape the outcome. In many cases these choices are too many to be fully understood by those not directly involved in the development, which leads to opacity. It is the experts' task to communicate as well as possible the limitations of their approach, although it is not obvious how. It is important for users and developers to realise that models are not certain, neutral or innocent.

In the development of the WFDE, an important issue for some actors was the transparency of the instrument. In their view, it was vital to be able to trace how the predictions of the effects of measures were produced in order to fully justify their advice to policy makers. However, in the end the developers sacrificed transparency to what they saw as most important, the strength of the predictions. This discussion is related to the discussion of 'reversibility' in ANT. Reversibility means that the chain of evidence can be retraced from a conclusion back to the original observations or measurements to establish whether this chain is unbroken. Although many conclusions will be accepted in good faith, reversibility is an essential part of scientific practice.

ANT demands questioning assumptions on who are relevant actors, and what are practices and interactions that affect whatever it is that is studied. It also demands attention to detail. Through this detail I was able to arrive at a better understanding of the WFD policy process and the development of the WFDE. Letting go of the initial assumption that the domains of policy and expertise are essentially separate allowed me to see in what way the various actors were actually connected. In addition, the approach allowed me to see the importance of non-humans actors, such as data and information systems. They shaped in many ways the properties of the WFDE - another non-human actor - and with that, the results and the advice that is provided to policy makers.

Samenvatting

De Kaderrichtlijn Water (KRW) trad in werking in 2000 en heeft als doel de kwaliteit en de ecologie van alle wateren in de Lidstaten van de Europese Unie te beschermen en waar nodig te verbeteren. Om aan de nieuwe eisen die deze Europese wet stelt te kunnen voldoen, werden in Nederland nieuwe methoden, technieken en (beleids)instrumenten voor waterbeheer ontwikkeld. Hiermee moesten de huidige toestand van de wateren, evenals de kosten en effecten van eventuele maatregelen, kunnen worden bepaald.

De KRW is een voorbeeld van 'evidence based policy making', dat wil zeggen beleid dat wordt gebaseerd op het best mogelijke bewijs met de bedoeling de effectiviteit van dat beleid te vergroten. De Europese Unie en vele landen van de wereld hebben deze visie op beleidsontwikkeling omarmd. Het bewijs wordt in veel gevallen geleverd door experts. Het ideaalbeeld van experts en expertise is dat deze onpartijdig zijn en dus onafhankelijk van enig beleid dat er een uitvloeisel van zou kunnen zijn. In de praktijk is de relatie tussen beleid en expertise echter niet zo eenduidig, wat in dit proefschrift ook zal blijken.

De experts waarover dit proefschrift gaat, werken in (toegepast) onderzoeksinstituten, bij ingenieursbureaus en waterbeheerorganisaties. Expert zijn of hebben van expertise is geen absoluut, maar een relatief fenomeen. Iemand kan een expert zijn op één gebied, maar niet op een ander. Op ieder gebied wordt de mate van expertise bepaald door een vergelijking met de expertise van anderen. Mijn proefschrift laat hopelijk zien dat ik meer expertise heb op het gebied van de implementatie van de KRW dan de meeste mensen, maar sommige anderen hebben zeker meer expertise dan ik op het gebied van de juridische of uitvoerende kant van de KRW of het meten van de huidige toestand van de wateren.

Een manier om expertise toegankelijk te maken voor beleidsontwikkeling is via het gebruiken van een zogenaamd beslissingsondersteunend systeem (BOS, in het Engels DSS). BOSsen zijn softwareproducten die gebruikers helpen om een beslissing te nemen door inzicht te geven in de effecten van maatregelen. Ze bestaan in de regel uit een of meer modellen en bieden mogelijkheden om verschillende beleidsmaatregelen met elkaar te vergelijken. In dit proefschrift staat de uitvoering van de KRW in Nederland en daarbij de ontwikkeling van een BOS, genaamd de KRW Verkenner, centraal. Ik verwijs steeds naar dat specifieke BOS met de Engelse afkorting ervoor, de WFDE.

Dit proefschrift levert een bijdrage aan het debat over de zin en onzin van 'evidence based policy making' door een dieper inzicht te geven in de relatie tussen de domeinen van expertise en beleid en de rol van BOSsen als bemiddelaar tussen deze domeinen. In de loop van het onderzoek heb ik daaraan een onderzoekstechnische doelstelling toegevoegd, namelijk de vraag of 'Actor-Network-Theory' (ANT) een zinvolle bijdrage kan leveren aan onderzoek op dit gebied. Het proefschrift is gebaseerd op beleidsdocumenten, projectdocumenten, 42 interviews en observaties van 30 bijeenkomsten met betrekking tot de ontwikkeling van de WFDE. Het materiaal is in hoofdzaak geanalyseerd met gebruikmaking van Atlas.ti, een softwarehulpmiddel dat de analyse van kwalitatieve data ondersteunt. In hoofdstuk 2 ga ik hier dieper op in.

In hoofdstuk 3 begin ik met de inhoudelijke kant van het proefschrift. Allereerst wordt de uitvoering van de KRW in Nederland beschreven, met als belangrijkste vraag of de KRW bijdraagt aan het bereiken van een meer integraal waterbeheer. Hoewel op papier het Nederlandse planproces van de

KRW de integratie zowel op verschillende schaalniveaus als tussen sectoren bevordert, blijkt in de praktijk dat de integratie van sectoren beperkt was. Zowel op Nederlands als op Europees niveau botst de KRW met het landbouwbeleid. Op beide niveaus is gekozen het landbouwbeleid onveranderd te laten, waardoor de KRW-doelstellingen eigenlijk niet af te dwingen waren. Op regionaal en lokaal niveau binnen Nederland hadden de verantwoordelijke waterbeheerorganisaties niet de bevoegdheden om maatregelen te nemen die andere sectoren aangingen. Aangezien er geen lokale of regionale autoriteiten waren (en zijn) voor landbouw, natuur of industrie was het moeilijk om op dat niveau goede partners te vinden om integraal beleid mee te ontwikkelen. Bijna alle maatregelen in het kader van de KRW werden uiteindelijk door de waterschappen en Rijkswaterstaat genomen. Voor de landbouwsector heeft de invoering van de KRW - behalve incidentele vrijwillige maatregelen - geen gevolgen gehad, ondanks het feit dat de huidige landbouwpraktijk een van de belangrijkste belemmeringen is voor het behalen van de KRW-doelstellingen.

De KRW introduceerde nieuwe eisen aan het beheren van de waterkwaliteit en –ecologie met nieuwe begrippen en nieuwe standaarden waaraan voldaan moest worden. Die begrippen en standaarden werden uitgewerkt door experts van verschillende onderzoekinstituten, ingenieursbureaus en waterbeheerorganisaties, terwijl ondertussen ook de eerste planronde voor de KRW werd uitgevoerd. De technische aspecten van de uitvoering van de KRW overschaduwden de discussies over wat een wenselijke staat van de wateren zou zijn en wat partijen daarvoor zouden willen doen of laten. De technische insteek van de uitvoering van de KRW zorgde er ook voor dat deze gedomineerd werd door experts. Belangenorganisaties waren niet altijd in staat de technische debatten te voeren en vertegenwoordigd te zijn op de vele besprekingen.

Om de rol van expertise verder uit te diepen gaat hoofdstuk 4 in op de ontwikkeling van het beslissingsondersteunend systeem, de WFDE. Dit hoofdstuk is gebaseerd op het analyseren van documenten en interviews. Bij de start van de ontwikkeling van de WFDE waren er twee doelstellingen. Het zou een eenvoudig te gebruiken, interactief systeem worden dat belanghebbenden tijdens besprekingen direct informatie zou verschaffen over de verwachte effecten van voorgestelde maatregelen. Hierdoor zouden de deelnemers meer inbreng krijgen in de besluitvorming en minder afhankelijk worden van expertadviezen. Verder zou het systeem een gedeelde kennisbasis worden voor de waterbeheerders. Dit hoofdstuk gaat uitgebreid in op de verschillende bijdragen van de betrokken partijen en hun betrokkenheid bij verschillende andere softwarepakketten.

Mijn beschrijving van de ontwikkeling van de WFDE laat zien dat de technische aspecten van het instrument steeds belangrijker werden gevonden en dat de bijdrage die het systeem aan het besluitvormingsproces zou leveren daaraan ondergeschikt werd gemaakt. Na een evaluatie in 2009 werd de WFDE compleet opnieuw ontwikkeld. Het projectteam voor deze herontwikkeling bestond uit experts van verschillende organisaties die goed met elkaar samenwerkten. De aansturing van het project werd echter gehinderd door de onzekerheid van de financiering, het gebrek aan beschikbare kennis op het gebied van ecologie en verschillende inzichten over welke aspecten essentieel waren voor met name het ecologisch model in de WFDE. In 2013 was het resultaat een systeem dat de effecten van maatregelen kon doorrekenen, maar dat zo ingewikkeld was dat alleen experts het nog konden gebruiken.

Hoofdstuk 5 analyseert de ontwikkeling van de WFDE tot eind 2009 om te ontdekken hoe in het ontwikkelproces ideeën van de gebruikers over validiteit en bruikbaarheid van de informatie geleverd door het BOS gevormd en veranderd werden. In dit verband verwijst validiteit naar het vermogen van het systeem de werkelijkheid juist weer te geven. Bruikbare informatie is die informatie die besluitvorming op verschillende manieren kan verbeteren: verbreden van alternatieven, verhelderen van keuzes en mogelijk maken om doelen te behalen

De analyse laat de complexiteit zien van het balanceren van de verschillende aspecten van het ontwikkelen van een BOS. De ontwikkelaars moesten laveren tussen de verschillende spanningsvelden in het proces. De verschillende groepen gebruikers hadden verschillende percepties van bruikbare informatie en verschillende groepen experts verschilden van inzicht over wat een valide representatie van de werkelijkheid was. Voor sommige experts was het essentieel dat de modellen opgebouwd werden uit oorzaak-gevolgrelaties die de natuurlijke processen weergaven, terwijl anderen statistische relaties acceptabel vonden. Tijdens de ontwikkeling van de eerste versie van de WFDE betrokken de ontwikkelaars gebruikers bij het ontwikkelen van valide en bruikbare informatie en het realiseren van de gebruikersvriendelijkheid van het product. De ontwikkelaars waren zich terdege bewust van wat er nodig was voor een succesvol ontwikkelingsproces, maar dit bewustzijn bleek geen garantie voor succes te zijn. Een belangrijke doelgroep van de WFDE, de waterschappen, bleek ontevreden. Daarom werd de WFDE na 2009 opnieuw ontwikkeld.

Om een dieper inzicht in de relatie tussen expertise en beleid te ontwikkelen is vanaf hoofdstuk 6 Actor-Netwerk-Theorie gebruikt. Ten eerste is de hele periode van de ontwikkeling van de WFDE geanalyseerd om na te gaan hoe de doelen van het instrument in de loop van de tijd veranderden en waarom het instrument zo anders is geworden dan oorspronkelijk bedoeld. Deze analyse draait om een van de paradoxen van de Janushoofden van Latour: als de machine werkt, zullen de mensen overtuigd zijn/de machine zal werken als alle relevante mensen overtuigd zijn. De these van deze paradox is dat het werken van een machine niet een objectief vast te stellen toestand is, maar dat er meerdere mogelijke toestanden zijn die, afhankelijk van opvattingen van mensen, al dan niet werkend genoemd worden. Voor de WFDE gold dat de ontwikkelaars binnen de beperkingen die ze hadden de best mogelijke machine wilden opleveren. Echter, niet alle actoren definieerden kwaliteit op dezelfde manier. Wat voor de ontwikkelaars werkte, werkte niet voor alle betrokkenen.

In termen van ANT is de WFDE een uitkomst van het actor-network, dat bestaat uit menselijke en niet-menselijke actoren die samen de WFDE vorm hebben gegeven. De voortdurende interacties tussen betrokkenen, documenten, de WFDE zelf, andere instrumenten, enzovoorts, hadden als resultaat dat wat de WFDE voor wie moest doen steeds opnieuw werd bepaald. Hoofdstuk 6 laat zien hoe de WFDE in staat was bepaalde actoren te overtuigen door bijvoorbeeld nieuwe doelgroepen aan te trekken of door de doelstellingen van de WFDE aan te passen. Door de aard van de verbindingen tussen actoren na te gaan werd duidelijk dat menselijke actoren verbonden waren door de disciplines waarin zij werkten, door gezamenlijke projecten, eerder werk en de softwareontwikkeling waarbij ze betrokken waren. Deze relaties kunnen sterker zijn dan de formele banden die op papier staan.

Sommige veranderingen in de doelen van de WFDE werden bewust gerealiseerd en verantwoord door de ontwikkelaars door te verwijzen naar nieuwe inzichten, ontbrekende kennis of financiering, of om bepaalde groepen gebruikers tegemoet te komen, zoals de specialisten bij de waterschappen.

Dat het resultaat was dat de focus steeds meer op de technische specificaties van het instrument kwam te liggen, werd niet onderkend. De doelstelling een instrument op te leveren dat het besluitvormingsproces zou kunnen ondersteunen verdween langzaam uit beeld. Ook werd het aantal andere softwarepakketen waaraan de WFDE verbonden was steeds groter. Deze verbindingen stelden allemaal hun eisen aan gebruikte formats, processtructuren en algoritmes.

Hoofdstuk 7 bespreekt het concept harmonisatie, aangezien dat een relevant concept is voor zowel het domein van beleid als van expertise. Harmonisatie kan op verschillende manieren worden gedefinieerd. Het kan een eerste stap zijn op weg naar standaardisatie, door zaken vergelijkbaar te maken, maar (nog) niet gelijk. Harmonisatie kan ook een doel op zich zijn, bijvoorbeeld voor de Europese Unie. Harmonisatie van wetgeving, normen, standaards enzovoorts stelt de Unie in staat te toetsen of aan de gestelde eisen voldaan wordt en er een gelijk speelveld is tussen de landen. De specifieke invulling kan per land verschillend zijn en daarmee behouden de landen hun autonomie in het ontwikkelen van nationaal beleid. Ook in de wetenschap wordt gestreefd naar harmonisatie, of naar standaardisatie. De wetenschap streeft bijvoorbeeld naar standaardisatie van eenheden, zoals voor temperatuur. De wetenschappelijke standaard is dat temperatuur wordt gemeten in graden Kelvin, terwijl in Nederland graden Celsius wordt gebruikt. Door omrekenmethodes worden deze eenheden vergelijkbaar gemaakt.

Binnen de EU vereist harmonisatie samenwerking tussen de lidstaten en ook binnen de lidstaten om wetgeving, procedures en normen op elkaar af te stemmen. Dit proefschrift betreft alleen de harmonisatie als gevolg van de invoering van de KRW in Nederland. Door de uitvoering van de KRW zijn een aantal Nederlandse praktijken op het gebied van waterkwaliteit en ecologie geharmoniseerd, doordat nieuwe begrippen en daarbij behorende specifieke procedures en praktijken werden geïntroduceerd. De bestaande praktijken, begrippen en instrumenten werden echter niet geheel verlaten. Deze hebben ook een stempel gedrukt op hoe de KRW is uitgevoerd. De taal, begrippen en standaarden van de KRW zijn onderdeel geworden van procedures, hulpmiddelen en instrumenten, zoals de WFDE. Een deel van de eigenschappen van de WFDE kan worden verklaard uit de KRW: het instrument was een gevolg van de KRW, dus was de KRW ook een actor in de ontwikkeling van de WFDE.

Het gebruiken van modellen als de WFDE zou de bestaande praktijk van 'expert judgement' (het oordeel van de expert) moeten vervangen. Veel van de geïnterviewden betoogden dat het gebruiken van modellen beter was, omdat dat gepaard gaat met standaardisatie, waardoor resultaten herhaalbaar en navolgbaar zijn. In de praktijk bleek dat er lange debatten waren over wat er wel en niet in de modellen moest worden opgenomen. De grenzen van het vraagstuk en welke factoren relevant zijn, bleken niet objectief te bepalen. Dit gold ook voor de vraag welke methoden valide waren om tekortkomingen in een watersysteem en mogelijke maatregelen te beoordelen. Onenigheid over de relevantie en validiteit van de modellen in de WFDE waren voor sommige actoren reden op zoek te gaan naar andere instrumenten om mogelijke KRW-maatregelen te kunnen onderzoeken.

Uit her voorafgaande trek ik een aantal conclusies. Allereerst was het oorspronkelijke doel van de WFDE om gebruik door beleidsmakers tijdens bijeenkomsten met betrokkenen mogelijk te maken, zodat de deelnemers zelf informatie zouden kunnen selecteren en interpreteren. Zoals gezegd werd de WFDE uiteindelijk een instrument dat alleen door experts gebruikt kon worden. Daarmee behielden de experts hun dominante positie ten aanzien van de informatievoorziening voor besluitvorming, terwijl de informatieachterstand van andere betrokkenen bleef bestaan.

Ten tweede suggereert evidence based policy making dat de voor het beleid benodigde kennis onafhankelijk van het beleid kan worden ontwikkeld. De analyse van de invoering van de KRW in dit proefschrift laat echter zien dat het beleid en de kennis elkaar wederzijds beïnvloedden. In de worsteling met de complexiteit van de KRW waren beleid en kennisontwikkeling vaak zo verstrengeld dat ze niet meer uit elkaar te halen waren. Ik suggereer dat evidence based policy making het zoeken van een balans is tussen het produceren van kennis die relevant is voor het beleid, terwijl de wetenschappelijke standaarden niet uit het oog verloren mogen worden.

BOSsen en andere informatiesystemen om beleidsmakers te ondersteunen kunnen een methode zijn om kennis in te brengen in beleidsontwikkeling. Modellen kunnen inzichten genereren in complexe systemen, maar alle betrokkenen moeten zich realiseren dat de gekozen probleemdefinitie, afbakening, aannames, algoritmes en gebruikte data allemaal invloed hebben op de uitkomsten van de modellen. Vaak zijn er teveel keuzes gemaakt om door anderen dan de ontwikkelaars te kunnen doorzien. Het is de taak van de experts duidelijk te maken wat de beperkingen zijn van de gekozen aanpak, maar dat is gemakkelijker gezegd dan gedaan. Het is van belang voor gebruikers en ontwikkelaars dat modellen niet zomaar zeker, neutraal of onschuldig worden gevonden of gemaakt.

In de ontwikkeling van de WFDE was voor een deel van de betrokkenen de transparantie van het instrument essentieel om te kunnen verantwoorden hoe hun advies tot stand was gekomen. Het debat over transparantie sluit aan bij het debat over 'omkeerbaarheid' binnen ANT. Omkeerbaarheid verwijst naar de eis dat de hele keten van bewijsvoering in de wetenschap omkeerbaar moet zijn: alle stappen in de bewijsvoering moeten teruggezet kunnen worden om na te gaan of de keten als geheel houdbaar is. Dit betekent niet dat alle stappen voortduren opnieuw bekeken (moeten) worden - sommige stappen zijn geaccepteerde feiten - maar indien gewenst moet het wel mogelijk zijn. Omkeerbaarheid of transparantie is een essentieel onderdeel van het wetenschappelijk bedrijf. Uiteindelijk kozen de ontwikkelaars van de WFDE voor wat zij als belangrijkste zagen, namelijk de betrouwbaarheid van de voorspellingen van het model. Deze keuze ging ten koste van de transparantie wat betreft de werking van het model.

Door het nauwkeurig analyseren van details en vele lijnen van interpretatie te volgen in het ontwerpproces van de WFDE was ik in staat een diepgaand inzicht te verwerven in de ontwikkeling van de WFDE en de beleidsontwikkeling voor de KRW. ANT vraagt de onderzoeker om aannames over wie de relevante actoren zijn en welke praktijken en interacties bestudeerd moeten worden zoveel mogelijk los te laten. Door het proces te onderzoeken met een hoge mate van detail komen deze actoren, praktijken en interacties pas naar voren. Het loslaten van de aanname dat beleid en kennisontwikkeling los van elkaar plaatsvinden heeft me in staat gesteld de vele verbindingen te zien. Verder heeft ANT me ook helpen realiseren hoe belangrijk niet-menselijke actoren, zoals data en informatiesystemen, zijn. Niet alleen hebben dergelijke actoren op vele manieren een andere niet-menselijke actor vormgegeven, maar daarmee hebben ze ook de resultaten en de adviezen die aan beleidsmakers worden geleverd beïnvloed.

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Chapter 1

Introduction

1.1 The Water Framework Directive

In 2000 the Water Framework Directive (WFD) came into force. This European Union (EU) directive aims to protect and restore water quality and ecology in all waters in EU Member States. Like other EU regulations, the WFD also contributes to legal harmonisation between the Member Countries to ensure a level playing ground for all businesses in the EU.

The implementation of the WFD requires the collaboration of a large number of parties, as an integrated approach at river basin level and the active participation of stakeholders are mandatory. Extensive scientific and technical knowledge was needed to establish the current status of the surface and ground waters in all member states and to assess the effects possible solutions were expected to have on the quality and ecology of those waters. As this knowledge was not all readily available, parallel to the first round of WFD planning between 2000 and 2009, many scientific questions needed to be resolved.

The implementation of the WFD can be characterised as evidence based policy making, an approach that is embraced by the EU (Lee and Kirkpatrick 2006; European Commission 2015). The preamble to the Water Framework Directive states that "the Community is to take account of available scientific and technical data" (2000/60/EC; WFD, consideration). The approach resulted from the political appeal for policy that "works" (Davies et al. 2000; Bullock et al. 2001; Banks 2009). Evidence based policy making supports "rational development of public services" by supplying "evidence" on "what interventions or strategies should be used to meet the goals and satisfy the client needs" (Davies et al. 2000 p3). Once goals and client needs are defined (in a separate process), evidence from a variety of sources should show whether the policies developed were effective - or would be effective - to reach those goals and to meet those needs (Bullock et al. 2001). The UK cabinet office listed these sources of evidence as follows: "expert knowledge; existing domestic and international research; existing statistics; stakeholder consultation; evaluation of previous policies; new research, if appropriate; or secondary sources, including the Internet". Evidence regarding the effectiveness of measures "can also include analysis of the outcome of consultation, costings of policy options and the results of economic or statistical modelling" (The UK cabinet office, 1999, cited in Davies et al. 2000 p23).

In practice, policy making is often supported by so-called decision support systems (DSSs), which can be defined as "interactive, computer-based systems, which help decision makers use data and models to solve unstructured problems" (Gorry and Morton 1971, quoted in Turban and Aronson 2001, p13). In other words, DSSs are software tools – often containing one or more models – that provide insights in societal problems and the possible solutions for these problems. As the 'best' option depends on the values used to judge the quality of presented solutions, true DSSs should allow decision makers to include these values such as costs, political objectives or feasibility.

In order to support WFD implementation in the Netherlands, the WFD Explorer (WFDE) was developed. The WFDE was originally positioned as a DSS that would support the implementation of the WFD by offering policy makers the option to discover the effects of possible measures. This would allow selection of more promising measures before actual implementation of these measures. The WFDE development started late 2004, when both the exact form and time-frame of the planning process for the implementation of the WFD and the technical procedures to analyse the water systems were not yet known. In the second round of WFD planning, after 2009, the WFDE underwent a process of redesign. As I will show in the thesis, this redesign changed the WFDE from a DSS into a modelling instrument for experts.

1.2 This thesis: experts supporting policy makers

Evidence – and the expertise that produces it – is, not surprisingly, crucial in evidence based decision making, but policy makers often express concerns about a lack of readily available, accessible and understandable expertise. “Whichever part of the public sector one is concerned with, one observation is clear: the current state of research based knowledge is insufficient to inform many areas of policy and practice” (Nutley et al. 2002). In most cases different disciplines are involved and the relation between these fields of expertise is often unclear. Meanwhile, the experts who want to support policy makers frequently express their disappointment that the elegant solutions they have developed are not being used by policy makers to solve problems in practice. Money and time would be wasted on measures that are not ‘rational’ or ‘optimal’ for stated objectives, or good alternatives ignored due to a lack of knowledge.

To denote the situation in which science and policy are insufficiently connected, the term science-policy gap is often used (Quevauviller et al. 2005; Spruijt et al. 2014). A major solution to fill this gap would actually be the use of decision support systems (DSS). There is no lack of studies providing recommendations on how to develop a DSS to bridge this gap and how to structure the process of development itself (for example: Borowski and Hare 2005; Jakeman et al. 2006; McIntosh et al. 2011). The relation between the users and the developers is often seen as crucial. The expertise provided has to correspond with the needs of the users and the policy process they are involved in. That seems obvious, but this statement is too general to help developers and users improve the development process. So far DSSs have not been very successful in bridging the science-policy gap, but it remains unclear why.

As both evidence based policy making and the role of DSSs are not fully understood yet, in this thesis I aim to provide a deeper understanding of the concept of evidence based policy making, more specifically the relation between the policy and expertise domains and the role of DSSs as an intermediary between the two.

Halfway through the thesis work, I decided to incorporate the methodological and philosophical research approach Actor-Network-Theory (ANT) to re-examine the relation between the policy domain and expertise domain. This led to a second aim of the thesis: assessing the contribution of Actor-Network-Theory to policy analysis and policy support tools.

In the individual chapters appropriate theoretical concepts will be elaborated, but before moving to those, in the next paragraphs I will offer a brief overview of debates on selected concepts that informed the presented thesis. I will revisit these debates in the conclusion. This chapter will end with an outline of the thesis chapters.

1.3 Experts and expertise

What makes an expert an expert? There is no objective way to determine who is, and who is not, an expert (Jasanoff 2003 p394). A simple definition of experts is that experts are persons with expertise. Expertise is the specific knowledge, experience and skills that experts have in their field. It is important to add "in their field", as experts are obviously not knowledgeable about everything. "Expertise is not merely something in the heads and hands of skilled persons, constituted through their deep familiarity with the problem in question, but it is something acquired and deployed, within particular historical, political, and cultural contexts" (Jasanoff 2003 p393). Jasanoff emphasises here that expertise is always a product of the environment in which it was developed, taught and used.

Another simple definition is that experts are those that are perceived as experts. Being an expert is not an absolute, but a relationist concept. Whether one is perceived as an expert or not is decided in relation to others: one can be an expert in relation to one group and an amateur in relation to another. Collins and Evans (2008) distinguish a number of levels of expertise such as "interactional expertise" for someone who knows enough to discuss issues with the 'true' experts and "contributory expertise" for those who are at the forefront of their fields. Although these levels of expertise are recognisable, they are again not absolute but determined by the comparison with others. They do not solve the issue of how to recognise the 'true' expert.

This leads to the next question: why are experts perceived as experts? One expert may recognise another easily if the field of expertise is close: an expert is someone who knows as much as or more than they do, for instance. Or one relies on titles - symbols for acceptance in the scientific community - or reputation, number of peer reviewed papers and so on. Expertise can not only be found in scientific circles, as has been noted by many authors (for instance Wynne 1992). For example, farmers can develop an intimate knowledge of the local conditions, weather patterns and what not, based on their daily experiences. Similarly, avid bird watchers may distinguish hundreds of birds based on their calls and may have vital expertise to share for instance with nature conservationists.

Although experts are often equated with scientists, in this thesis most of the experts would not be considered scientists, though most do have an academic degree and all would say they apply scientifically grounded knowledge and methods. A common trait of all experts in this thesis is that they apply their expertise to analyse or solve some problem or issue in society.

One group of experts works at applied research institutes and consultancies. They consider themselves applied scientists, engineers, modellers; or more specifically ecologists, hydrologists, water systems analysts, water quality analysts; or even more specifically, specialist on fish in shallow lakes. Although in some cases they do perform original research as well, most of their work consists of applying scientific knowledge.

The second group of experts in this thesis are staff at (water) authorities who are employed for their specific disciplinary expertise and they too apply scientific knowledge, but they are involved in the management of a specific water system. They consider themselves to be engineers, hydrologists, ecologists, and so on.

A third group of experts are the policy advisors at the (water) authorities. They apply their more general knowledge of the water system together with their expertise of policy processes or management to solve societal issues. Some also have background in a specific water-related discipline and continue to work in that discipline as well.

1.4 EXPERTISE AND POLICY

Although nobody can be against using evidence to support policy decisions, how to do so is less evident: "the simple and unproblematic models of EBPP[1] – where evidence is created by research experts and drawn on as necessary by policy makers and practitioners – fail as either accurate descriptions or effective prescriptions"(Nutley et al. 2002) The evidence based policy approach can be seen as a revival, or continuation, of earlier interests in improving the quality of policy by using knowledge in a broad sense (Solesbury 2001). Its focus on effectiveness raises concerns regarding instrumental rationality and technocratic politics (Sanderson 2002). Sanderson's concern is that measures may be chosen because they are thought to produce the objectives, regardless of whether society deems them appropriate, which could devalue the ethical and moral dimensions of policy making. "We are re-engaging in long-standing debates about knowledge and power, rationality and politics, democracy and technocracy" (Solesbury 2001 p4).

Science is quite often seen as a "source of facts and theories about reality that can and should settle disputes and guide political action" (Sarewitz 2004 p386). The ideal image of expertise - not only scientific expertise - for policy is for many that its advice should be impartial, indifferent to any policy that may be developed based on it. For this to be possible the knowledge needs to be developed independently from the policy demands. This ideal is reflected in the term 'speaking truth to power'(Wildavsky 1989; for more discussion see also Hoppe 1999; Jasanoff 2003). Science would in this positivist view have the authority to settle disputes on the facts.

In many cases, however, science would not have taken up the policy issues without being specifically asked to do so by the policy domain. Science usually prefers variables of interest that can be adequately isolated, whereas in 'real world problems' that is often hard or impossible. Furthermore, policy issues often do not fall within the limits of one specific discipline and the different disciplines may come up with contradicting advice, based on the accepted practices in their disciplines (Yearley 2005). The debates on the scientific evidence can be used politically (i.e. Nelkin 1975), as is reflected in the term 'expertise as ammunition' (Van Bommel 2008). So knowledge can be a source of power, but can also be used by the powerful to advance their interests.

[1] EBPP evidence based policy planning

In positivism expertise is viewed as unproblematic, but science and technology studies (STS)[1] have long showed differently. In her response to Collins and Evans' (2002; 2003) criticism on science studies, Jasanoff (2003 p392) states that science studies aims to explain the origin of the power science has in society. One line of enquiry concerns the nature of science and technology. Latour (1987), for instance, analysed how scientists construct facts through a lot of work enrolling measurements, instruments, colleagues, adversaries and so on. Nature does not decide on the facts; facts are the result of closing controversies. Importantly, the value of knowledge is determined by larger groups of people, based on relations of trust (Yearley 2005 p110). Bijker (1997) focussed on technology. He established that it is not the superiority of the technology in itself that produces its success, and that technology and users co-evolve. For example, because of the modern "safety" bicycle, with two equally sized wheels, new users such as women and delivery boys started cycling and cycling became a means of transport instead of a sport.

Another line of enquiry focusses on the role of science and technology in society. Nelkin (1975), for example, looked at scientific advice for policy and showed how different problem descriptions can produce very different outcomes that can all be scientifically correct, but can serve very different interests. Wynne (1992) demonstrated how scientific facts can be scientifically correct, but locally invalid. Another view is that science developed in the lab cannot always be used reliably in the outside world as conditions may differ too much. Communication on these facts without providing the necessary insights in their limitations can lead to inappropriate policy advice and loss of trust in science. Furthermore, other groups (in Wynne's case farmers) may have knowledge that is very valuable, but is not heeded. Jasanoff (2010) also looked at the issue of trust. Analysing the use of science in the climate change debate, she argues that in this debate knowledge is detached from meaning; whereas science is based on "detached observations, meaning emerges from embedded experience" (Jasanoff 2010 p235). This explains to some extent the scepticism science encounters there. In addition, with current mass communication technology, "… people can exercise far more choice in deciding whose claims to believe…" (Jasanoff 2010 p239)

The above brief summaries do not do justice to the diversity, and internal debates, of science and technology studies, but do indicate that the relation between science and society, of which policy is a part, is much more complicated than the positivist view would suggest. It draws attention to other forms of knowledge and issues of trust and credibility when dealing with policy or the general public. It also questions the existence of a knowable outside reality and the authority of science. "Expertise is neither neutral nor innocent with respect to the allocation of power" (Jasanoff 2003 p397).

1.5 Decision Support Systems (DSS), Models and modelling

As in this thesis decision support systems (DSS) are looked at as intermediaries between the domain of expertise and policy, I end the introduction with an exploration of the terms DSS and model. In environmental modelling, models are used to predict all sort of things, such as the weather (for the practice of weather prediction, see Fine 2009), floods or climate change (for climate modelling see

[1] I use the term STS as an overarching term that includes science studies, sociology of scientific knowledge, sociology of science and the sociology of technology.

Edwards 2010; Petersen 2012). For policy makers, models can be useful if they can predict the effect of (policy) measures on the phenomena the policy engages with. To this end decision support systems (DSSs) are developed. The first part of this introduction already provided a definition of DSSs, arguing that DSSs are software tools – often containing one or more models – that provide insights in societal problems and the possible solutions for these problems, and help policy makers to make decisions regarding this problem.

DSSs are part of the information systems (IS) discipline. “Essentially, DSS is about developing and deploying IT-based systems to support decision processes” (Arnott and Pervan 2008 p 657). More specifically, decision support systems are “computerized information systems designed to help decision makers and stakeholders define and discuss different problems and come up with various solutions and paths to take. DSS (sic) typically take (sic) use of different criteria, show the interrelations among multiple criteria, and also enable a comparison of the results” (Horlitz 2007 in Andersson et al. 2012 p544). Decision support systems generally include some form of model that represents (part of) the workings of the system that is pertinent to the decisions at hand. Very importantly, but not often discussed in the literature, they require data to be operated.

‘Model’ can mean any number of things (see for instance Kouw 2012). Well-known types of models are scale-models, such as model trains, cars or houses that replicate the properties of existing objects, only much smaller. In science, physical models are used as a means to study processes, for instance by using scale models of rivers to study flow patterns or sedimentation. A model can also be a conceptual model describing a system in words or equations.

Models are artefacts that represent (part) of reality. Models are always made for a specific purpose, scientific understanding for instance. They can also be a means to design another model, or to develop an artefact such as a dam or a factory, or to develop policy that subsequently leads to actions that change the described reality. Sjoerd Zwart (2015 p271) discusses the “cascade of mean-end relations” and proposes a “two-level description” separating the model itself and the uses of the model. When a model travels between science and policy it can be seen as a “boundary object”, an object that spans two domains, and is a means to exchange and discuss ideas and values pertinent to these domains (Star and Griesemer 1989). The discussion on the use of the word model in section 2.5 provides an example of this concept.

In this thesis models are mathematical representations of (water) systems on computers, in other words computer models. Models in science and engineering can be made to serve a number of different functions. Luciano Raso wrote: “A model is a mathematical object that mimics reality in order to make predictions by quantifying some variables of interest” (Raso 2013 p 3). He continues by explaining how a physical system can be analysed, how sub-systems can be modelled and then integrated into a larger model. His emphasis is on ‘mimicking reality’ to ‘predict the future’. The assumption is here that from equations representing the processes currently at work in the system at hand, we can infer information on how the system will function in the future. The model does not necessarily entail the entire system, only ‘some variables of interest’. How or by whom these variables are chosen Raso does not elaborate.

Shervan Gharari describes models first as “an encapsulated form of our knowledge“ (Gharari 2016 p 2). Two paragraphs later he states models are the “brainchild of modellers on how a real system might work” (Gharari 2016 p 3). He continues to explain that models are sets of hypotheses that can (or often cannot, according to him) be tested and proven right or wrong. Models can have multiple functions: they can be a materialisation of existing knowledge that can be used for example for predictions, or they can be a means to develop new knowledge. In many cases they are a combination of what is perceived as ‘knowledge’ and what is perceived as ‘assumptions’ based on expert judgement or ‘hypotheses’ that can be tested. This means that modelling is also a craft or a skill (Fine 2009; Edwards 2010; Kouw 2012). What is applied is not only active knowledge, but also tacit knowledge, experience and a measure of creativity. Modelling is also a located practice (Suchman 2002), meaning that the manner in which existing standards, techniques and methods are applied differs according to where the practice takes place.

One way of developing new knowledge through modelling is by doing experiments when experiments with the actual system are not possible, for instance experimenting with dyke breaches in inhabited areas. Furthermore, models can be used to do experiments based on equations that are too complex to handle without computers. Models based on equations that cannot be solved analytically are often called ‘simulation’ (Frigg and Reiss 2009).This is, for example, the case in climate modelling (see for instance Edwards 2010; Petersen 2012). The models discussed in this thesis represent existing knowledge. Not all relations pertinent to the modelled systems are known, however, so approximations, assumptions or work-arounds are used.

An important distinction for this thesis is between the conceptual ‘bucket’-type models, that reduce a water system to a number of theoretical units, buckets, and ‘physically-based’ or ‘deterministic’ models, that more realistically mimic the processes in the physical system.

Ending this introduction I return to Raso, who specifically focusses on models for decision support: “Models are used to build up knowledge providing the information on how the decision u affects the output y” (Raso 2013 p 4), whereby u and y are supposed to be variables “meaningful to the stakeholders”. In this one sentence he combines two possible objectives of modelling for decision support: accumulating knowledge and giving information; both these functions play a part in the development of the WFDE, as this thesis will show. Furthermore, he suggests that the target audience should in some way determine what is taken into account in the modelling process. He also touches on another important function for models and that is prediction. Predicting the effect of policy measures is often what the policy makers hope a model can do for them and that is why these models are such an important element of DSSs.

1.6 Thesis outline

The next chapter elaborates the research approach and provides details regarding the collection and analysis of my data. The analysis of interviews and project documents was to a large extent performed using a computer-assisted qualitative data analysis system.

In chapter 3, I discuss the WFD and its implementation in the Netherlands. The chapter details the institutional and organisational arrangements and whether they promote the integration of different levels of government and the different sectors responsible for the quality and ecology of the water system. The postscript describes the role of expertise in the WFD planning process.

In the following chapter (4), I move from the policy domain to the expertise domain through a description of the practice of developing the decision support system WFDE over nearly nine years.

In the next two chapters I dive deeper into the actual development process of the WFDE. First, chapter 5 analyses how, throughout the development process of the instrument, users and developers had different perceptions on useful information and validity.

Second, chapter 6 examines how the objectives for the WFDE shifted through the interactions between actors and non-human actors. It covers the whole period of developing both the first and second WFDE and provides an understanding of why the redesigned instrument (WFDE-2) turned out to be so different from the originally proposed instrument.

Chapter 7 demonstrates how policy and expertise interact for the implementation of the WFD in the Netherlands. The chapter is arranged around the issue of harmonisation that is important to both policy makers and experts.

In the concluding chapter (8), I weave the various strands of the discussions together to reflect on the overarching topics of this thesis.

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Chapter 2

Research approach and methods

As indicated in the introduction, this thesis concerns the relation of experts and expertise with policy making. Its focus is on the development of a decision support system (DSS) - or modelling instrument - as a materialisation of expertise, and related policy. Data was collected concerning the implementation of the Water Framework Directive (WFD) in the Netherlands and the development of a DSS called the WFD Explorer (WFDE), developed to support the implementation.

2.1 INTRODUCTION

This chapter explains what I did, and how and why I did it, to enhance the credibility of the research by demonstrating methodological awareness (Seale 1999). In addition, it hopes to provide support to others who want to apply qualitative methods. Bryman (2008) describes qualitative research simply as being more concerned with words than with numbers. This very broad definition allows for different traditions of qualitative research (Bryman 2008 p366). While qualitative, or interpretative, research is widely used in health and nursing-related fields (Silverman 2013), it is not common in water management studies. Although interesting examples certainly exist (for example Van Bommel 2008; Van den Brink 2009; Heems and Kothuis 2012; Kaspersma 2013), the possibilities provided by this approach are not always recognised within 'mainstream' water management research.

Each of the following paragraphs will address the questions: what is the value of this approach or method for this research, what did I do and why did I do it that way? The first section discusses the general research approach used (2.2), including the issue of quality in qualitative research. Next, the methods of collecting data, as well as the value of the data, will be discussed (2.3). The next section concerns the process of analysis and the application of computer-assisted data analysis, by means of Atlas.ti (2.4). The chapter concludes with an example of part of the research approach in practice, to stimulate a better understanding of the methods applied (2.5). As the example concerns the meaning of the words 'Decision Support System' and 'model' it may also be informative for those who are unfamiliar with these terms.

2.2 THE RESEARCH APPROACH

My research started with my participation in the project called i-Five: Innovative Instruments and Institutions In Implementing the WFD. The objective was to compare the WFD implementation process in Germany, France and the Netherlands in two ways. First, the WFD implementation process in each country was analysed to assess its effectiveness. Second, for each country a successful innovation to support the WFD implementation was analysed to assess the factors leading to success, as well as the transferability of these innovations to other countries. The research consortium selected the software tool called the WFDE as the innovation that would be the focus of the Dutch case. After the funding was granted, Delft University of Technology hired me to perform the Dutch case study in the project.

In the i-Five project the comparative framework was elaborated in iterative meetings between the research team and practitioners from the three countries, all involved in the WFD planning process. The deliverables were the case study reports, a comparison of the cases and a policy support tool, which can all be found on the project website[1]. At the end of the project a workshop was organised in each country, to disseminate the results to local practitioners. Furthermore, we organised a workshop in Brussels, Belgium, aimed at practitioners at the EU level.

A few months into the project, I realised that the WFDE at that time was maybe not as successful as had been assumed. When I was given the opportunity to develop an element of the i-Five research into a PhD study, I decided to study the redesign of the WFDE (up to the release of the second version, WFDE-2) up-close, as I still had many unanswered questions.

The research question was very open and similarly the data was collected in a very open way. I chose to let the data shape the direction of the research, narrowing down on the basis of a first analysis and zooming in on specific topics because they puzzled me. This approach would allow for a broad view on the role of expertise and would ensure that the elements focussed on would represent the most interesting ones, in my view.

This approach comes closest to a grounded theory approach as described by Kathy Charmaz (2014). She writes: "Grounded theory methods consist of systematic, yet flexible guidelines for collecting and analysing qualitative data to construct theories from the data themselves (…). Grounded theory begins with inductive data, invokes iterative strategies of going back and forth between data and analysis, uses comparative methods, and keeps you interacting and involved with your data and emerging analysis" (Charmaz 2014 p1). Grounded theory was first developed by Glaser and Strauss (1967). The method's continued development included an often used book by Strauss and Corbin (1990).

Consistent with this approach, the literature study was not performed before the start of the data collection, but parallel to it. (For a detailed discussion concerning this issue see for example McGhee et al. 2007.) Specific issues were explored through literature when significant. In due time, different theoretical lenses were applied, which will be presented in the relevant chapters of the thesis.

Quality in qualitative research

In the field of qualitative research, specific criteria have been developed to assess the quality of research, as the nature of qualitative research would not allow simply applying criteria such as replicability, reliability and validity in the same way as in quantitative research. Bryman (2008) notes that applying these criteria would mean assuming that there is only one true, or valid, account of social reality. Seale (1999) discusses how acknowledging the possibility of multiple valid accounts makes it hard to set quality standards. Denzin (2009) discusses various evaluation methods and concludes that a single golden standard for qualitative research does not exist. This, however, does not mean that anything goes. Not every account is valid. "The world does not tolerate all understandings of it equally" (Kirk and Miller 1986 p11, quoted in Silverman 2013 p289). Qualitative research can be seen as a craft skill, (Seale 1999) where good practices are recognised as valuable. Methodological rules and interpretive guidelines are there, but they "are open to change and differing interpretation and this is how it should be" (Denzin 2009 p154).

Although I agree with what is remarked in the previous paragraph, I note that the same can be said of quantitative field studies. One of the criteria that is seen as hard to meet in qualitative sciences is

[1] http://www.actoranalysis.net/i-five/

replication, as the exact properties of the setting that was studied will never be the same. However, as the field of water management demonstrates, in quantitative approaches complete replicability is also not feasible. Whether studying soil moisture, water quality or the maintenance requirements of hydraulic structures, measurements will differ from one corner of the mountain slope to the other and from one polder to the other, from one year to another. The heterogeneity of the terrain; the chosen location for measurement; the weather conditions; the specific equipment used; which parameters were chosen to be measured; all these things influence the collected data and have to be accounted for. The influence of this heterogeneity can be reduced by doing lab experiments, but the question remains how these results translate to the real world where variables cannot be isolated and interactions between them cannot be avoided.

Authors of social science methodology handbooks such as Bryman's, or qualitative analysis handbooks such as Silverman's, do not question the value of the mentioned quality criteria for natural sciences. However, science and technology studies (see for instance Yearley 2005) have shown that in science, for instance in physics, engineering (Collins and Pinch 1998) or weather forecasting (Fine 2009), outcomes also depend on the chosen measuring equipment, data processing methods, and professional insights and skills.

In the last two chapters I will demonstrate that data quality was an issue for the developers of the WFDE as well. The model they developed was derived from data that had issues of completeness, representativeness and generalisation. Furthermore, in the pilot study the developers were confronted with data that was incomplete in space or time, or was incompatible with the model because of the way they were measured or aggregated.

Despite the discussed reservations regarding quality criteria, I propose to apply three general criteria to assess the scientific quality of qualitative research as described by Silverman (2013) describes: analytic depth, credibility and the use of appropriate methods. These criteria are actually not that different from those that apply to quantitative research.

The first, analytic depth, refers to the extent to which theory is linked to data. As opposed to journalism, the result of research needs to contribute to theory development in the field of study and any theory needs to be founded on data. Furthermore, anecdotalism needs to be avoided, meaning that researchers consider (and present) not only those parts of the data that confirm their thoughts or present a dramatic example of a phenomenon, but the whole of the collected data.

The next, credibility, is also referred to as internal validity. Silverman (2013 p444) defines it as the extent to which any research claim has been shown to be based on evidence. As Le Compte and Goetz (1982; quoted by Bryman 2008 p376) say, internal validity is how well the observations match the developed theory. The value of an account depends on ensuring that the account is arrived at according to rigorous research practice. This requires transparency in how the data is collected and how findings are derived from the data. Other credibility enhancing methods Bryman refers to are respondent validation, where the participants in the study are asked to comment on the accounts or the results of the study; and triangulation, in which other data sources are used to corroborate the findings. Peräkylä (2011 p365) describes validity as the credibility of the researchers' interpretations: "The validity of research concerns the interpretation of observations: whether or not the inferences the researcher makes are supported by the data, and sensible in relation to earlier research."

The last criterion is that the methods need to be appropriate, sensitive to the issue at hand and chosen because they match the research question, not because of the researchers' familiarity with the method or their personal preference. Methodological awareness is related to this. The researcher needs to be aware of what influence the choice of methods, and the way these are employed, have on the results of the study. This requires regular reflection on the relation between methods and outcomes.

A case as the base of analysis

In this research a case is the base of the analysis. An often-used definition of a case study is "an empirical enquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (Yin 2009). In engineering research, case studies are common and represent the real life situation in which a new or improved design, or product, tool, model, is tested. Case studies then represent the move from laboratory to practice.

Silverman (2010) identifies three features of case studies. First, each case study has boundaries. What is and what is not included in the case should be defined at an early stage of the research. Second, a case is by definition representative of the phenomenon the researcher is interested in, and third: "Case studies seek to preserve the wholeness and integrity of the case" (Silverman 2010 p138).

To start with the second feature Silverman identified, I will elaborate why I chose this case. At first, the case study was chosen to fit the objectives of the i-Five project (see 2.2). I continued studying the WFDE development because it provides an interesting example of how experts and expertise play a role in policy planning through the means of a modelling instrument. My interest was triggered by my surprise at seeing competent experts struggling to achieve success in the development of the instrument. At the start of the WFDE development, the WFDE was explicitly framed as an instrument to bridge the science-policy gap. Furthermore, it was to be a shared knowledge base for the users as it was based on expertise from different fields. Both the disputed and the undisputed expertise in the case provided interesting material for analysis of what expertise is incorporated and in what way. In addition, this case offered me the advantage of being able to follow the developments over an extended period of time.

After I was kindly allowed to join the project meetings, I had access to such a large amount of rich material that an in-depth qualitative analysis of the one case over time was chosen. Adding a second case for comparison would have reduced the depth of the analysis, although I do think this approach would also have led to interesting insights.

Silverman's first feature, the boundaries of the case, were firstly those of time: the first round of the WFD policy planning and two rounds of the WFDE development. The first round of the WFD planning and the WFDE development I studied in retrospect through interviews and documents. The second round of the WFDE development I followed closely from early 2009 to early 2013. From April 2011 to the end of 2012, I attended the project team meetings. My intention was to collect data until the release of the WFDE-2. In April 2011 the release was expected early 2012, but as the release was postponed several times, the period of collecting data was extended until March 2013, when the WFDE-2 was presented at a national symposium.

Another delimitation was the focus on the (accounts of) actions of actors and their effects. I followed the actions of the developers. In addition, I interviewed those people who had an influence on the development either as a funder, prospective user or sub-contractor to the work regarding on the one hand the WFD planning process and on the other the WFDE development process. I did not explore the debates concerning how best to reach the WFD objectives.

As to the third feature Silverman describes, I used different sources of data and different methods of collecting and analysing them to preserve what he calls “the wholeness and integrity” of the case, or in other words to do justice to the complexity of the case. The use of different types of data was in some cases cross-checking the data, but mostly using different sources served to enrich the understanding of the phenomenon studied by incorporating accounts from different viewpoints. It was more like moving the camera to see from different perspectives and making a composite photo than overlaying different layers of colour to form a picture.

2.3 DATA SOURCES AND DATA COLLECTION

The data used for the analysis were:
- interviews with key actors,
- policy reports and project documents,
- observations of project team meetings and consultation meetings for users.

Policy reports and project documents can be seen as naturally occurring data; they exist without the interventions of the researcher (Silverman 2010 p131,132). Interviews are the result of interaction between the interviewer and the interviewee and would not have occurred without the interviewer taking the initiative. Behaviour, as in a meeting, is naturally occurring, but the presence of the observer can have an influence and what is noted depends on the observer. I don’t want to suggest that either natural or not-natural data would be better, but I simply want to draw attention to the role of the researcher in the creation of the data, which can be relevant to the interpretation of the data. A description of each data source will follow, consisting of how the data was collected, its quantity and its quality.

Figure 1: research diaries and voice recorder

Interviews

Interviewing is probably the most commonly used technique for data collection in qualitative analysis (Silverman 2010; Charmaz 2014). I decided to do interviews as they would provide access to information that is generally not documented. What choices were made can be to some extent derived from the documentation on the instrument development, but when reasons are provided they tend to be biased to the arguments that legitimise that choice. What is generally not documented is the debate behind the choice, or the change the meaning of a proposed action underwent in the debate.

An interviewer should question what information is collected through the interview. Do interviews present a true picture of reality, such as facts and events, or feelings and meanings that can perhaps not be accessed through other means? Do they represent "authentic accounts of subjective experience" as emotionalists would claim (Silverman 2001 quoted in Miller and Glassner 2011 p131), or accounts people construct of this reality, as a response to the questions you ask (Silverman 2010 p225)? Silverman (2010 p45 and p48) does not choose between these positions, but states that it depends on your research approach. As Miller and Glassner (2011 p133) phrase it, "Research cannot provide a mirror image of the social world that positivists strive for, but it may provide access to the meanings people attribute to their experiences and social worlds."

Many interviewees would not have reflected on the WFD or the WFDE the way they did, had they not been interviewed. Several people remarked upon that themselves; some even thanked me for providing them with this opportunity to reflect on the process they were in or had been in. Though I acknowledge the constructed nature of accounts, both in naturally occurring data and in interviews, the construction of the accounts were not the focus of the research. The accounts collected through interviews provided reflections on a lived experience as well on meanings regarding aspects of the WFD and the WFDE development process that I could not have accessed in other ways. Accounts to me were a source of data that, like any data, needed to be treated with critical respect. Where possible, elements such as data, names, events, were cross-checked.

Quantity and quality

A total of 43 interviews with 37 individuals was conducted over the period of January 2009 to March 2013. The first three were explorative and two of these three interviewees were revisited later. The next 24 interviews concerned mainly the development of the first WFD Explorer (WFDE-1) and the first round of the planning process for the implementation of the WFD in the Netherlands. The last 16 interviews focused on the development of the second WFD Explorer (WFDE-2) and to a lesser extent the preparations of the second round of WFD-planning. The interviews lasted between one and three hours.

For interviews it is generally not the quantity, but the quality that is seen as most important (Guest et al. 2006; Silverman 2010). The quality depends on the choice of interviewees as well as the manner of conducting the interviews. Regarding the first, my intention was to interview people who influenced the WFD planning or the WFDE development, representing different roles in the process, in order to get many different perceptions on the same phenomenon and, specifically for the WFDE development, to be able to trace back the influences of the actors

The first three interviewees participated in the i-Five project. Starting from these persons, I used the snowball technique - asking interviewees for suggestions for people to interview next. In addition, I used lists of people involved in the WFD planning process that I found through internet searches, lists of participants in WFDE user meetings and lists of the developers and funders in project reports.

The eighteen interviewees that were involved in the WFD-planning process included people in different positions at water boards, municipalities, provinces, Rijkswaterstaat, and the ministry of Infrastructure and the Environment. Six out of eighteen were also involved in the WFDE development, as (prospective) users or funders.

The nineteen interviewees that were actively developing the WFDE were programmers, members of the original consortium, the later project team or the steering commission and external contributors or test-users. Ten out of nineteen were also involved in other, WFD planning-related projects, as part of their work at a water authority or research institute or as an advisor to one or more water authorities. The presentation of the numbers here may suggest that distinctions between the groups were clear, but sometimes it was hard to decide in which group to include an interviewee.

Although a variety of people was interviewed, there are always limitations to the sample. Regarding my research on the WFD implementation, I limited myself to governmental actors, as the focus was on how governmental authorities coped with the new task of implementing the WFD. As the group of involved actors was large, the focus was on two river basin districts, Rhine-West and the Meuse. I started with the Meuse basin as the waterboard Brabantse Delta, a partner in the i-Five project, is in the Meuse basin. As a comparison Rhine-West was chosen because it covers a large and central area of the Netherlands and the two river basins have a different hydro-morphology. I added the national level, as it coordinated the WFD-planning process.

For the development of the WFDE, it was easier to identify all actors involved, as the group was smaller, but even so I could not speak with everyone who was involved one way or another. As many different roles and organisations were represented as possible.

Interview procedure

I promised the interviewees anonymity, so they could talk freely. Some interviewees asked for (written) confirmation that I would ensure that their identity could not be deduced based on my writings. Apparently some issues were considered sensitive. Because of the comparatively small world of the WFD and even smaller world of the WFDE development, anonymity not only means I name no names, but I will also not quote interviewees referring to their specific role. Gender was not a research theme, but I would like to note that the number of women interviewed was three. This number represents the dominance of men in both the WFD planning and in the WFDE development and this means that if I would refer to a certain person as “she” this person would be quickly recognisable, so “(s)he” will be used as a neutral form for all.

An interview is not a natural situation: the interviewees are aware of the fact that the interviewer wants information from them. Silverman (2010) warns that if respondents are aware of your interests, this can affect their responses. Some are eager to give you what they think you want; others are wary not to discuss sensitive issues. I kept my introduction to the interview very general and told interviewees who wanted to know more that I would provide more information after the interview in order not to influence their answers. The interviews were of an open nature. The questions were slightly adapted for the different types of interviewees: funders, developers, policy planners and (prospective) users of WFDE.

Charmaz and Bryant (2010 p301) suggest that asking few questions allows interviewees to tell their stories without too much steering by the interviewer, although in a later phase as the research gains a specific focus, more specific questions are in order. Therefore, I used a list of interview topics. The starting question was: what was/is your role in the planning process for the WFD and/or the WFDE development process? I asked interviewees to focus on what they actually did, what actions they undertook. On the basis of the answer (sometimes taking 20 minutes or even half an hour), I would continue with topics not addressed yet, or topics I wanted to delve into more. My strategy was to say little at the start of an interview, but towards the end I would sometimes confront interviewees with opinions expressed by (anonymous) others to stimulate further discussions. For the last set of interviews, I added a number of more specific (though still open-ended) questions because of some specific elements I wanted to focus on.

Interviewees “respond to us based on who we are” (Miller and Glassner 2011 p134) both in the role and the social category they perceive us in. I worked for a waterboard before starting on this study and that helped to establish rapport with interviewees in that field. Many interviewees were trained at Delft University of Technology (DUT), which helped to establish rapport with another part of the interviewees. At DUT many of my colleagues use modelling tools, so I know the “talk” (Collins 2009) in water management and modelling practice well enough to ask sensible questions and be a credible partner in discussions.

All but the first six of the interviews were recorded. I made interview reports in which the half-finished phrases or ambiguous remarks were explicitly rephrased, asking the interviewee whether this was what they meant. These reports were then sent to the interviewees for their approval as a means of respondent validation (Bryman 2008 p377). Many interviewees made changes in the report, mostly minor ones. Some interviewees provided additions to what was said in the interview. In those cases where my account differed from the interviewee’s account, I listened to the recording again and rethought both my and the interviewee’s account. In a number of reports interviewees toned down opinions they had expressed. Although the reports used in the analysis were the corrected ones, note was made of the changes as a possible signal for saliency.

Policy reports and project documents

To understand the policy process (chapter 3), I went through the policy documents related to the WFD implementation in the Netherlands. They were collected through snowballing and internet searches. I went through the WFD itself, the official national planning documents, the waterboard WFD reports or sections on the WFD in the waterboard management plans, the River Basin Management Plans, and various evaluations of the national or regional planning processes, with an emphasis on the river basin districts Rhine West and the Meuse.

To analyse the WFDE development, I collected as many documents as I could get access to from both the first development period (2004-2009, WFDE-1) and the second (2009-2013, WFDE-2). Documents from the first phase included project plans, newsletters, presentations and progress reports. Documents from the second phase included the plan for the redevelopment, the minutes of all project meetings, the accompanying papers and reports, some of the steering committee documentation, public presentations and newsletters.

During the period that I attended team meetings (see below), I received all documents the team members received, which amounted to three thick folders. In addition, I received all the minutes and a good part of the documents that were on the agenda of the meetings in the period before I attended them.

The quantity of the collected documents was quite large. This allowed a good understanding of the issues that were discussed. However, the documents rarely provided insight in the individual underlying reasons for supporting decisions or taking part in discussions. Furthermore, a limitation of the documents was that they mostly represented the point of view of the governmental actors on the WFD implementation and that of the developing partners on the WFDE implementation.

Observations

Observing “real life” behaviour is a main technique in ethnography (Puddephatt et al. 2009; Gobo 2011). Ethnography focusses on behaviour and behavioural patterns as they are more consistent than expressed opinions. Repeated observations of the same setting allows for a fairly objective study of this behaviour (Gobo 2011 p29,30).

In ethnography access to the situation of interest is often controlled by so-called gatekeepers (Silverman 2010 p203). As I was interested in the details of the development of the second WFDE and the development was only partly public, I tried to get access to what happened back-stage. Silverman provides some suggestions on how to develop a relation of trust with the people studied. One is making sure that not only the boss agrees with the researcher’s presence, but all the people in the studied group; another is demonstrating that the researcher’s attitude towards the group is non-judgemental.

This last one proved not so easy. I sent the case-study report I wrote for i-Five to all interviewees who contributed to it. The report of the development of the first WFDE is an evaluation and an analysis of its lack of success. The responses I got on the report were generally positive. The interviewees found the analysis thorough and accurate, but that didn’t mean everyone was happy with it. The developers were worried that a taint would cling to the WFDE. I attended public meetings of the WFDE development and informally talked with several people involved. Slowly, I managed to convince them that my goal was not to judge the work they do, but to better understand the process and product.

The redesign phase started November 2009. Starting April 2011, the project team gracefully allowed me to attend their meetings. In total, I attended eight public user meetings, seventeen internal project team meetings and three internal demonstrations of newly developed functionalities, (sprints).

The public meetings were attended to see and hear how developers and funders interacted with potential users and to informally speak with the users. During the meetings, I made notes that were developed into reports as soon as possible afterwards. The meetings were different in setting and in the number of people attending. Some were hands-on demonstrations for around fifteen people with little more talk than required to get started with the software. Others were discussion meetings with groups of various sizes; the last one was the big conference for the launch of the WFDE-2, which was attended by around a hundred people.

The internal meetings provided more longitudinal information. They were nearly always held in the same meeting room; the composition of the group varied little and mainly reflected the small changes in the team composition over time. The project team members kindly consented to my presence in the meetings, though they had only a general idea of what I was working on. New members of the project team were informed of my role in the team, though not explicitly asked for consent. I could see some people were uncomfortable with the idea of being observed, though the regular members of the team got quite used to me. Once in a few meetings a comment was made that was viewed as undiplomatic and most eyes would go in my direction to see if I noted that down, so they did not quite forget I was observing them.

I made no recordings and anonymity was promised regarding what was said in the meetings. I rarely contributed to the discussions and if I did it was mainly regarding language issues or to ask some explanation, to avoid disturbing the flow of the discussion. My most active contributions were helping to set up a time-line for the completion of the pilot project.

During the meetings, I made elaborate notes that were usually extended in the return train. The focus was on controversy and discussions, who took the lead, how decisions were arrived at, and whose word was decisive in what matters. The observations were written up in reports, separating what I saw and heard from what I surmised or thought by using italics for the last two.

After each period of programming, a ‘sprint’, the results would be demonstrated to the project team. These sprint-demos provided very interesting insights in how the project team interacted with the programming team. The leader of the latter team chaired those meetings and demonstrated what had been developed during the last two or three weeks. The project team would then ask questions to better understand the functionalities and suggest changes or additions. Again, I took notes and wrote reports. After the first sprint demo I attended, a developer invited me to the meeting of the programming team, directly after the sprint where the comments would be discussed. However, as I came unannounced, the programming team felt quite uncomfortable and I was later told they would not invite me again. The team leader of the programming team did grant me an interview and explained in detail the working procedures in the team and the interaction between the two teams.

Other relevant meetings I attended include public thematic meetings where model instruments such as the WFDE were presented or discussed (Water Mosaic meetings, Deltares models day); meetings on the WFD organised by Leo Santbergen - a policy planner working on the WFD-implementation at the waterboard Brabantse Delta - as part of his PhD project (Santbergen 2013); and meetings where practitioners and scientists discussed the WFD, which culminated in a collection of essays (Van der Arend et al. 2010). Furthermore, in the i-Five project, meetings were organised that were attended by people involved in the WFD and the WFDE. Finally, I organised a stakeholder meeting to present the results of the i-Five project. All these meeting provided opportunities to informally discuss the WFD and/or the WFDE. I made notes of these discussions in my research diaries and they contributed to my thinking, but I did not analyse them as part of the data sets.

The steering group set the requirements for the development process, but I chose to focus on the discussions in the project team, where the experts discussed the details of the instrument. In addition, I had the impression that my presence in the steering group might undermine the trust I had built-up with the project team, because I noticed how they treaded carefully in discussing debates with the steering group.

Although I think, overall, I had little influence on the behaviour of the people I observed, what I wrote down as observations has limitations. I made no recordings, so I could not make literal transcriptions of the discussions and I cannot hope to be complete; even so, I think a wealth of information was collected.

2.4 DATA ANALYSIS

This section will describe the analytical process by first providing some insights in the general procedures in computer-assisted qualitative data-analysis and Atlas.ti, followed by the procedures I applied for this thesis specifically.

Computer assisted qualitative data analysis software (CAQDAS)

To perform the data-analysis, I used computer-aided qualitative data-analysis software (CAQDAS). CAQDAS supports coding - or labelling - the data, a procedure in qualitative analysis that predates computers. A main advantage of the use of CAQDAS is the ease with which different selections of data can be retrieved, to analyse them further or to compare them with other selections of data. As making comparisons is an important technique in qualitative analysis (Silverman 2010 p279), it is valuable to have a tool that allows doing this in a flexible and easy manner, encouraging the analyst to continue comparing, which would be very cumbersome manually, or even with a word processor.

Other advantages are that CAQDAS allows the researcher to handle large amounts of data without losing overview. It supports a rigorous analysis because it helps the researcher treating all the data in the same way. For instance, every time a code is attached to a piece of data, the researcher can directly see the definition of the code and ascertain that the coded fragment matches the definition. Furthermore, the software can increase the speed of analysis by mechanising part of the work and it allows teamwork, because several people can work on the same data-set (Silverman 2010 p251-267). It facilitates constructing theory bottom-up, by first using descriptive coding and subsequently developing theoretical, overarching codes (Silverman 2010; Friese 2012; Charmaz 2014). I would add to the list the increased transparency of the work. A researcher can easily provide lists of codes (the codebook) together with their definitions and overviews of the number of times these codes are applied in each primary document. Even if the primary data is too sensitive to share with others, in this manner the development of the analysis can be presented.

Terms used in Atlas.ti

Different CAQDAS packages are available and the terminology used in them varies, so I will clarify some procedural terms as applied in Atlas.ti. This software was originally developed to support grounded theory, but can also be applied for other types of qualitative analysis. A good book on qualitative data analysis and a manual for Atlas.ti is by Susanne Friese (2012).

In Atlas.ti the units of analysis are called hermeneutic units (HU). A HU consists of primary documents (the data: interviews - reports or sound recordings -, documents, images and the like) together with the coding applied, the networks drawn and the memos written regarding the analysis. All elements of the HU can be exported to make tables, graphs or lists.

Primary documents that share certain characteristics can be grouped into 'families', for instance all the interviewees who work for waterboards, or all the documents that were written by a certain author. Whether families are made, and on the basis of what criteria, depends on how analysis is developed, so the choices made are an important aspect of the research design.

A main procedure in qualitative analysis is 'coding'. Coding means that selected parts of the data are labelled. The coded fragments can be words, sentences, paragraphs or bigger chunks of text, again depending on the chosen type of analysis. A coded fragment (or unit) is called a 'quote'. The codes can be descriptive of the content of the quote (for example ecological knowledge rules), or theoretical (for example expertise). Codes can also be grouped into families, which can help to move from descriptive to more abstract or theoretical coding.

To facilitate developing the relations between codes, Atlas.ti enables users to draw networks. The codes can be dragged into the network generator and can then easily be connected by lines that represent the relation between the codes, such as 'caused by', 'influenced by', 'part of' and so on. The resulting diagrams help to keep an overview of the coding as well as to develop theory.

Throughout the analysis, all steps in the procedure and all choices made in the course of the analysis can (and should) be written down in memos. Beside these methodological memos, researchers are recommended to keep track of all their thoughts regarding the research project in memos, so the whole project is in one (virtual) location and all elements can be linked to each other (Friese 2012).

Analytical procedures for this thesis

For the i-Five reports, the WFD policy documents and the WFDE-1 project documents were analysed. I developed timelines for both the WFD and the WFDE-1 showing: when did actors get involved and in what capacity; when did pilots start and end; when were user-meetings or courses organised; what major reports were produced at what time? Furthermore, I evaluated the planning process according to the framework developed with the stakeholders. The i-Five work was mainly descriptive and aimed at providing support for policy development.

After finishing i-Five, I analysed the Rhine West water management plans of the waterboards and the other Rhine West documents that feed into the River Basin Management Plans (see chapter 3) by coding them in Atlas.ti. It was a rough type of coding, limited to first labelling all passages specifically WFD-related, then coding these regarding specific topics I wanted to pursue for the (conference) papers on the WFD I was writing at that time. This helped me see the potential of the software.

The next stage of my research consisted of a qualitative analysis of the WFDE with the aid of Atlas.ti. The interviews, minutes, and observations were uploaded into three separate HUs, to keep the codebooks a workable size. The other project documents were read as background material and some of them were later assembled in a fourth HU as key documents for an additional analysis. Paragraphs were an appropriate unit for coding because these are manageable units that allowed me to distinguish between the topics that are discussed, without separating them from their context.

While coding the data-sets, I wrote memos to keep track of what I did and how I did it. As the material is all in Dutch and the writing was to be in English, making notes, coding and writing memos was done in a mix of the two languages. The analytical ideas evolved partly through memo writing in Atlas.ti, but also through my research diaries.

To start with, all the minutes were coded, using an open coding technique, meaning I developed the codes while going through all the minutes, not beforehand. I attached a code to each paragraph. Some paragraphs had more than one code. The lists of codes used for each HU are in the annexes.

The number of times a code was applied provided insights in what kind of information was in the gathered data. The number of words in the coded quotes indicated how much information was available on the coded topics. Atlas.ti allows an easy generation of tables with the numbers of quotes per code or the number of words per code per document. For each of the HUs these frequency tables are included in the annexes.

Using a consistent unit for coding allows using the number of times the code is applied, or the number of words per code, as an indicator of the importance this topic has in the specific data set. This does not imply that these topics were by definition the most important for answering the research questions. The fact that some topics were hardly discussed was also significant for my research.

The minutes provided a good overview of what actions were undertaken to arrive at a successful software instrument. It showed the chronology of events as well as who undertook what task. One of the first things analysed more in-depth from the minutes were the lists of actions, which show who took up what task in the project team. The team members accepted tasks based on their expertise, their role in the team and time restraints. The analysis of the task lists gives a first impression of the expertise available in the team, the importance attached to topics, and changes in focus during the period of study.

Next, the interviews were coded in the same way: open coding at paragraph level, again allowing more than one code per paragraph. As the list of codes was getting longer, I organised the codes in themes to get a better overview. The making of families facilitated systematic comparisons between groups. I attached labels to the interviewees: developers, funders, policy planners / potential users. Later, I added labels referring to whether people worked on a national scale (at the ministry for instance) or a regional scale (waterboards, municipalities). Lastly, I labelled the people working in the field of, or were trained as, ecologists in order to analyse whether this specific group had different ideas on the usefulness of information systems for their work.

Subsequently, the observations were also analysed through open coding. They allowed me to fill in certain gaps in my analysis, specifically on controversies and how they were resolved.

After the initial analysis of the data, I concluded that in the project team meetings the policy process was hardly discussed, although the objective of the instrument was to support the policy process. To arrive at a better understanding of what I saw as a discrepancy, I decided to do a detailed analysis of the objectives the team of developers, the different organisations and the individuals were striving for, and how and why these changed over time (see chapter 6). Although the minutes were useful to analyse certain aspects, these objectives were hardly mentioned in the minutes.

Therefore, 16 key documents were compiled over the whole period of design (late 2004 until the end of 2012) and were uploaded in another HU. This procedure is called theoretical sampling (Charmaz 2014), which means choosing a sample from among the data that can help develop the understanding of a specific element, as opposed to a random sample or a sample that is representative for a certain group of people, demographic or type of document. The documents were selected on the basis of their role in the process and their content, specifically those in which the objectives would have a prominent role, such as project plans written to persuade funders to invest money in the project, manuals for users and reports describing how the instrument was developed and used.

The list contains a comparatively large number of documents from 2009 because in that year the first release was evaluated and the redesign process was prepared. The full annotated list, as produced in Atlas.ti, can be found in the annexes The key documents were coded to answer questions about the objectives, the targeted users and the scope and scale of the instrument. An important step in the analysis was the pairwise comparison of the documents to track any shifts in these aspects. The result of this comparison will be discussed in chapter 6.

I drew networks to map the relations between the different codes. This was a way of generating ideas on how to analyse the data further to arrive at a better understanding of the data. The networks are not results, but means to develop the analysis.

An important technique in qualitative analysis is constant comparison. I made comparisons between different codes, documents, families of interviewees and data sets. This means I selected a certain topic, for example objectives or policy planning, and looked at the accounts in different documents or different families of interviewees, by making queries in Atlas.ti. Furthermore, I developed time-lines of actions, overviews of who did what, and actor-network diagrams at different points in time.

Visualising actor-networks.

In Actor-Network-Theory different methods have been, and are being, developed to visualise the analysis, see for example the work by Venturini (2010; 2012) or the website related to Latour's (2005) book Reassembling the Social[1].

I developed a way of visualising the connections between actors in what I called 'snapshots', to emphasize the temporary nature of these networks. The value of the snapshots lies in its ability to tell a story that would take many words to tell. Placing the snapshots one after the other, gave a sense of the changes that took place in the network.

I drew ovals positioned around the central object of study: the WFDE. Next, lines were drawn to connect the ovals with each other. The thickness of the connecting lines indicates the strength of the connection. Obviously, the strength cannot be directly measured, but I defined three types of relations for each pair of actors. The more relations, the thicker the line was.

Non-human actors, such as information systems, do not finance each other nor do they develop each other. They are however consulted in the sense that they are analysed to see how connections can be made between two information systems (thin line) and they can in fact be truly connected in the sense that functionality or data is shared (medium line). A step further is the integration of the one in the other (thick line). Similarly, between human and non-human actors, the relations were funding, developing and consulting. Between human actors the relations taken into account were: funding, information sharing, decision making.

[1] http://www.bruno-latour.fr/virtual/EN/index.html.

Actors may have many relations with other actors in the snapshot, but I only included them when they concerned the WFDE. If for example an actor funds the main developer to develop something regarding dyke management and this has no relation with the WFDE, this connection would not be included.

The way non-human actors affect other actors (human or not) will be discussed in chapters 6,7 and 8.

2.5 Example of research approach in practice

Detailed justifications of how my methods led to analysis and results in each chapter would be too time- and space-consuming, but this example provides some details on how the methods described above panned out in practice.

The words 'Decision Support System' or 'DSS' and 'model' were used a lot in the project documentation. In the interviews, the term DSS was not used often unless prompted by me. Instead most people used the more generic term 'instrument'. Model, on the other hand, was used a lot in the interviews and also in the observed meetings. While writing my initial report on the WFDE development as part of the i-Five project, I struggled with how to use these terms. Both in the literature examined and in the material collected, they seemed to be overlapping terms and they were used in different ways by different people.

I thought that maybe there was a difference in perception between developers and (groups of) users regarding the meaning of 'model' and 'DSS' and that understanding this difference could account for the apparent mismatch in what had been developed and what the users wanted. Therefore, the last 16 interviews ended with a few specific questions on how the interviewee defined 'model' and 'DSS'and how they would refer to the WFDE.

I was surprised that most people gave nearly the same definition of 'model'. Even the wording was very much the same: a model is a (partial) representation of reality. When asked to elaborate on this, unsurprisingly, the answers showed a clear division between those who worked with computer-based models and those who didn't, in the level of detail they employed on what could be contained in a model, or how you can develop or use the model. Not only the developers, but also a good part of the interviewed funders and users had worked with or on models at some time.

I was not surprised to see the differences in definitions of DSS, because they corresponded to the different uses of the term in the literature. Often mentioned was that a DSS was a software tool that showed the effect of actions or measures, usually through some kind of simulation that required some kind of model to be run. Some mentioned allowing a comparison of the results of different courses of action as an important property. And for some a DSS was anything that helped you to make a decision, so a checklist on a piece of paper could also be a DSS.

For most interviewees these were hardly relevant questions, though. Many shrugged at being asked whether the WFDE was a DSS or a model or something else. Many said that as it supported making a decision, it could be called a DSS, but what did it matter how you called it? Some said they didn't like the term DSS, saying it was just a buzz word that was used to sell products. Many simply called the WFDE an instrument or tool. The WFDE clearly contained a model, or even more than one, and could contribute to the decision making process, there was no dispute on that.

I had the feeling that I was barking up the wrong tree. The word DSS didn't seem to matter much and the word model seemed unambiguous. So if there was a difference in perception on the WFDE, it did not seem to lodge in the choice of words.

I had another look at my observations and all interviews to reanalyse my hypothesis. What I realised was that the word 'model' was a carry-all term. In the context of the WFDE it was in fact used for quite different things. I drew a schematic of the WFDE components according to the explanations of the developers (see figure 1). The left side, the instrument, the developers saw as their responsibility. The right side, the application, they saw as the responsibility of the users. Only for the pilots would they develop the application. It required a model of the water system (schematisation) which required data regarding the waters, but also the relations between these waters, therefore it was seen as a model. In addition, data about emissions and characteristics of the waters was required.

Next, I drew circles around all the different components that were called models[1]. The developers mainly used the word model for the four smaller (red) circles: the three models in the instrument and the schematisation of the studied water system. To the developers, the largest yellow circle was the 'project', encompassing the development of the WFDE and also the pilot project (consisting of the elements in the smaller yellow circle): in the redesign phase this was the national application, sometimes also called model or model-application.

For many users the left side of the schematic was the 'instrument', which would facilitate modelling, and they rarely talked about the individual components. Their main interest was in the application, mostly referred to as 'the' model, and the whole project was seen by some as a model development, using the term model as a synonym for DSS or instrument or the WFDE.

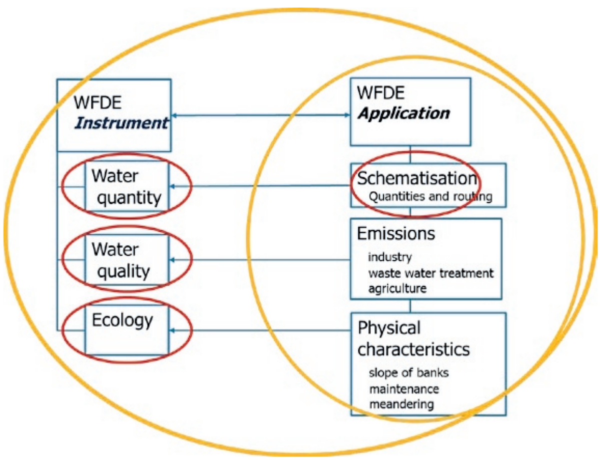

Figure 1: meanings of the word model in the context of the WFDE

The developers often expressed their concern of what they viewed as a lack of users' understanding of the difference between the instrument and the application. They felt that it was their job to develop an 'instrument' and nothing more. They did work on pilots or pilot-applications. There were two reasons for them to do so. First, it was seen as the only way to really test the instrument.

[1] I could have tried to quantify this, but actually there is little value in doing so as the data sample I have is not representative enough to say that developers use the word model x times more often than users or something similar.

Second, for the WFDE-2 they got separate funding to deliver the national application to perform a specific study: the study of manure policy measures.

Users, however, often expressed their surprise when they realised that the project would deliver ‘only’ the instrument and they would have to develop an application themselves. When the regional users understood they were not supposed to use the national application developed in the pilot for WFDE-2, they were even more surprised. The developers justified that by saying that each application was different, depending on the nature of the study. The national application for instance did not perform well when zoomed in too closely on specific regions. Making a cut-out would additionally cause all sorts of boundary issues that would have to be dealt with.

Some users had simply expected an application to be part of the package, as one of the funders phrased it. Without an application the instrument could do nothing and what they needed was something they could apply immediately. Other users were triggered by the national pilot. If that was developed, why would it not be made available to all? From the users’ point of view, the WFDE without a working application was like buying a car without an engine, while from the developers’ point of view they had produced a fully working car, but the users wanted a navigation device and fuel as well.

In conclusion, the analysis of the definitions of DSS and model used by interviewees yielded very little, but when looking at how the words were used in practice, an interesting difference in perception did emerge. Users and developers had different expectations of what the project would deliver, but they were not aware of that because the terms they used were the same, though they referred to different things.

There are two points to this story. The first is methodological. In this case asking specific questions based on a hypothesis led in unproductive directions, while analysing more naturally occurring talk proved more fruitful. I tested my hypothesis and rejected it, but the rejection of the hypothesis did not bring me closer to a better understanding, while retracing my thought process and reanalysing my data did. Methods are means; understanding is the goal and it can come through circuitous ways.

The second is related to the analysis. On the one hand the analysis nicely illustrates how the WFDE functioned as a boundary object. On the other it demonstrates how the meaning of a boundary object can change. The terms used in a development process can be interpreted differently by different actors without anyone realising it for a long time. This can lead to frustration later because one may feel that agreements are not kept while the other may feel they are asked to deliver what was never promised. The obvious suggestion is to clarify terms at the start. However, in this case the actors agreed on the definition of model and still interpreted the word in entirely different ways. It is impossible to avoid miscommunication entirely, but being aware that miscommunication happens quite often may help with recognising the symptoms and may stimulate more reflection on the process. For a more elaborate discussion of the importance of language in interdisciplinary contexts, I refer to Bracken and Oughton (2006).

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Chapter 3

Does the implementation of the Water Framework Directive promote integrated management in the Netherlands?

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Abstract

The Water Framework Directive (2000/60/EC; WFD) is one of the most important European water directives of the past years. The WFD follows an integrated approach, but does it also promote integrated management in practice? In the Netherlands, the WFD has been implemented keeping the existing legal, financial and institutional framework intact as much as possible. An advantage of this arrangement is that the setting of objectives, the selection of measures for reaching the objectives and funding are well tuned to each other. This creates good conditions for the implementation of the programme of measures. A downside of this arrangement is the complexity of coordination. Coordination between different levels within the water management sector was relatively successful, but coordination with other sectors was not so successful, leading to a programme of measures consisting almost exclusively of water management measures. In the various coordination processes the role of intermediaries was significant, by supplying expertise or improving the coordination process or smoothing relations.

3.1 INTRODUCTION

The Water Framework Directive (2000/60/EC; WFD) is one of the most important European water directives of the past years. The WFD follows an integrated approach on the basis of river basins. The key question addressed in this article is whether the WFD also promotes integrated management in practice?

To answer this question, this article describes the implementation of the WFD in the Netherlands, focusing on the issue of integration and coordination. “Coordination” is defined as mutual adjustment of goals and activities between different actors. “Integration” goes a bit further and involves the simultaneous consideration of different interests, resulting in one approach.

The Netherlands are an interesting case for studying integration and coordination in water management because they have a long water management history (see Ven 2004), but no tradition of managing water on the basis of river basins, as is required by the WFD.

This article is based on research conducted as part of the European I-Five project. In this project three case studies have been conducted on the effectiveness of innovative instruments and institutions for implementing the WFD in France, Germany and the Netherlands. The Dutch case study focused on the Dutch part of the Meuse basin and more specifically the area of waterboard Brabantse Delta. For the case study policy documents were analysed and 14 in-depth interviews were conducted with persons involved in the implementation process. In addition, scientific literature on the WFD was used. More information on the project and the full case study report can be found on the project’s website (www.I-five.eu).

This article first introduces the WFD and discusses the need for coordination in the implementation of the WFD. Next, it describes the institutional setting for the implementation in the Netherlands, the authorities involved, the political setting, and the river basin management planning process until December 2009, focusing on the coordination between the authorities and other stakeholders. The article concludes with two lessons for the next planning round (2012-2015).

3.2 THE WATER FRAMEWORK DIRECTIVE AND THE NEED FOR INTEGRATION

The Water Framework Directive (2000/60/EC; WFD) entered into force on 22 December 2000. The purpose of the WFD is to prevent the deterioration of the “water status” and achieve a “good water status” by 2015. The status of a surface water body is good when both its chemical status and its ecological status are good. The good chemical status is defined in terms of limit values for water quality, whereas the good ecological status is defined as a slight deviation from the natural conditions (Annex V, WFD). The directive prescribes a procedure for defining the good ecological status for specific water bodies, involving the identification of the different water bodies, the determination of their “type”, the establishment of “reference conditions” for each type of water body. For artificial or heavily modified water bodies, the ecological objective is not to achieve the “good ecological status”, but the “good ecological potential”, which is bit less strict because the effect of irreversible hydro-morphological changes is taken into account. Furthermore, the 2015 deadline may be postponed to 2021 or 2027 if it is technically not feasible or disproportionately expensive to reach the objectives of a good status or potential in 2015. For the same reasons Member States may set lower objectives.

A key component of the WFD is the development of river basin management plans (RBMPs), the first version of which had to be finished on 22 December 2009. The RBMPs contain, among others, the environmental objectives for the different water bodies, justification for phasing and for setting lower objectives, and a summary of the programme of measures for reaching the objectives. In transboundary basins these plans have to be international or at least internationally coordinated. While doing all this, Member States have to “encourage the active involvement of all interested parties” (WFD, art. 14).

River basin management entails dealing in an integrated manner with issues such as upstream and downstream effects, water quality and water quantity, and water and adjacent land-use (Mitchell 1990; Moss 2004; Mostert et al. 2008). In most countries, water management institutions do not operate on a river basin scale. Related policy sectors such as spatial planning, agriculture and nature protection certainly have no corresponding institutions at the river basin level (see Kastens and Newig 2007 for a discussion on Lower Saxony). In theory, river basin management can be established by organising water management according to hydrological units or by ensuring integration of management practices through extensive coordination processes (Mostert 1998). In practice, the first option is often not politically feasible and could create new boundaries between the new river basin management units and the existing institutions (Mostert 1998; Biswas 2004; Moss 2004; Cash et al. 2006). Hence, there will always be a need to coordinate across boundaries.

The need for coordination has been recognized in many integrated approaches that have developed in the past thirty years, such as integrated environmental management (Margerum and Born 1995; Margerum 1999), Integrated Coastal Zone Management (ICZM) and integrated water resources management (Mitchell 1990; GWP 2000; Mitchell 2005; Mostert et al. 2008). As stated by Cash et al. (2006; Horlitz 2007), “evidence is accumulating that supports the hypothesis that those systems that more consciously address scale issues and the dynamic linkages across levels are more successful at (1) assessing problems and (2) finding solutions that are more politically and ecologically sustainable”.

The WFD itself calls explicitly for integration at the European level of different policy areas relevant to water (consideration 16): “Further integration of protection and sustainable management of water into other Community policy areas such as energy, transport, agriculture, fisheries, regional policy and tourism is necessary. This Directive should provide a basis for a continued dialogue and for the development of strategies towards a further integration of policy areas. This Directive can also make an important contribution to other areas of cooperation between Member State inter alia, the European spatial development perspective (ESDP).”

Implicitly, the WFD requires coordination between government levels because the environmental objectives have to be established at the river basin level, but the measures to reach them will often be local. It requires coordination between sectors because the programme of measures has to be cost-effective (CIS 2003), and sometimes measures in the field of agriculture or land use are more cost effective than water management measures.

Moreover, the WFD requires coordination between experts and the authorities. Setting objectives and selecting measures for reaching the objectives require a lot of knowledge on the effects of measures on ecology. Since much of this knowledge was not yet available in 2000 (Lagacé et al. 2008), it had to be developed during the implementation process, in parallel and coordinated with the river basin management planning process.

Finally, as discussed, the WFD requires that active involvement of all interested parties is encouraged. This may be seen as a form of coordination too: between government and stakeholders.

The WFD does not prescribe how coordination should be achieved. Every country will have to make its own arrangements. An important role could be played by so-called "intermediaries": individuals or organisations that perform boundary work between different organisations (Moss et al. 2009, p.21) Intermediaries "are defined by the relations within which they are situated, rather than by a particular organisational characteristic or form". They can work across levels or across sectors, supply expertise to or improve relations between organisations, and contribute to innovation and learning (Moss et al. 2009). The Dutch case provides several examples of intermediaries. They will be described in some detail, together with the impact that they had on the implementation process.

3.3 General setting of the WFD implementation process in the Netherlands

Institutional setting

Water management in the Netherlands is organised at three administrative levels: national, provincial and local (municipalities and specialised waterboards). At the national level, national water policy is formulated and the legislative framework is established. Many operational powers are, however, delegated to local authorities. The lower level authorities can formulate their own policies and regulations within the framework established by the higher level authorities. The higher levels also influence the lower through the advice they give, the possibility to annul their decisions, and informal political and administrative relations (Perdok and Wessel 1998).

At the national level, three ministers were most important for water management: the deputy minister for water management, who functions under the Minister for Transport, Public Works and Water management (V&W), the Minister of Housing, Spatial Planning and the Environment (VROM), and the Minister of Agriculture, Nature and Food Quality (LNV). In October 2010, V&W merged with VROM to form the Ministry of Environment and Infrastructure (E&I), and LNV with the Ministry of Economic Affairs to form the Ministry of Economics, Agriculture and Innovation (AE&I). The deputy minister of V&W (now E&I) coordinates water policy. She conferred with VROM and LNV and political representatives of the associations of municipalities, waterboards and provinces in the National Water Commission (NWO). NWO is supported by direction group, with high ranking Ministry staff and high officials of the associations mentioned before, and a number of working groups on specific issues. The working groups are staffed by staff members from the authorities involved and stakeholder organisations such as drinking water companies, environmental and agricultural organisations.

Regional surface water management in the Netherlands is the responsibility of 27 waterboards. The waterboards are directly elected by the inhabitants of their area. They levy their own taxes, that account for nearly all the budget they have, and are therefore fairly independent. Recently, they also became responsible for regulating most groundwater abstractions. The state waters (the large rivers, the sea, the estuaries and large lakes) are managed by Rijkswaterstaat, a department of the Ministry of V&W Rijkswaterstaat is funded through the national budget. The collection of waste water is a responsibility of the municipalities (but treatment is the responsibility of the waterboards). The 12 provinces supervise waterboards and municipalities, regulate the largest groundwater abstractions and have important competencies in the field of spatial planning and nature protection.

The WFD requires the designation of a competent authority or competent authorities for the implementation of the WFD. In the Netherlands the councils of all waterboards, provinces and municipalities have been designated as competent authorities. The Minister of V&W has been designated as “coordinating competent authority”, “when needed together” with the Minister of VROM (now the same minister) and the Minister of LNV. All these authorities kept the competencies that they had and are accountable for their part in the implementation of the WFD.

As said in the previous section, the WFD requires coordination at river basin level. The Netherlands are at the end of four international rivers: the Rhine, the Meuse, the Scheldt and the Ems. The Rhine basin in the Netherlands is split up into four sub-basins, making a total of seven river basin units (Figure 1). For each of these seven units, commissions have been established with representatives from all involved competent authorities. The political representatives gather in a river basin platform, RBO, which is supported by the RAO, consisting of staff members (senior policy makers or technical experts) from the same organisations. The Minister of V&W is represented by civil servants of the regional branches of Rijkswaterstaat.

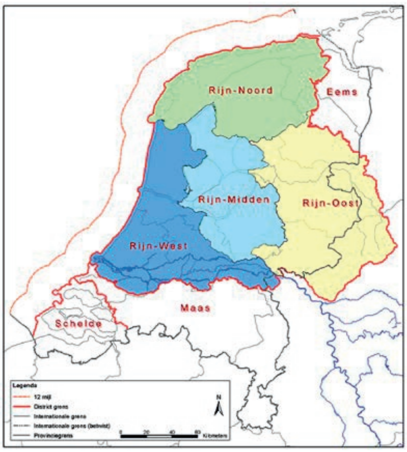

Figure 1 river basin (sub)districts (www.kaderrichtlijnwater.nl, accessed September 12, 2007)

The RBOs have a purely coordinating function. They discuss the regional issues, draw up common goals where possible and try to make sure that the goals and actions of the different organisations do not conflict with each other. Decision making and implementation of the decisions is done within the different institutions, and agreements reached in the RBO have to be ratified by each organisation individually.

For each river basin unit there was a river basin coordinator to keep the process described above on track. A national coordinating river basins desk, staffed by the Ministry of V&W, supported national government and the individual RBOs and RAOs (Coördinatiebureau Stroomgebieden Nederland, CSN). The chairmen of the RAOs cooperated closely with the CSN. In addition, they met with the NWO three times a year. The authorities in the river basin districts established local staff support for the RBO, RAO and corresponding sounding board group. The form in which this was organised differed between the districts. In each river basin unit a sounding board group was formed to provide a platform for other organised stakeholders. In addition, a sounding board group was set up at the national level.

The financial system largely corresponds with the institutional structure. Measures in water management are generally financed and executed by the same authority that is responsible for drawing up the measures. Cost recovery for water services in the Netherlands was high before WFD was implemented and will remain high.

The institutional structure for implementing the WFD in the Netherlands is depicted in figure 2.

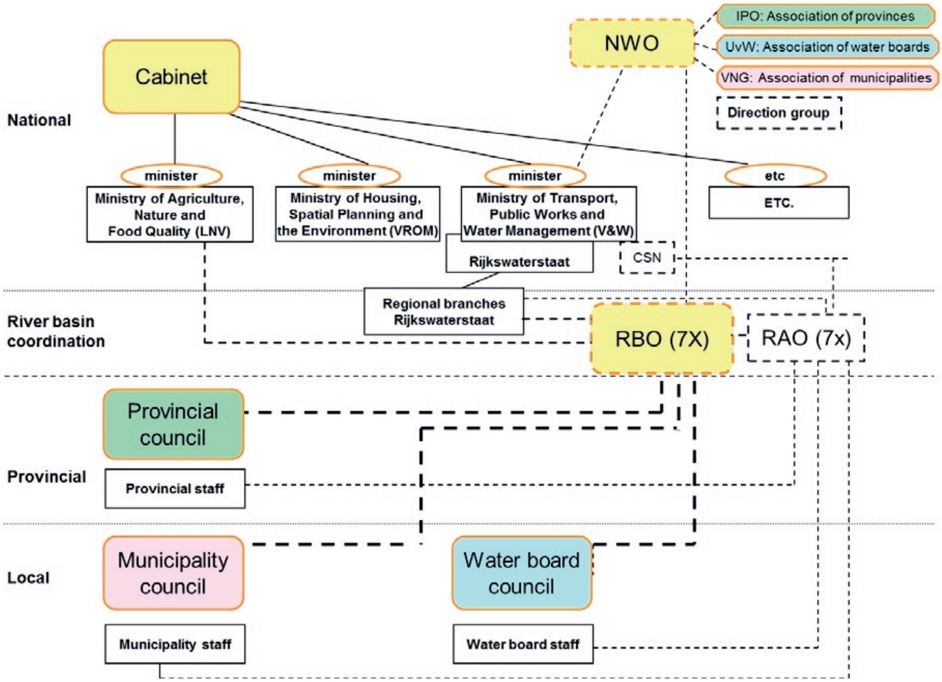

Figure 2: Institutional structure for implementing the WFD in the Netherlands

Political setting

An important event that influenced political attitudes towards the WFD was the publication of the Aquarein study in December 2003 (Van der Bolt et al. 2003). This study had been commissioned by

LNV and explored the consequences of the WFD for agriculture, nature, recreation and fisheries. It concluded that, to reach a good ecological status, it might be necessary to reduce the agricultural area by two-thirds. Even then it would be impossible to reach a good ecological status in some areas because of the time-lag in releasing chemical substances that have accumulated in the soil. The study did not take into account the possibility of setting lower objectives.

The Aquarein study caused a lot of debate and especially farmers and farmers associations were highly concerned about the possible impact of WFD on their livelihood (Huitema and Bressers 2006; Mostert 2008). Parliament refused to discuss the WFD Implementation Act that would transpose the WFD into Dutch law. Already before the publication of the study, the Deputy Minister of V&W had promised a brief on the level of ambition in the implementation of the WFD, but this brief had not yet been presented. Furthermore, Parliament criticised the nature of the implementation of the WFD up to that point: stakeholders had not yet been involved.

The ambition brief was presented on 23 April 2004 and expressed government's intentions to take a "pragmatic" or "realistic" approach to the implementation of the WFD (Staatssecretaris van Verkeer en Waterstaat 2004). The Netherlands would do what is "reasonable", but would not go to the very limit to achieve a good status for all waters. The current land use would be the basis of the measures: no changes in land use would be considered. Moreover, no new restrictions on manure use would be introduced on top of those already required by the new manure act. This act was passed after the Netherlands had been condemned by the Court of Justice of the EU for failing to fulfil the obligations under the European Nitrates Directive (91/676/EEC).

Planning process

The river basin management plans have been developed in three parallel tracks. The first track was the deliberations between the various authorities and with organised stakeholders at river basin level in the RBO, RAO and sounding board group. In each basin the process was organised differently. In the Meuse area, the RBO, RAO and the sounding board group were supported by the project bureau Meuse from September 2005 to December 2009, when the project bureau was disbanded. The project bureau consisted of nine staff members from the different competent authorities in the basin. It had a set budget for projects supporting the implementation of WFD. The project bureau was responsible for the preparation of policy papers, and other documents to be discussed in the RBO. The project bureau supported a number of working groups for sub-basin areas and for specific themes, providing them with information from the national level. These working groups were also staffed by the competent authorities represented in the RBO.

The second track was called the area process ("gebiedsproces"), and took place at the sub-basin level. In the area process, authorities and organised stakeholders, such as farmers' organisations, drinking water companies, industries depending on water supply and environmental organisations, discussed the objectives and measures that were considered for their area. In some cases, authorities and organised stakeholders deliberated together, in other cases separately. These processes were led by the waterboards (Dekker 2008).

The third track was the development of the different water management plans. The waterboards, for instance, develop an operational water management plan every 6 years. The measures that the waterboards have to take for reaching the environmental objectives of the WFD have been included in that plan, but other aspects as well, such as safety and water quantity. The different organisations each had their own process of setting objectives and choosing measures. Of course, the results of the different tracks had to be interchanged. Furthermore, the individual plans had to be coordinated with the plans of the other authorities (Uitenboogaart et al. 2009).

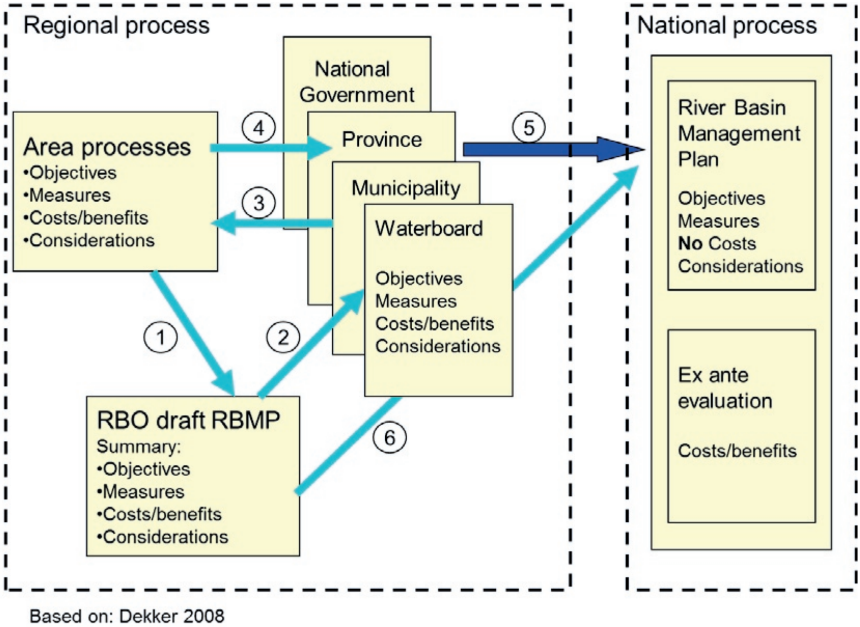

Figure 3: planning cycle for development river basin management plans

Figure 3 depicts the planning process. It shows the different types of plans and how they are interconnected. First, a loop went from area process to the RBO (1) and the specific plans of the competent authorities (2) and then back to the area processes (3). This loop was followed several times. The end results are area process reports, which were formalised in the plans of each institution individually (4). The plans include the environmental objectives and measures for which the organisation is responsible. These plans were decided upon by the elected council of the pertinent institution and the institutions are subsequently legally obliged to implement the measures in the water plans by 2012. The (draft) plans were input for the RBMPs, which were drafted at the Ministry of V&W (5). In addition, the RBOs made a summary of the objectives and their justification and of the programme of measures for their basin, which also provided input for the RBMPs (6). Finally, a writing team at the Ministry of V&W ensured that the different RBMPs have a similar structure and style. The RBMPs do not include costs and benefits. The costs and benefits were analysed in a separate document, called the “Ex Ante Evaluation”, written by the Netherlands Environmental Assessment Agency (Planbureau voor de Leefomgeving 2008).

The water management plan of the waterboard Brabantse Delta was prepared on the basis of "Integral Area Analysis". The waterboard area was split up into 26 areas. For each area an analysis was made of all water issues, whether related to quantity or to quality, and all related programmes for improvement based on national and provincial policy and regulations were reviewed, conferring with other stakeholders, to determine possible actions to improve the status of the water system.

3.4 Coordination

Coordination across levels

At the national level, guidelines and timetables for the WFD process were developed that drew upon consensus by the authorities and organised stakeholders involved. At the start of the implementation process, there was no national methodology on how to assess the status of water bodies according to the WFD. The development of the new method was a subject of debate among water managers at different levels and in the working groups supporting the NWO. In practice, the initiative was with the waterboard. Their proposals were sent to the provinces, who generally accepted them and drew up their own plans accordingly. The plans of the provinces would go to the national government, which would then draw up their plans. This process is called "going up the ladder". Where necessary, the whole process would go down the ladder again, to resolve possible disagreements (Uitenboogaart et al. 2009).

After a period of informal consultations, going "up and down the ladder", a Cabinet Order was issued that formalised the good chemical status and defined the "good ecological status" for natural surface water bodies. The ecological objectives for heavily modified and artificial water bodies were established at provincial level. Based on those objectives, the waterboards could derive operational objectives for each water body in their area. In parallel, measures were developed and chosen in coordination with other involved parties through the area processes and the RBO coordination process as described before.

International coordination is also crucial to solve certain water quality issues and is required by the WFD as well. The existing intergovernmental river basin commissions for the Rhine, Meuse, Scheldt and Ems dealt mainly with issues that were of importance for the entire river basin. Little transboundary coordination at the provincial or waterboard level has taken place: the waterboards mostly took the inflow of water from abroad as a given. Some regional transboundary meetings were organised, but they were mainly informative.

Coordination across sectors

As discussed, many authorities have been appointed "competent authority" for the WFD. In theory, this would ensure an integrated, cross-sectoral approach. In practice, however, the water sector feels most responsible for the implementation of the WFD and, with some exceptions, only water management measures have been considered for inclusion in the programme of measures.

The major challenges for the implementation of the WFD in the Netherlands are the hydro-morphological situation of the water bodies and eutrophication. Many modifications of hydro-morphology are perceived to be irreversible, but even so, measures can be taken to improve connectivity and living conditions for aquatic life. Many of these measures, however, require space, and space is scarce. In each case negotiations have to take place to acquire the necessary land on a voluntary basis. VROM could have provided regulations, procedures or possibly subsidies to ease the acquisition of land for WFD-related measures, but no such provisions were made.

Eutrophication is caused to a large extent by nutrients from agriculture, which are regulated by LNV. Yet, although LNV is a competent authority for the WFD, it did not consider revising its manure policy in order to facilitate the attainment of WFD objectives. In the same manner, present land use was not to be changed to accommodate the WFD requirements (Staatssecretaris van Verkeer en Waterstaat 2004). As these measures were not taken into consideration, the costs and effects of these measures have not been assessed and compared with other possible measures to see what would be the most cost-effective option, as the WFD requires.

Coordination between waterboards and municipalities

Waterboards and municipalities both operate at the local level, but the area of the first is larger and they have very different functions. The waterboards and the Ministry of V&W saw cooperation with municipalities as an important means for reaching WFD objectives. Although the municipalities are a competent authority for implementing the WFD, they were not always aware of the implications. Until 2006, they had little dealing with water quality issues and were hardly informed by the national authorities or the waterboards about the WFD. This provided room for unfounded negative perceptions of the WFD.

To increase the municipalities' awareness of water management issues in general and the WFD requirements in particular, a water ambassador have been appointed in each waterboard area. Water ambassadors are in nearly all cases a staff member of one of the municipalities in the area of the waterboard. The water ambassadors informed their colleagues in their own and in other municipalities on the WFD, stimulated the active participation of municipalities in the area processes, and promoted support for the plans that were developed. Moreover, they promoted that municipal councils officially adopted measures for implementing the WFD, which could then be included in the RBMPs. Finally, they aimed to promote interest among council members in water issues and the relation with municipal tasks. The costs of the water ambassadors for WFD were covered by the Ministry of V&W from 2006 to 2009, the period of drafting the RBMPs.

The water ambassadors played an important role in increasing awareness in municipalities that improving water quality is not merely something for the water management organisations. In the Meuse area, the WFD process led to a relatively large number of measures to be taken by municipalities, compared to other river basins. Eighteen out of twenty-one municipalities in the area of the Brabantse Delta adopted these measures. Some, however, did not want the measures to be included into the RBMP. A municipal decision is a clear intention to take measures, an obligation of best effort, but measures in the RBMP were felt to be an obligation of result and therefore better to be avoided as the result is hard to guarantee.

Coordination with organised stakeholders

The WFD calls for the “encouragement of active involvement of all interested parties” (art. 14 WFD). “Interested parties” covers both members of the general public and organised stakeholders, such as agricultural and environmental organisations, drinking water companies, and industries that depend on clean water (CIS 2002; Wolters et al. 2006). The general public was informed and consulted both on a national, river basin and regional level, but according to several interviewees active involvement was limited to a number of local processes, such as the 26 integrated area analysis performed by the waterboard Brabantse Delta (Junier 2010). This is confirmed by other studies (Ten Heuvelhof et al. 2010; Behagel and Van der Arend 2012).

Organised stakeholders were represented at the national level in a sounding board group and in the working groups supporting the NWO. At river basin level they were represented in the sounding board groups connected to the RBOs. Moreover, in some area processes organised stakeholders participated in the discussions between the authorities, while in other cases separate processes were organised. All the official participatory processes in the Netherlands together add up to 140 (Behagel and Van der Arend 2012 p 76).

Some stakeholders stated that it was impossible for them to attend all meetings of all platforms in the River Basin Area because there were simply too many (Smit et al. 2009; Ten Heuvelhof et al. 2010; Behagel and Van der Arend 2012); . Another problem was the high level of technicality and complexity concerning the process of setting objectives and choosing measures. This meant that active participation required a lot of expertise and time. For this reason, some organised stakeholders could not keep up with the process (Smit et al. 2009; Behagel and Van der Arend 2012). Similar problems were encountered in England and Wales. As Howarth (2009) put it: "... key aspects of the WFD are being implemented in a highly technocratic way that is not readily available to public participation or scrutiny", which makes it "...likely to be the exclusive preserve of a relatively small number of technically expert stakeholders”.

The regional sounding boards could not formally give advice that had to be taken into account, but they did influence decisions. Some participants remarked that they could not see the results of the participation process in the official plans. This is partly due to the high level of aggregation in the plans: individual measures are no longer visible. According to Behagel and Van der Arend (2012), the input of some interest groups did not get included in the plans because of “institutional boundaries between ministries, costs, and the fear of committing to measures”. This caused frustration with several organised stakeholders in the field of nature, recreation and environment.

The farmers have definitely taken a keen interest in the WFD. They feel they have a role to play in the process since they are important water users and collectively influence water quality significantly. A large proportion of the farmers is represented by LTO, which is a highly professional interest group. It employs well-educated staff to represent the farmers’ interests and to advise their members on every aspect related to agricultural production. LTO has drafted a position paper on the WFD, published in June 2006. The paper was published as a brochure and sent out to the authorities involved in the WFD process. It was also a means to inform their own members. The accompanying letter expressed LTO’s concern that too stringent restrictions would severely harm the sector, hereby referring to the Aquarein study. In 2007, another position paper was published, stating that they were pleased to see that the objectives were toned down, but these were still considered to be too ambitious. The paper reminded the readers of what the Aquarein study had pointed out: if the ambitions are set high, two-thirds of the agricultural land will have to be taken out of production (LTO 2007).

LTO representatives were active in basically all the different sounding board groups and the area processes. They lobbied at all levels of decision making and sent in written responses to the various draft plans. The LTO organised meetings for farmers, provided information on their website and through newsletters and brochures.

Integration of expertise

When the WFD was being developed, technical experts involved in the development of the directive were well aware that the knowledge required to implement it was not available yet (Lagacé et al. 2008). In the Netherlands this was clearly the case: methods and tools to determine the current state were not available, and the relation between measures and effects is still largely unknown. This introduced another group of actors to the stage: research institutes, universities and consultancies. The WFD inspired a lively discussion of the available knowledge and a search for new knowledge, especially in the field of ecology. As this took place while the WFD was being implemented, implementation was complicated further.

Research was performed on, for instance, new tools for assessing the current status of water bodies and monitoring methods, locations and frequencies. Expertise and instruments were developed at different levels and by different actors. To support the implementation of the WFD, the three ministries most involved each had a software tool developed by “their” research institute. In addition, the project bureau for the Meuse basin funded the development of a hydrodynamic model of the Meuse basin and a database to facilitate the systematic and consistent collection of data from the various competent authorities and reporting of this information to the national level. The model was used by most waterboards in the basin, although to a lesser extent then was expected. The usefulness of the database was recognised and the national authorities made it the standard for the whole country. STOWA (the foundation for applied water research of the waterboards, provinces and the Ministry of Infrastructure and the Environment) developed among others “metrics” to assess the ecological status. This methodology was later adopted nationally by NWO. Individual waterboards had consultancies develop models of their own area and some waterboards experts developed models themselves. These methodologies can (and will) be refined in the next round of developing RBMP’s, but what had been achieved presents a valuable basis to work on.

Results of the process

In December 2009, four RBMPs were published and four programmes of measures had been developed. The RBMPs form part of the National Water Plan and constitute the Dutch part of the international RBMPs for the Rhine, Meuse, Scheldt and Ems. They moreover contain a summary of the programme of measures. The measures themselves can be found in the management plan for the state waters and in the management plans of the waterboards. Furthermore, 51 municipalities –

out of a total of 430 – have officially adopted measures for implementing the WFD (Ministerie van Verkeer en Waterstaat 2009).

For 86% of the surface water bodies the deadlines of 2015 for reaching the objectives has been extended (Ministerie van Verkeer en Waterstaat et al. 2009). According to the Ex-Ante evaluation, only between 40 and 60% of the water bodies will have reached a good status or potential by 2027 if all planned measures are implemented (Planbureau voor de Leefomgeving 2008). Lowering of objectives will be considered only in the third round of RBMP development, between 2018 and 2021 (Ministerie van Verkeer en Waterstaat et al. 2009).

Measures have been chosen on the basis of their assumed effectiveness. Because in many instances the effect of measures is uncertain, the RBMPs propose to conduct more research. As hydro-morphology is seen as one of the major problems in reaching WFD objectives, many measures adapt the physical properties of water bodies to a more natural state. 2500 km of banks will be made more nature-friendly (soft banks, gradual change from land to water) and 635 fish ladders will be constructed (Ministerie van Verkeer en Waterstaat et al. 2009).

Nutrients are the other main obstacle to reaching a good status or potential. Although agriculture causes about two thirds of the nutrients in the water (Planbureau voor de Leefomgeving 2008), no national policies were adopted to reduce these emissions. Instead, improving the efficiency of waste water treatment plants is proposed as a (not very cost effective) measure. The quality improvement is so low that the cost-effectiveness cannot be determined (Planbureau voor de Leefomgeving 2008). Improving waste water treatment is a measure that the water management sector can take on its own. It will be hard to reach the required limit values for phosphates because of leaching out from agricultural soils for decennia to come. With the present manure policy, build-up of phosphates in the soil even continues (Planbureau voor de Leefomgeving 2008).

3.5 ANALYSIS

Coordination

In the Netherlands, the WFD has been implemented while keeping the existing legal, financial and institutional framework intact as much as possible. The existing institutions in water management have all been appointed competent authorities for the WFD and only a coordinating structure on the river basin level, without legal competencies, has been added. An advantage of this arrangement is that policy development, implementation of measures and funding are well tuned to each other. This creates good conditions for the implementation of the programmes of measures. A downside of this arrangement is the complexity of coordination. The process had to be performed at different levels and between different sectors, coordinating between a huge number of competent authorities and with many other stakeholders.

The implementation process appears to have been effective in establishing coordination across levels. The content of the different plans corresponds well with each other and none of the interviewees expressed discontent in this field. The waterboards have taken the initiative in developing the river basin management plans, for instance by organising the area processes and providing draft objectives and measures as the basis for the RBO deliberations. In this way they have been influential in determining objectives and measures. Objectives were set at national (natural waters) or provincial level (highly modified or artificial waters), based on proposals from the waterboards and regional Rijkswaterstaat divisions. In this way, there was both attention for local tailoring and for coordination at a higher level. Hence, the Netherlands seem to have found a “middle path” between ”top-down approaches, which are too blunt and insensitive to local constraints and opportunities” and “bottom-up approaches, which are too insensitive to the contribution of local actions to larger problems” (Cash et al. 2006).

In theory, the institutional arrangement should also promote the integration of sectors, at least at the national level, but in practice it did not. The four river basin plans and their corresponding programmes of measures show that measures were mainly planned in the water sector. The majority of measures are in re-naturalising banks (2500 km) and installing fish ladders (635). Out of 430 municipalities, only 51 have commited to taking measures. Other sectors, such as agriculture, spatial planning and economy, have not officially committed themselves to take measures (Ministerie van Verkeer en Waterstaat et al. 2009). As the ambition brief (Staatssecretaris van Verkeer en Waterstaat 2004) from the cabinet excluded claims of land use change or changes in national manure policy, there was little room for measures in these areas. The actors at a local level, predominantly the waterboards, have no authority to take measures in these sectors. Therefore, it may come as no surprise that the measures in the programme of measures concern mainly the water management sector.

Diffuse pollution by agriculture is generally seen as one of the largest problems to be solved within the requirements of the WFD. To quote Wiering, Rijswick et al., “integration of water management with the agricultural sector is not sufficiently established, either at the European level or at the national level. This has severe consequences for water pollution caused by agriculture. It is not, however, something that can be solved at the decentralised level or by water management alone” (Wiering et al. 2009, p. 232). Agriculture is an important economic sector and the interest of the farmers, their position in the competition with farmers in other (European) countries was not to be impaired (Uitenboogaart et al. 2009).

The waterboards, in most cases, cannot implement the measures without the support of others, so they used the area process, the RBO-process and the sounding board groups to organise support for the measures they proposed and hope to implement in cooperation with others. Furthermore, the provinces have taken on a coordination role in the RBO-process. These parties clearly felt they had the responsibility to act. The municipalities showed some hesitation to commit themselves to the WFD process.

The number of participatory processes and the sheer technical complexity of the deliberations on the WFD hindered the active participation of organised stakeholders. Only the professional and large stakeholders could really handle the complexity. Still, according to 10 interviewees (out of 14), the main result of the process was increased support for WFD measures by those who were involved, facilitated by the many opportunities to discuss different points of view. All agreed that coordination between the organisations improved through the planning process. This is confirmed by the official evaluation of the WFD implementation process (Ten Heuvelhof et al. 2010).

Role of intermediaries

Four intermediaries emerge from our description: STOWA, Project bureau Meuse, water ambassadors and LTO. STOWA connected the waterboards to the Ministry of V&W by providing expertise to both, using the expertise from these organisations as well as from knowledge institutes such as Deltares and Alterra. STOWA was not established specifically for the implementation of WFD, but used the position it had as a knowledge broker to influence the policy process. The expertise they brought in was discussed at all levels of the water management scale. STOWA in this way supported learning and innovation.

The project bureau Meuse had been established by the competent authorities for a limited period of time, to bring together all parties interested in the implementation of the WFD in the basin. It facilitated deliberation between all parties involved and supported innovation and learning by organising and facilitating the working groups, discussing for instance monitoring, and by funding the development of specific instruments. This role could not have been played easily by one of the authorities in the river basin individually.

The role of water ambassadors was not to provide expertise or facilitate the process, but to establish a more personal link between waterboards and municipalities in order to promote awareness about the WFD. In the Meuse area this resulted in relatively active cooperation by municipalities in the implementation process and in a better understanding between municipalities and waterboards. Moreover, the water ambassadors have acted as an example for the Delta-ambassadors, which have recently been appointed to support the implementation of the Dutch Delta programme for improving safety against flooding.

LTO is a highly professional and influential organisation that represents farmers' interests. They contract research, give advice to both farmers and authorities about the impact of regulation and policy on farming, and lobby actively at all levels in different policy fields. They have had impact on the many participatory processes they joined. Seven interviewees stated that the farmers organisations had had a negative effect on the ambition level of the objectives that were set. Five were neutral, two were positive about the role of famers organisations. These five neutrals and two positives remarked that although they were in general not in favour of ambitious objectives and not inclined to take measures, they were constructive partners in the discussions. In some cases, such as the area processes led by waterboard Hollands Noorderkwartier and waterboard Rijnland, farmers and water managers have engaged in joint research to investigate possible measures farmers can implement on their own land.

The intermediaries in this case study contributed to the coordination processes in various ways: by facilitating the process itself, by improving relations, by supplying expertise, or by advocating the interests of a group of stakeholders. The organisations were established specifically for the implementation of the WFD or already existed and adapted to the opportunities provided by the WFD implementation process. They were paid for by the waterboards, the Ministry of V&W, the regional competent authorities, or the farmers. Within this diversity the common factor is that they function in-between the various actors involved in the WFD implementation process.

3.6 CONCLUSION AND OUTLOOK

The aim of this article was to find out whether the WFD promotes integrated water management in practice, using the Netherlands and more specifically the Meuse basin and the area of waterboards De Brabantse Delta as an example. The answer to this question is mixed. On paper, the set-up for implementing the WFD promotes both cross-level and cross-sectoral coordination. In practice, however, cross-sectoral coordination was limited because of conflicting interests which were not integrated at the national and European level and could not be integrated at the regional level. Integration of stakeholders in the implementation process was limited because the highly technical character of this process in fact excluded certain stakeholders. Although intermediaries could not resolve all coordination problems, they did play a positive role in connecting different organisations and individuals, bringing in expertise and supporting learning and innovation.

Two lessons emerge for the next planning round (2012-2015). First, the issue of coordination between water management and other sectors needs to be addressed at both the European and the national level. A key issue at the European level is the common agricultural policy, while also the link between nature protection and the WFD may sometimes cause tension, e.g. when species that are protected under the Habitat directive live in a heavily modified water body that according to the WFD should be restored to a more natural state. At the national level, closer cooperation between different sectors is called for. In the end, implementing the WFD in the Netherlands is not the responsibility of the water sector alone, but of the Netherlands as a Member State, including the agricultural and spatial planning sector.

Secondly, the implementation of the WFD should be less "technical" in order to involve more stakeholders actively and achieve the necessary "buy in". It is true that the WFD itself is very complex, but in the end the whole WFD revolves around only two issues: setting environmental objectives and developing and implementing measures for achieving these objectives. Or perhaps it revolves around only one thing: getting cleaner and more natural water at acceptable costs.

Acknowledgements

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Post script: The role of expertise

As expertise for policy is the main concern in this thesis, the post script to chapter 3 will add some detail on the role of expertise in the policy planning process for the Water Framework Directive (WFD).

The planning process for WFD implementation consisted of setting objectives and choosing cost-effective measures to reach the good status or good potential for all waters. Each water body was to be assessed in the context of the river basin. The setting of objectives and choosing of measures was viewed as a political process, but this process required a large amount of input from experts concerning the present status, the good status and the effects that measures would have on the status of the water bodies. This required going through a number of technical steps:

- defining the boundaries of river basins (and river basin districts)
- defining the boundaries of water bodies
- developing a typology for water bodies to assign a type to a water body such as 'slow flowing brook'
- developing a reference status for each type
- developing a classification system to classify water bodies as 'natural', 'heavily modified' or 'artificial'
- developing metrics to assess the Ecological Quality Ratio (EQR)
- developing a water quality monitoring system
- defining a 'good status' or 'good potential'
- assessing the effectiveness and costs of measures

The procedures, protocols and tools to go through these steps were developed in parallel with the planning process in small committees of experts from waterboards, Rijkswaterstaat, research institutes and consultancies. This development interacted with the development of the Common Implementation Strategy (CIS) guideline documents that operationalized the WFD requirements at the European level. As the technical part was not ready at the start of the policy planning, many technical debates dominated the planning process.

One of the persons responsible for the WFD planning process at the Ministry of V&W explained that they purposely set up the planning process with a major role for the professionals working at the water authorities. (S)he believed that the expert opinion of this group was vital for developing cost-effective programmes of measures and wanted them to arrive at consensus before the proposals were presented to the politically responsible decision makers. Many interviewees, but also authors of other studies on the WFD, reflected on the fact that technical procedures, methods and such were so pervasive in the implementation process that the issue of making political choices was overshadowed (Ten Heuvelhof et al. 2010; Behagel and Van der Arend 2012; Santbergen 2013).

Zooming in on the planning process, the role of experts and expertise in WFD implementation in the Netherlands has different aspects. I will select a few telling examples. The first is Aquarein (Van der Bolt et al. 2003), that is briefly mentioned in this chapter, as an example of how expertise can shape policy. This study by Alterra was mentioned in 9 interviews out of 42 (but keep in mind only about half of the interviewees are directly involved in WFD implementation). All who mentioned it (I didn't specifically ask) did so because they felt it had had a major influence on the implementation process.

Some interviewees praised the shock effect of the report, a wake-up call that made politicians take the directive more seriously and led to a more realistic and pragmatic approach to WFD implementation. Others blamed it for the ensuing lack of ambition, starting from the ‘ambition brief’ which had a lasting influence on the low ambition level of the authorities involved.

Other interviewees suggested that the model used for Aquarein was deliberately set up to demonstrate the disastrous effect WFD would have on agriculture, so farmers could continue their practices as before. They perceived the study as biased, pointing out that the Ministry of Agriculture commissioned this report. Others remarked that Aquarein neglected to take into account the possibility of derogations and by doing so presented too bleak a picture of what WFD implementation would mean for agriculture in the Netherlands. The model may have been fine, but the outcomes were viewed as one-sided. Representatives from a research institute (not Alterra) said that the report corresponded with their own research and stated that the objectives set in the first round of WFD planning could not be met without a major restructuring of the agricultural sector. The setting of objectives, according to them, had not been unambitious; however, due to a lack of information, they had often been set to the default value of 0,6 EQR (meaning good, without using derogations), which in many cases was hard to reach.

The report supported the farmers’ case, intentionally or not. The government responded by declaring, in the ambition brief, that in view of the recent measures to comply with the nitrate directive no generic agricultural measures to reach WFD objectives would be taken. This position was strengthened by the acceptance of a motion in 2007, requesting the government not to inflict any additional costs - on top of the nitrate action programme - on the agrarian sector as a consequence of the implementation of the Water Framework Directive (motie Van der Vlies, June 28, 2007). The agricultural organisations used the report’s results in their campaign to lower the WFD objectives from the start, instead of waiting to use this derogation until the last planning period, as the pragmatic approach stipulates (LTO 2006; LTO 2007). The campaign, however, did not succeed.

Since the measures would be limited to the hydro-morphological aspects and waste water treatment the playing field was outlined and the ball was in the court of the water management authorities. However, some interesting examples showed that local collaboration between sectors can lead to measures going beyond the legal requirements. For instance, the waterboard Hollands Noorderkwartier organised a working group including farmer organisations, the neighbouring waterboard Rijnland and the local environmental agency[1], in order to address specific water quality issues related to flower bulb growing. It resulted in joint experiments to reduce the impact of the sector on water quality (Hoogheemraadschap Hollands Noorderkwartier 2008). Several waterboards developed plans, collaborating with municipalities and nature area managers, applying for synergy funding from the nature department.

Aquarein showed how expertise can affect policy. Some people were convinced that the expertise of Alterra was deliberately used by the Ministry of LNV in order to protect the interests of the agricultural sector. Even if that is not so, it is a striking example of how expertise can be perceived. The resulting policy, the pragmatic implementation (or the ambition brief) had in turn a large effect on the technical procedures that experts were asked to develop. An example is the classification of

[1] Local municipalities work together in the field of environmental protection through an environmental agency executing joint policy (permits, monitoring, fines).

water bodies, that showed a strong bias toward non-natural water bodies as will be elaborated in chapter 7.

A second aspect of the role of experts and expertise was in the setting of objectives and the choosing of measures. Although these were acknowledged to be political choices, they also required much expert input. The objectives were related to the assessment of the good ecological potential of a water body, which was viewed as a technical matter. As most water bodies were classified as non-natural, the objectives were derived from the maximum ecological potential a water body could have. Roughly put, this means the properties the water body would have if all human influence were reversed. The good potential would then be the properties the water would have if all but the 'necessary' human influence were reversed. Obviously these are very technical, as well as very contentious, matters. What would be the reference state of a drainage canal and, for that matter, what is reversible and what is not? Here policy and expertise were intimately entwined.

Thirdly, there was the process of knowledge development within the various communities of experts. Much of the knowledge regarding the effects of measures on water-based ecology was not available. The gaps in knowledge were dealt with in many different ways. Research projects were set up, but most would not yield results in time for the first planning period. Expert judgement as is elaborated in chapter 7 was one method of dealing with this.

Another method to deal with gaps in knowledge was using modelling tools to simulate the (possible) effects of measures in various ways. In the first round of planning, three different model instruments were adapted or developed to support the WFD implementation; the Waterplanner, the WFD ECHO and the WFD Explorer. Although the models had a similar main goal - showing the effects of (WFD) measures on ecology and/or the chemical properties of the water - they had a different emphasis as they were developed by different people for different specific purposes.

The Waterplanner was developed by the PBL Netherlands Environmental Assessment Agency. PBL is an institute funded by the Ministry of Housing, Spatial Planning and the Environment (VROM)[1], with the objective to provide independent scientific policy evaluations, solicited or un-solicited[2]. As they anticipated doing an evaluation of WFD, but also other studies regarding ecology and water quality, they developed the Waterplanner. The Waterplanner calculated the effects of sets of measures on the Dutch water system as a whole. It worked on a national scale, providing an overall picture, not a specific prediction for a specific location.

The PBL was asked to do the ex-ante evaluation of the effects -and assessing the costs and benefits- of the measures included in the WFD programmes of measures (Planbureau voor de Leefomgeving 2008). They used the Waterplanner to model the effect of the provisional programmes, first normalising all planned measures into one set of measures. The effects were related to the set objectives, which were also not finalised at the time. The ex-ante evaluation was done instead of the societal cost-benefit analysis (scba) the WFD requires, because a complete scba was deemed

[1] VROM merged with V&W to form the Ministry of Infrastructure and the Environment (I&E)
[2] Website PBL, 22 10 2013, http://www.pbl.nl/en/aboutpbl : We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all our studies. We conduct solicited and unsolicited research that is always independent and scientifically sound.

impossible due to too many methodological controversies and time constraints at the time (Santbergen 2013; Planbureau voor de Leefomgeving 2008).

The WFD ECHO was a tool developed by Alterra to calculate the effects of measures on the chemical properties of surface water[1]. The ministry of LNV commissioned the ex-ante evaluation for agriculture and the WFD (Van der Bolt et al. 2008) for which the ECHO was applied. The approach was based on the work done for Aquarein. For the ex-ante evaluation for agriculture, the Netherlands was divided into 119 sub-areas. The ECHO calculates the water quality on the basis of simplified balances of nutrients going in and out of the sub-areas. The effect the ECHO calculated was the current manure policy combined with the programmes of measures described in the draft RBMPs for the years 2015 and 2027. In addition they calculated the effect of extra measures at the level of farms, plots or ditches, such as precision farming or helofytes filters.

Both for the ECHO and the Waterplanner, data from the waterboards was needed. The PBL used the data as supplied for the national planning process, Alterra asked for additional data or the same but in a different format. There was little understanding for this. Some interviewees vented their dissatisfaction with both the data collection and the lack of feed-back on the results of Alterra's calculations. These interviewees were much in favour of merging the different instruments.

The WFDE will be the subject of discussion in the next chapters.

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Chapter 4

WFDE development in three components and five phases

The previous chapter concerned the implementation of the Water Framework Directive (WFD) in the Netherlands. To support the planning process an instrument was developed, the WFD-Explorer (WFDE). This chapter presents a chronological description of the development of the instrument over a period of nine years, from its inception to the first release of the redesigned instrument, as a background for the following three chapters. These will only present the case description required for the specific analyses presented in the respective chapters.

4.1 INTRODUCTION

This chapter describes the development of the WFDE focusing on the changes over time of the following three components of the instrument:

- The user interface, allowing the user to access and manipulate the models and data that constitute the core of the instrument;
- The ecological model, a set of 'rules' that describe the relations between the physical and chemical properties of a water body and the ecological properties;
- The water quantity and chemical quality model, describing the water flows through the water system and the concentrations of a number of chemical substances.

For the description the development process is divided in five phases:

- 1: proposal writing, planning, prototypes (2004-2006)
- 2: from prototype to operational instrument (2006-2008)
- 3: evaluation of the WFDE-1 (2009)
- 4: redesign (2009-2011)
- 5: pilot and release of the WFDE-2 (2011-2013)

In addition, I will present actor-network diagrams (see chapter 2) that visualize the main actors involved in the development of the WFDE. As the actor-networks change over time, separate actor-network diagrams for each phase were drawn. To emphasize the temporary nature of these networks, I refer to the diagrams as 'snapshots'.

The snapshots are centred on the WFDE, and only the actors that had a direct impact on the development of the WFDE and the relations between these actors that concerned the WFDE have been included. Please note: it is likely that there are many more relations between these actors; I only included them when they concerned the WFDE.

The snapshots foreshadow the use of Actor-Network-Theory (see chapter 6). Latour (1996 p 2) specifically warns not to confuse actor-network theory with the study of social networks, which he describes as the "social relations of individual human actors in the sense of their frequency, distribution, homogeneity, proximity". The actors in the snapshots are related on the basis that they do things together: they negotiate; they exchange money, knowledge, data and so on. Actions are key; through actions the actor-network and the resulting WFDE are shaped. It is typical for actor-network-theory that non-human actors are not a-priori assigned another status than human actors;

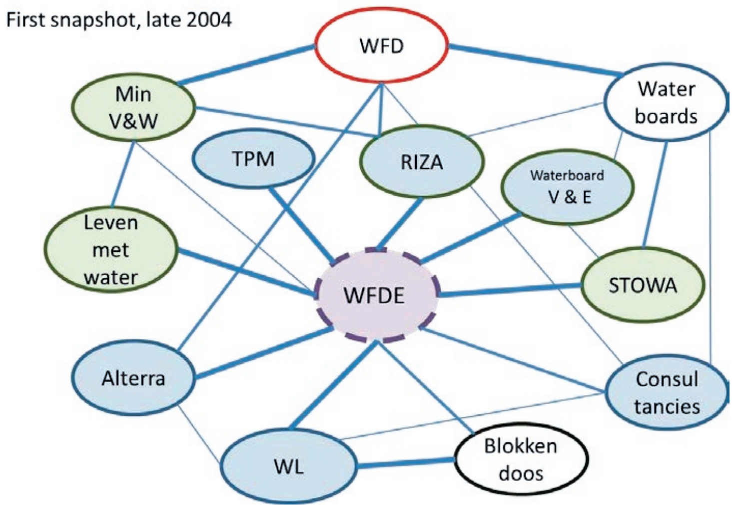
also, actor-networks are fluid in the sense that connections are made and broken over time. Latour (1996 p3) moreover remarks that nodes (actors) have as many dimensions as they have connections, a metaphorical expression that is not easily visualised. This suggests that connections are different in nature, can have multiple purposes, and therefore each connection needs to be investigated. In the snapshots presented in this paper, the connections can best be viewed as vectors that have both a strength and a direction (a type of effect), although the following actor-networks are drawn in a simple plane. The trial of strength, as in a tug-of-war, by all these actors determines the direction in which the result of the actor-network (the WFDE) will go.

4.2 The five phases of WFDE development

Proposal writing, planning, prototype (2004-2006)

The implementation of the WFD in the Netherlands meant new requirements for policy making, as well as new opportunities for authorities, research institutions and companies (see chapter 3). With this in mind, RIZA and WL | Delft Hydraulics came together and initiated the development of a decision support system, specifically to support WFD planning. RIZA was a research institute of the authority for the national waters, Rijkswaterstaat, part of the Ministry of Transport, Public Works and Water Management (Min V&W). It had a good reputation in both water quality and quantity management. WL | Delft Hydraulics, or in short WL, was a research institute known especially for water quantity-related research. The two parties had worked together on many occasions and they would become joint leaders of the consortium. Their intention was to develop an instrument similar to the Blokkendoos, or “Planning kit for the rivers”, which WL had developed for Rijkswaterstaat to support communication between parties involved in flood risk management for the main rivers. It allowed users to directly assess the effects of flood risk reduction measures (Schijndel 2006). It was not a modelling instrument, but a presentation tool that showed the results of earlier model runs. The instrument RIZA and WL intended to develop would focus on ecology rather than flood risk and would supply the information that RIZA and WL thought to be indispensable for WFD implementation.

Before the actual development of the prototype could start, RIZA and WL sought partners to work with, as well as funders. Funding was obtained from the Leven met Water (LmW) fund that was initiated by various governmental authorities to stimulate innovative approaches for water management. Furthermore, STOWA, the research funding foundation for the waterboards, was willing to contribute financially. One waterboard joined the consortium and contributed in kind, as did RIZA. Moreover, the faculty of Technology, Policy and Management (TPM) of the Delft University of Technology was contacted because the initiators had collaborated with them before and they were known to have an interest in participatory policy development and the development of instruments to support such processes. In addition, Alterra, the Dutch research institute for nature and agriculture, was asked to join as they had knowledge of ecosystems as well as data sets and instruments that were considered useful. Finally, representatives of two consultancies with expertise in the field of ecology and information systems joined the consortium.



In the first snapshot, the WFDE node is given a dotted line, as it was discussed, but not yet realised. The green outlines signify the actors that contributed to the funding, the blue are all the other human actors. Blue fill refers to all actors actively involved in the WFDE development. The red outlines refer to policy domains and the black are artefacts. The weight of a line indicates the strength of the connection (see chapter 2.4).

The consortium partners wrote a research proposal with three strands of research. The first was the development of a user-friendly interface to encourage its use in the planning process. Policy makers at the waterboards were expected to be the users, as they would be active in the planning process. The waterboards were expected to implement and fund a large part of WFDE measures. The second research strand was to monitor how the WFD policy planning process was going to be organised, as the WFD was new and it was unknown how exactly it would be implemented. The consortium kept in touch with those responsible for the design of the planning process and prospective users, and explored how, when and where the instrument could play a role in the planning process. The third strand was to develop a model that could give an indication of the effects of measures on ecology. Although various partners brought in expertise in this field, no all-encompassing ecological model existed in the Netherlands and therefore an important task was to compile the available knowledge from all partners in a usable way.

The parties involved expected that the use of a shared body of knowledge, materialised in the instrument, would contribute to a standardisation of the policy planning process in the Netherlands. If all water management organisations used the same methodology and the same terminology, this would enhance the transparency and efficiency of the decision making process (Consortium development WFD Explorer 2005). Additionally, an instrument such as this would help to justify to the European Commission the environmental objectives set for the different Dutch water bodies. This was clearly something the national water management organisations, the directorate-general Water (DGW) of the Ministry of V&W and Rijkswaterstaat, were interested in.

The user interface should enable any interested user, explicitly including non-experts, to manipulate the instrument. Therefore, the consortium decided that it would provide a screen showing a basic map, a list of possible measures, a list of water bodies in the region at stake, and the result of the measures in ecological quality scores on each of the four indicators required by the WFD[12]. The map would depict the water bodies in colours representing the scores. It would enable the users to assess the total scores for water bodies as well as the scores on individual indicators, both currently and as a result of measures. The interface should enable an exploration of possible measures providing input for discussions between stakeholders, so ample consideration was to be given to the look of the interface: a minimum of options, the use of non-specialist language, and a clear lay-out and graphics.

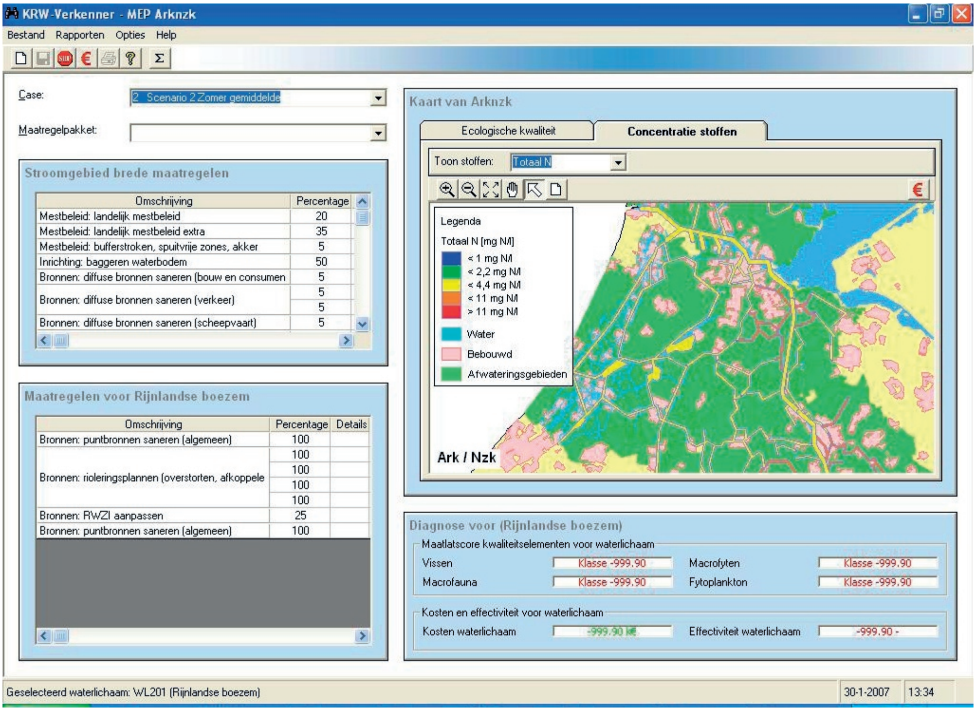


Figure 2 screenshot user-interface WFDE-1

To assess the effects of measures, the ecological model was key. The consortium intended to develop a deterministic set of rules describing the effects of the physical and chemical properties of water bodies on the ecological indicators. The idea was to use a list of possible WFD measures provided by the national water authority. When the proposal was written, this list was not yet available, but it was expected to contain a large variety of measures. To allow users to explore these measures, they would be listed in simple terms. The instrument would translate the chosen measure into specific changes in physical and/or chemical properties of the water body. The assumption was that these properties could be used to predict the ecology of a water body. Five groups of parameters or

[12] phytoplankton, water plants, invertebrates, fish,

‘steering variables’ were identified: flow (hydrology, such as flow speed, water depth, etc.); substances (water quality, such as nutrients, acidity, etc.); structure (water body properties, such as water body profile, type of bank, canalisation, weirs, etc.) and system (climate, topography, soil type, etc.). Water management practices such as mowing and dredging were also to be taken into account. The effect of the changes in specific steering variables on the individual ecological indicators, using WFD-specific metrics, would be calculated and subsequently compiled to represent the future status of a water body.

Sophistication in the water quantity and quality modelling was not required, as the WFDE was meant to be an exploratory instrument and it required a high calculation speed to be applicable in interactive settings. Moreover, water quality and quantity were seen as mere input for the more important and innovative ecological model. In addition, the consortium was under time pressure due to the funding scheme, which required a working prototype within a year in order to secure additional funding. When the development started, the developers soon switched to running calculations ‘on demand’ instead of presenting the outcomes of pre-defined options - abandoning the idea of the ‘flood-kit’ - because of the many different water-body types and measures. This presented an additional reason to limit calculation time.

In October 2005, the first prototype of the WFDE was completed. This “proof of concept” convinced LmW to extend its funding to the end of 2006. The development of the rule-sets contributing to the ecological model was an important part of the research. As part of the proof of concept, rule-sets had been developed for two types of water bodies, lakes and brooks, demonstrating that changes in physical properties could be related to changes in the ecological scores, but many rules were still missing due to lacking data and disagreement over the proposed rules based on expert-judgement.

In the first prototype, a ‘bucket’ model had been incorporated that represented water bodies and their drainage areas as ‘buckets’, or water basins. It catered for a relatively small number of ‘buckets’ and only a limited number of attributes, such as water volume, chemical properties, sources of nutrients, types of banks, level of meandering. The model could also calculate simple chemical balances representing water quality. The focus was on rendering those aspects that were relevant for ecology, rather than a perfect representation of all the processes in the water system. The development of the bucket model was seen as a specialised, but routine, task and was given to an experienced WL engineer working relatively independently. Yet, the bucket model design would influence the development of the WFDE for many years.

The mathematics in the bucket model described water balances, not actual flows, based on averages over time (summer or winter). For lakes, water turbidity was taken into account by an additional equation describing wind friction causing substances to swirl in the water. For streams and canals water depth was included and a distinction was made between water bodies that were regulated by weirs and those that were not, which was relevant for connectivity and therefore fish migration. Furthermore, underwater surface roughness was included as this relates to vegetation growth and flow speed.

In late 2006, a second prototype was completed, covering all types of water bodies and over forty types of measures. By then, TPM had lost interest in the project, as the focus shifted to the technical completion and perfection of the instrument, while the connection with the policy process moved to the background. Alterra also retracted from the development, as far as I can reconstruct due to disagreement regarding the representation of the nutrients emitted by agriculture. On the other hand, the Ministry of Transport, Public Works and Water Management, regional divisions of Rijkswaterstaat and several waterboards were getting more interested, as the WFDE was potentially very useful for WFD implementation.

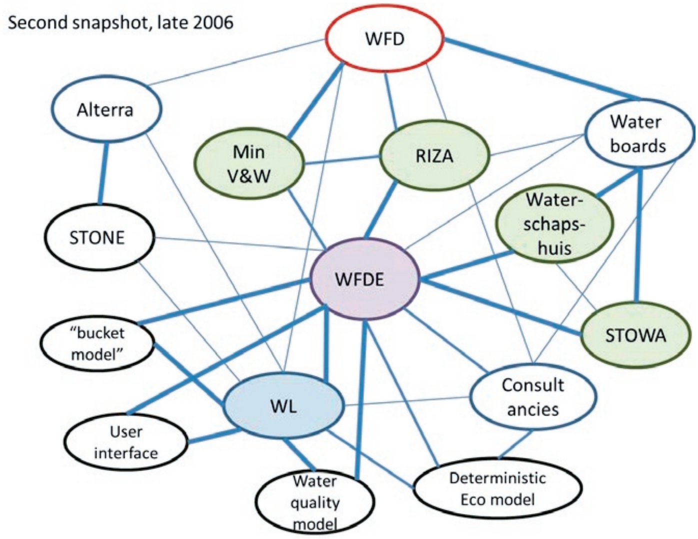
From prototype to operational instrument (2006-2008)

The next phase of the development required a new organisational structure of the project that was better suited for issues such as the training of potential users and operation and maintenance (O&M). Starting with a loosely-organised research-oriented project, the parties interested in continued development developed a more formal hierarchical structure. RIZA became the main client and process manager for the project, and WL the main contractor and project manager. Staff from both organisations formed the project group that would turn the prototype into a product that could be transferred to the waterboards and any other interested party.

The WFDE was to be freely available, so no funding could be generated from the use of the instrument. For the continued development and maintenance of the instrument, the project team sought other funding. A new funder in this phase was the Waterschapshuis, the institute for the management of joint ICT services for the waterboards, signalling that most waterboards were expected to start using the WFDE. A formal steering board was established with all the funding parties (the DGW, RIZA, STOWA and the Waterschapshuis) and a representative of the consultancy sector. In 2007, these funders agreed to jointly fund WFDE, each contributing an equal amount. Additional specific requests, such as those from RWS for specific applications, would be paid for separately. That became the model for the following years: a small sum for general development was to be increased with funding for specific functionalities and studies, or with resources from related projects.

The operational instrument was to have the same four elements as the earlier prototypes: a user interface, the deterministic ecological model, the 'bucket' model for water quantity and the coupled water quality processes model. Documents in this period no longer mentioned the 'planning kit' as a model to follow. Although Alterra was no longer one of the developers, they agreed to facilitate the use of their STONE[13] data and scenarios. STONE was thought to provide the best available information on nutrients and manure scenarios, but it used different units of analysis than the WFDE, so STONE could not easily be connected to the WFDE.

[13] STONE is a simulation model that is used to assess the consequences of manure policies for the emission of nitrogen and phosphorous to ground water and surface water. It is used for national policy evaluations. (http://www.wageningenur.nl/nl/Expertises-Dienstverlening/Onderzoeksinstituten/Alterra/Faciliteiten-Producten/Software/STONE/Over-STONE.htm, accessed 20 11 2013)



In the first half of 2006, the second prototype of the WFDE was tested in four pilot studies, three in the Netherlands by a number of waterboards and three regional offices of Rijkswaterstaat, and the fourth in Belgium by the University of Gent. All applications were set up for different purposes, but all focussed on water quality and none on ecology.

In September 2006, a prototype version was made available for other users than the pilot hosts. Although the instrument was not yet complete, interested users - amongst which many regional water authorities - could already start developing their own application by making a schematisation of their own water system; this meant filling the 'bucket model' with local data. It was estimated to take six months. In many cases consultancies were hired for this task. The idea was that if the schematisation was finished they could start using their application as soon as the fully operational version of the WFDE was released.

End of March 2007, the first full version of the WFDE was released, together with an elaborate manual, detailing when, why and how to use the instrument and when not to. New versions were released shortly afterwards, to add functionalities or solve problems. The consortium received the first feedback from a growing group of users: consultancies as well as waterboards and Rijkswaterstaat. One of the first comments concerned the manual import of data. As the WFDE was supposed to be an exploratory instrument that was to provide a quick indication of the effects of measures, the developers had not anticipated the need to handle large amounts of data. Furthermore, the developers had focussed on the front-end of the instrument, the output, not on the back-end, the input, as developing that part was seen as a fairly routine matter. They assumed that the prospective end-users - policy planners - would first and foremost require a user-friendly interface, as the input was expected to be the responsibility of technical staff at waterboards or consultancies, who were assumed to accept the instrument as a normal part of their work.

Figure 3 screenshot starting screen WFDE-1

At the start of the second phase, the ecological model was incomplete and new rules were added incrementally. The developers allowed rules of different types, i.e. well-established deterministic rules, statistical relations and rules of thumb, to be included side by side. As said, the ecological model had to calculate the effect of each measure on each of the four indicators for all forty sub-types of waters that formed part of the new classification of waters developed for the implementation of the WFD. The main types were rivers (R), lakes (M), transitional waters (O) and coastal waters (K). To simplify incorporating the classification in the WFDE, water types were lumped. Moreover, each measure was described in a fact sheet in the 2006 manual, explaining how to apply and interpret the measure in the WFDE. Most fact sheets are one-pagers, but some are more elaborate. Although the developers had made an effort to be transparent, the main issue for users was that the modelled effects of measures were hard to trace back to the rule-sets. Therefore, users quickly discarded counter-intuitive results.

Peer reviews of the ecological knowledge rules by experts from various institutes and organisations were held in late 2006 and early 2007, which resulted in the rejection of several rules, such as those for water plants in river-type water bodies. Especially the second peer review was disheartening for the developers. Not only were some rules rejected, causing gaps, but it also became evident that the reviewers did not agree on the value of many other rules. Moreover, the assessment method chosen cancelled out the very negative and very positive reactions, which could lead to a qualification of 'acceptable' validity, while in reality confidence was low. On the other hand, as every effort had been put into finding and assessing ecological knowledge, many of the ecologists involved accepted that this was the best rule-set that could be had at the time.

Mid 2007, the developers had gotten the impression that the WFDE was not going to be used as a decision support instrument in the policy planning process. They thought one of the causes was that the user-interface did not provide all necessary information to users, and consequently improvements were planned for that part. In addition, the search for better measure-effect rules was intensified. Consultancies, research institutes and universities were approached for contributions. Some of the measure-effect relations could only be calculated with input from Alterra's modelling instrument STONE, but STONE was connected to the WFDE only in 2008, and in a roundabout way at that.

The bucket model, although apparently functioning well, elicited comments on the simplicity of water and substances balances and the limited number of buckets and attributes users could use. Users requested changes to enable more detailed and more precise calculations. The exact nature of the changes is unclear, but the concern that these changes would and did considerably increase calculation time is well-documented.

The late 2008 release had an improved user-interface for making reports and comparing different sets of measures. It contained more mapping facilities and it allowed for assigning specific norms per water body. The calculation time was said to be reduced in comparison with the previous release. By that time, however, it had become clear that the instrument would not be used much in the planning process, and after the atmosphere of anticipation and enthusiasm in 2007, the mood had changed to disappointment.

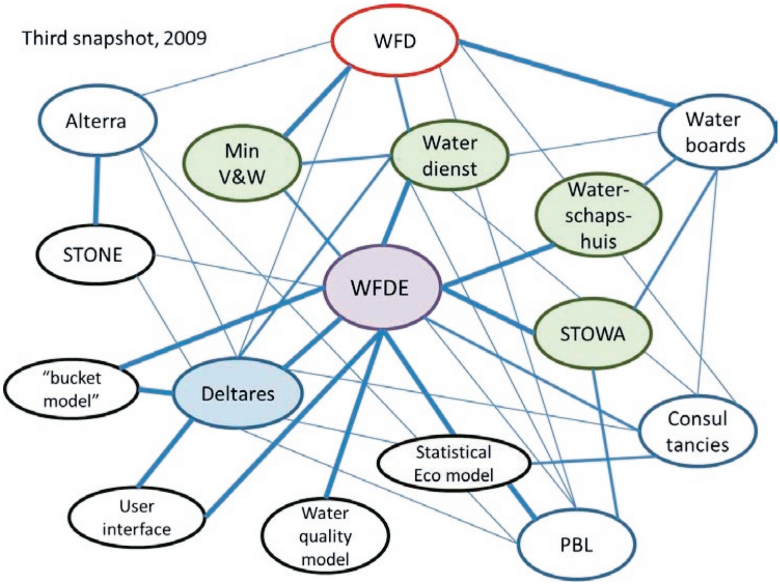
Evaluation and planned redesign (2009)

In January 2008, WL and parts of RIZA had merged to become Deltares, the applied research institute for delta areas[14]. Many of the RIZA experts on water quality and quantity became Deltares staff. The remainder of RIZA merged with (parts of) other research departments within Rijkswaterstaat to form the Waterdienst, the water-related knowledge institute within Rijkswaterstaat (for the transition at Rijkswaterstaat see Van den Brink 2009). The Waterdienst supported the policy development at the Ministry, but instead of doing research itself, it outsourced research to institutes and consultancies, such as Deltares.

In 2008-2009, the WFDE was evaluated. A consultancy was hired, one that had applied the WFDE itself for some waterboards, which conducted interviews with waterboard staff late 2008 (Reeze and Vlieger 2009). The starting point for the evaluation was that many waterboards were not using the WFDE, although they had started setting up the application or had expressed an interest in it. The objective was to find out why this was so, what alternatives to the WFDE were used, if any, and what would be needed to improve the WFDE. The main issues that came out of the evaluation concerned the flaws in the ecological model, the calculation speed, the user-interface, and the limitations of the water quality processes included. Another issue that became apparent was that the end-users, the policy makers, would hardly even look at the instrument before the specialised experts had approved of it.

[14] The merge also involved the research institute GeoDelft, parts of the research institute TNO and parts of other research institutes of Rijkswaterstaat

The steering group decided to continue the development of WFDE, leading to a new and last version being released in October 2009, but after that, Deltares was to completely redesign and reprogram the WFDE (hereafter WFDE-2). The parties involved were convinced of the promise the instrument had, but further improvements were clearly required. Several discussion meetings for the national stakeholders and one for the waterboards were organised to provide input for the redesign. The ideas were collected in the 'vision document' (July 2009) drafted by Deltares for the steering group.



For the ecological model, the developers still did not have a complete and coherent set of rules that produced acceptable results. A promising solution presented itself with the so-called ex-ante rules for ecology, which Royal Haskoning, a consultancy, had developed for the ex-ante evaluation of the WFD by the Environmental Assessment Agency (PBL) (Planbureau voor de Leefomgeving 2008). The PBL was (and is) an independent policy research institute financed by then the Ministry of VROM, now the Ministry of I&M. The ex-ante rules were based on statistical relations between water body properties and ecological indicators and had been developed using a neural network analysis. Like the earlier knowledge rules, these rules assume that ecology can be predicted on the basis of the physical and chemical properties, but no cause and effect relations are derived. The neural network only establishes that in cases where certain properties (steering variables) were present, there was typically a certain score on the scale used for WFD, the EQR[15]. In other words, it detects a statistical relation between steering variables and the ecological status.

The ex-ante rules were first mentioned in a newsletter in June 2008. In the article, the developers assessed whether and how they could be implemented in the WFDE. They could replace the existing rules, which the developers saw as incoherent, or they could fill in the gaps in the current rules-set or

[15] Ecological quality ratio; the EQR ranges from 0 to 1, where 0 is the worst and 1 the best possible status. The WFD states than the lowest scoring ecological indicator determines the overall score. One out, all out is how this is generally referred to. The WFDE allowed users to assess all four indicators separately.

substitute inadequate ones. In the newsletter and at subsequent meetings, the developers announced that the ex-ante rules would not be included before the end of 2009, but they were part of the last release of the WFDE-1 (October 2009) in the form of a decision tree (see figure 3). Transparency of the instrument was an important objective for the members of the steering board and therefore decision trees were chosen. These would also be included in the WFDE-2.

It remains unclear who promoted this change from a deterministic model to decision trees based on a statistical analysis, but it was evident that the new set of rules had credibility - which the old set lacked - because it was used to evaluate the measures for the WFD. It did not end discussions. A part of the users was opposed to this type of analysis because it provided no insight in the water system and the causes of a poor status. Others were dissatisfied with the hard cut-off points in the decision-trees method, which for example meant that a small difference in phosphorous concentration could mean the difference between two classes in the WFD metrics (figure 3).

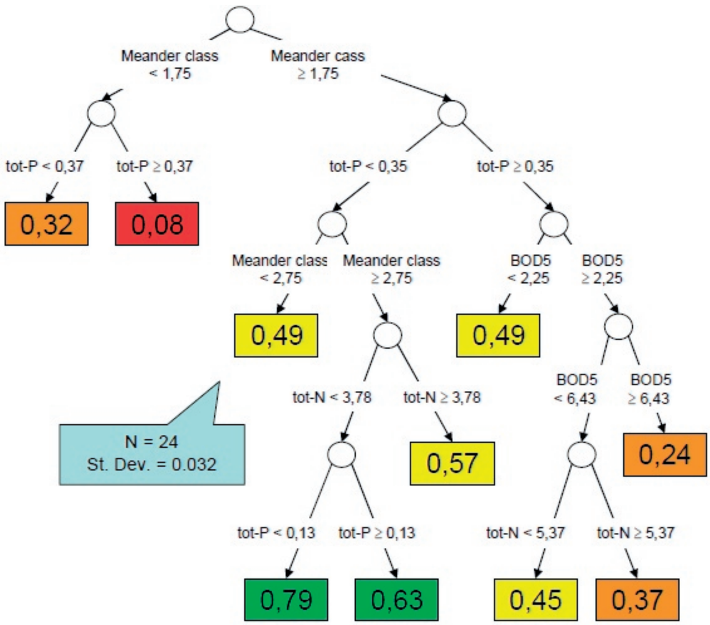


Figure 4 example of decison tree. Each end node is an average value (EQR, based on N samples). The number of values in the end node (N) and the standard deviation are presented as well.

The use of SOBEK, a Deltares instrument to develop water quantity models, instead of the bucket model was also ardently debated. The evaluation suggested that nearly all waterboards used SOBEK, and "everyone" would welcome using SOBEK (Reeze and Vlieger 2009)[16]. Deltares staff expressed their conviction that using SOBEK would allow for a much better representation of the water system and the water quality processes, as it would simulate them more realistically. At the public user

[16] I was rather surprised about the vehemence of this statement. My sources (and the interview reports included in the evaluation report) don't show that all waterboards did use SOBEK then. When the consortium began late 2004, fewer waterboards used SOBEK than when the consultancy evaluated the project and nearly all waterboards had thought about using it or experimented with it, which may explain their statement.

meeting in April 2009, the representative of the Ministry of V&W announced plans to use SOBEK in WFDE-2. A national SOBEK application would be made and cut-outs would be made available for regional uses. The minutes of the meeting note that participants viewed this as "less desirable". This is rather an understatement, as the waterboard representatives vehemently rejected this idea, claiming that any model for ecological assessments needed to be developed bottom-up and could never be derived from a generalised national model. The attendees did not, however, reject the use of SOBEK as such.

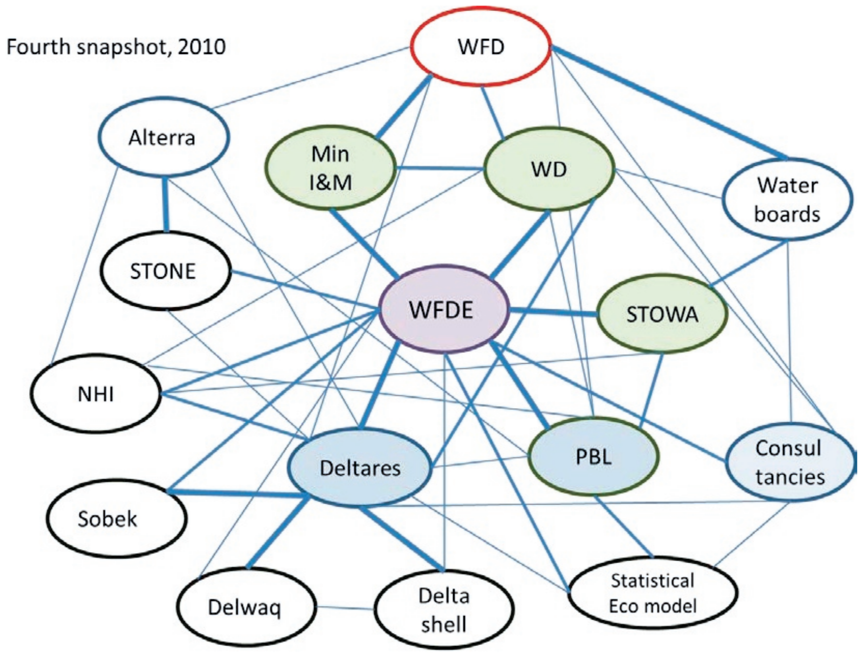
The vision-document of July 2009 referred both to 'connecting' WFDE and SOBEK and 'basing' WFDE-2 on SOBEK. However, the project plan of October 2009 stated that WFDE-2 would remain an independent instrument and would not become a module in or a shell around SOBEK. Incorporating SOBEK would mean users would have to pay SOBEK licence fees, while the funders insisted that the WFDE had to be made available for free.

Redesign (2009-2011)

For the redesign, which started November 2009, Deltares formed a 'coding team', consisting of the professional programmers who would write the code for the new WFDE, all Deltares staff. In addition to the steering group and project team, two advisory 'working groups' were started with Deltares staff as well as experts from other institutes and water authorities. One group was concerned with the ecological model and the other with the schematisation. STOWA provided funding for two external experts to join the working group for ecology and provide peer review on the developed ecological model.

Funding needed to be acquired on a year by year basis, and was always low. Deltares had to invest as well. As before, additional functionalities or deliverables were commissioned by individual funders, which made project planning and control quite complicated and the life of the steering group quite hard, as certain aspects of WFDE development were beyond their control. One of the steering group members called the development process "trying to aim at a moving target."

The PBL decided to participate in the redevelopment of the WFDE. They would contribute in kind and provide funding too. Two staff members joined the project team and one the steering board. All of them had many years' experience with the development and use of information systems for policy support. Their intention was to develop the WFDE into an instrument that could replace their own instrument, the 'Waterplanner', which had been used for the ex-ante evaluation.



The redesign started with the development of the specifications for WFDE-2. Instead of the standard procedure of writing terms of reference leading to a functional design, a new 'agile' software development method was chosen, involving writing so-called 'epics' that describe the processes the instrument would have to support from a users' perspective. User-stories would then describe the steps in the process in greater detail. The project team developed the epics and user-stories based on their experiences with WFDE-1 and the PBL instrument, the Waterplanner.

In March 2010, a staff member of Alterra joined the project team, contributing expertise in the field of water quality and programming, as well as access to data and scenarios in STONE, which was still viewed as the best source for data and measure-effect relations related to agricultural practices.

The actual programming was done in 2010, in four phases, each focussing on a specific part of the instrument. Figure 4 shows the conceptual model of the WFDE-2. In each phase a number of short sprints of two or three weeks were held, involving one or two user-stories. The results of each sprint were presented to the project team in a demo at the end of each sprint. This led to quick basic versions of the module concerned, which were further developed in subsequent sprints to arrive at the end-product. After each phase was completed, a user-meeting was organised to present the result. In 2011 pilots were scheduled, after which a few more sprints were scheduled to solve emerging issues.

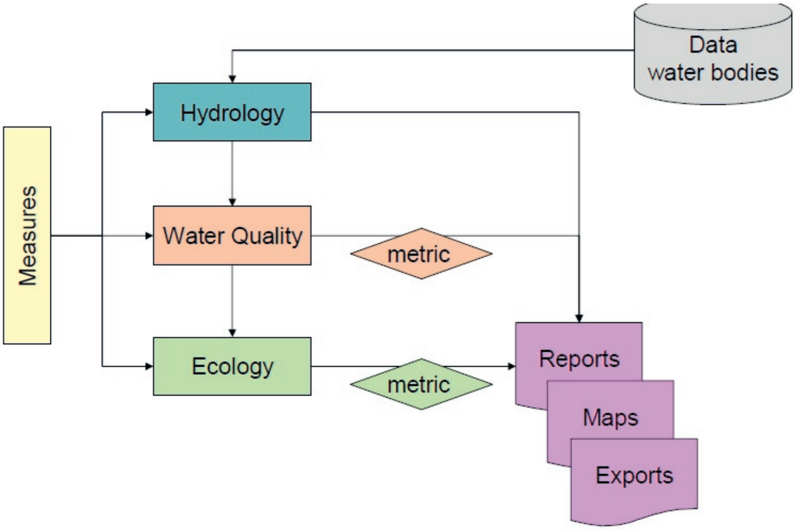


Figure 5 Conceptual model of WFDE-2
Source: Presentation Karlsruhe, accessed online 08 02 2016 https://publicwiki.deltares.nl/display/KRWV/Algemeen

The user-interface of WFDE-2 was to be usable by both experts and non-experts. It was centred on GIS functionalities: various types of maps could be imported to show the results on, but also to base the water system schematisation on. Tabs allowed for easy shifting between different views, while split-screens could show up to four views at the same time (see figure 5). The dominant work-flow started with automatic import, but it was also possible to start from a map and manually define water units and catchment units, plus connections between those. The effects of measures would be calculated by defining specific cases that applied specific measures. Measures had to be translated into changes in parameters by the users. Users could then choose to focus on water quality only, or run both water quality and ecology models. The top-left folder structure in figure 5 provides an overview of the various data used and the cases that have been calculated. The new user-interface had better graphic capabilities and provided many more options for the user. This, however, made it less useable for less-experienced users.

The WFDE-2 was one of the first instruments to be developed under the umbrella of Delta Shell, which explains much of its “look and feel”. Delta Shell was developed as a shared platform for Deltares software, so products could be easily connected and software development could benefit from the generic functionalities such as data base structures. On the downside, it limited the programmers’ room for manoeuvre.

The development of the ecological model itself was not part of the redesign project, but the ecological model was developed further by Deltares in a parallel project, with input from external experts. The WFDE project team tried to make certain that the model could be run within the WFDE, so information was exchanged and mutual consultation took place.

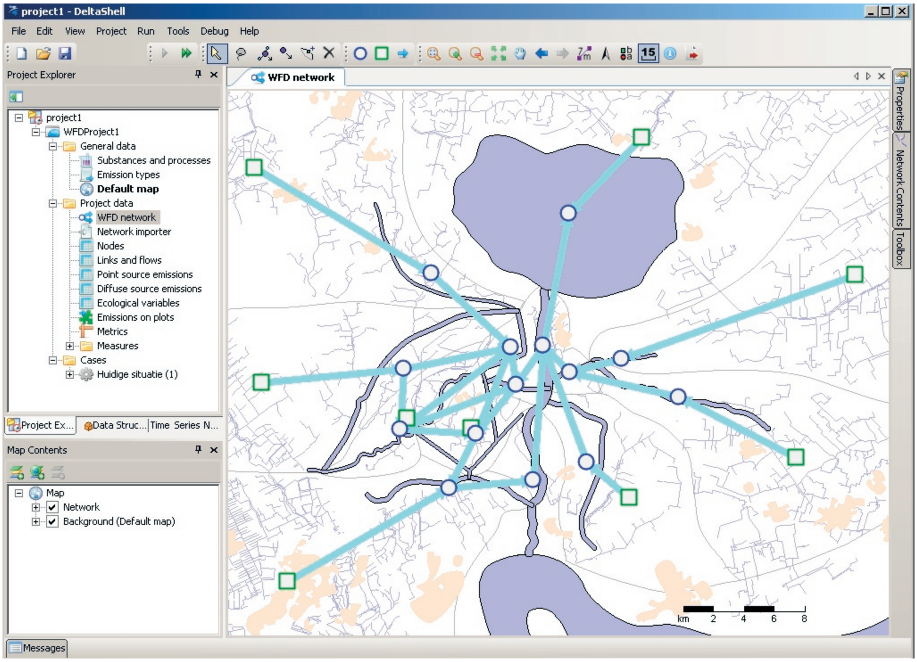


Figure 6: Screenshot user interface WFDE-2

The WFDE-2 started with an ecological model based on the ex-ante rules mentioned before. An update of these rules using the latest datasets was foreseen, but they were also planning to explore possible other methods. In time, an alternative statistical method was developed as a possible alternative for the neural network approach and the decision trees derived from that. In addition, preparations were made to include the ecotope concept that RWS had started to develop for the state waters. Ecotopes are areas within a water body with a specific ecosystem. The value of the ecotope is determined by the observed species and their abundance. The ecotope method would be more suited for the large national waters than the ex-ante rules, which were developed for the smaller regional waters. In a second parallel project, the rule-sets for the ecotope method were developed to describe measures and their effects in terms of changes in ecotope surfaces and characteristic species.

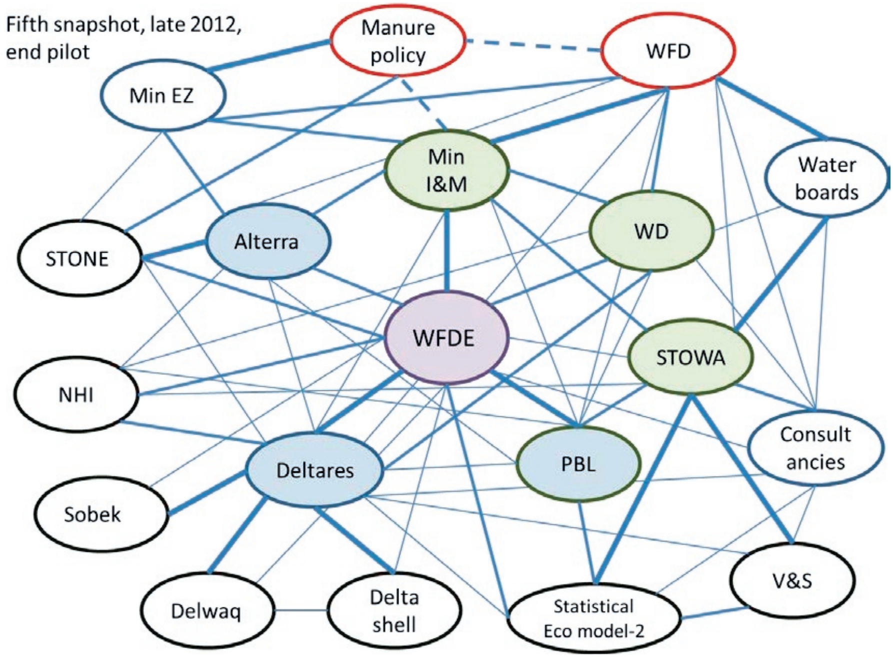
Another development was the emergence of the Volg- en Stuursysteem (V&S), an instrument for ecological water system assessment, first developed by a few waterboards and consultancies, including a Deltares expert that was part-time seconded to a waterboard. (S)he was also involved in the development of the ecological model for the WFDE. Part of V&S was the development of the 'traffic lights' method that was said to be more suitable for in-depth diagnosis of the water system and would therefore be useful to the regional water managers. The 'traffic lights' method consists of nine key factors that determine the status of a water. For each of these factors the light can be green, orange or red, according to their status, and they are ordered sequentially, each factor being a requisite for the following factors. STOWA co-funded this development. Later the Ministry of I&M provided funding to STOWA to continue this development. V&S might have become a competitor for the WFDE. However, the Ministry suggested that the traffic lights method would benefit both systems and would provide a connection between the two. The V&S would be suited for detailed, local, high resolution analyses and the WFDE for more general evaluations. As this 'traffic light' method was quite different from the statistical method, though it was similar to the ecotope method, this added new requirements to the set-up of the WFDE-2. As a result, the developers set up the ecological module to be as flexible as possible to accommodate the use of different methods side by side.

As said before, after all the talk about SOBEK, the steering board chose to develop a new bucket model instead. The new bucket model consisted of buckets representing either a water unit or a drainage area (sub-basin area) and of the links between these two. The new bucket model allowed for more sophisticated routing of water from a drainage area to one or more water units and between water units. A return flow option was included later, to facilitate polder systems in which water could be pumped in either direction. The calculations were still based on water- and substances balances, but now mostly on the basis of established (more complex) processes in Delwaq, another Deltares software package. More detailed schematisation was facilitated, so water bodies in the sense of the WFD could be split into different water units.

Still, the discussion on what to do with SOBEK continued throughout the redesign phase. The project team decided in March 2010 that the basic functionalities of WFDE-2 would not include any connection to SOBEK, but not much later they decided that at least an import from SOBEK to WFDE-2 should be facilitated. At last in 2012, a tool was developed that enabled a quick and easy - though one way only - conversion of a SOBEK model into the WFDE-2.

The developers communicated facilitating both the bucket-models and SOBEK–based models as a choice for flexibility instead of a single solution. It also helped to keep on board the waterboards who had invested in developing a specific model for WFDE-1. In interviews, staff from waterboards in the Meuse region remarked that they did not trust SOBEK to adequately model water quantity in gravity drainage systems, while interviewees from waterboards with polder systems (pumped drainage) claimed that the bucket model in WFDE-1 and later WFDE-2 did not work well for polders.

Pilot and release of WFDE-2 (2011-March 2013)



With the user meetings in July 2011, the redesign of the WFDE was completed, but the release of the WFDE-2 was postponed until the national pilot project had demonstrated that the instrument was working properly. Throughout the redesign phase, the developers had intended to do both a national and a regional pilot study to test the WFDE-2, but the funds within the project were not sufficient, so sponsors had to be sought. In the end, there was no regional pilot, as no sponsor could be found. The project had expected STOWA to provide funding, but they did not; instead they invested in the V&S.

At this stage, a discussion started regarding the 'terms of acceptance'. These terms would describe what requirements were to be met before the instrument would be formally accepted as a finished product and operations and maintenance procedures would be started. An uninvolved consultancy was asked to draw up a plan for O&M, but quickly concluded that this was not possible as there were no 'terms of acceptance'. To them it was therefore not clear what the instrument would be comprised of and what the standards of performance the O&M plan would have to ensure would be. This was a consequence of the incremental development of the WFDE-2. After months of deliberations Deltares wrote down the specifications of the current WFDE-2, which was accepted as the 'terms of acceptance', and the O&M plan was subsequently based on those.

The Ministry of I&M funded the national pilot, demanding it to be focussed on calculating the effect of current and alternative manure policy measures, basically combining the test with an actual policy analysis. This choice of topic for the national pilot attracted the attention of the Ministry of Economic Affairs (EZ), a merger of the former Ministry of Economic Affairs and Innovation and the Ministry of Agriculture, Food Safety and Nature. They opposed the notion to publish the results of alternative measures regarding manure policy, as this might influence the political debate and I&M was trespassing on their turf. The Ministry of I&M proposed to include EZ in the steering board, but met with opposition in that board, as some felt the ministry was hampering independent knowledge-gathering by asking not to publish the results. In the end, only current and agreed-upon measures were used for the calculations in the pilot.

The national pilot would require the development of one national schematisation of all Dutch water bodies and the translation of sets of measures into changes in certain parameters affecting water quality. Ecology was not part of this exercise. PBL and Waterdienst could make good use of the national schematisation, although they had mixed feelings concerning the combination of testing and actually using the instrument for policy analysis.

To develop this schematisation, a great amount of data concerning the connections between water bodies, chemical substances and size of waters—both physical and in terms of flow—was required. As there were problems with data availability, the national pilot project was delayed. The main source for the physical properties was the National Hydrological Instrument (NHI). The NHl comprises software, models and data regarding the water system, with the intention to develop into a consistent, comprehensive and shared hydrological toolbox[17]. It was subsidised by the water authorities and developed by a broad consortium of authorities, research institutes and consultancies. The data sets from NHI concerning the main national waters and different regional waters were, however, not compatible and could not easily be connected. In the summer of 2011, the problems of piecing together the different data became clear to everyone. After a lot of work, the developers finally managed to close the water-balance early autumn 2012.

In the meantime, many incremental improvements had been implemented in the WFDE-2, so that the actual running of the model was smooth and fast. The results of the pilot, however, were less accurate than expected. The report on the pilot application, approved December 2012, mentions 26 issues that needed to be solved to improve the application, some of them related to the WFDE-2, some to the application, and some to the NHI or other source instruments.

Small improvements (bug repairs, improving stability and handling) were made before the official release of WFDE-2 in March 2013. The release was accompanied by a new manual, without the elaborate introduction on when and where to use it. It only explained the functionalities. The release was celebrated by a well-attended seminar on March 7, which showed that there was interest among many parties: waterboards, divisions of Rijkswaterstaat, the Waterdienst, consultancies and research institutes.

By then, Deltares had already applied the WFDE-2 in studies that were indirectly used for the WFD planning process. One concerned "problematic substances", chemicals ranging from arsenic to zinc, to provide background information on chemical loads in water bodies in the Netherlands (Van Duijnhoven et al. 2012). The other deals with the effects of five innovative measures in agriculture (Van Oorschot 2012). The reports remark briefly on the fact that the application applied was still in the pilot stage, but only the modifications of the WFDE-2 application were made explicit, otherwise it is treated as simply 'a tool'.

[17] http://www.helpdeskwater.nl/onderwerpen/water-en-ruimte/waterkwantiteit/nhi/, accessed 03-02-2016

The second round of planning for the implementation of the WFD started in 2012 and most of the development of the river basin management plans (RBMP's) took place in 2013, making the WFDE-2 quite late for water authorities to apply it in the planning process. In 2014, the final RBMP's were drafted and in 2015 the public consultation took place. The second round of planning was completed in December 2015, with the approval of the plans by national government.

The user-interface of the WFDE-2 had not changed much after the first phase of the redesign. For the ecological model the developers had a choice of three methods: the ex-ante rules recalculated with new data sets by the same consultancy that did this before, the decision trees based on that neural network analysis (performed by the PBL), and the Product Unit Neural Network (PUNN) method develop by another consultancy. The PBL performed a comparison of the three methods and concluded that overall the PUNN performed best, judged on the basis of its predictive performance[18], although not by a wide margin (Visser 2012).

As the name suggests, PUNN is a neural network analysis. It is sometimes referred to as a 'white box neural network' as the result of the analysis is a readable mathematical function, making it more transparent than a black box neural network that produces an incomprehensible mathematical result. PUNN was set as the default method, even though PUNN was only a little more reliable. The other two methods were also incorporated in the model, but to access them users would have to request Deltares to 'unlock' them. The project team had decided that in this way they could best oversee how the instrument was used. The default would be sufficient for inexpert users and only expert users could be trusted to know which of the methods would be suited for what specific purpose. The ecotope method was facilitated as well, though it was not complete at the time of release.

None of the ecological models was applied in the national pilot. The new bucket model, however, proved able to handle 20.000 buckets in the pilot, performing most of required calculations in a matter of seconds, and with that it had overcome part of the critique on the WFDE-1. However, by now calculation speed was no longer a priority as it was no longer meant to be used in interactive sessions.

4.3. Concluding remarks

The description of the development process in this chapter focussed on the involvement of human and non-human actors in the shaping of the instrument. It elaborated how the nature of the instrument changed over time, both in terms of the objectives voiced by the developers and users about what it was supposed to do, and in terms of the actual product. The actor-network diagrams illustrated the increasing number of actors involved and the growing complexity of the relations between the various actors. If the number of connections is an indicator of success, the WFDE is likely to be successful. However, more is not automatically better. The durability of the connections, their resistance against opposition, is what matters most (see chapter 6).

[18] The predictive performance was measured through the 'Coefficient of Determination', an index for which 1 is a perfect prediction and 0 means the prediction's value is equal to using simply the average of the validation data set, therefore useless. The overall score for the PUNN method was 0,6.

The involvement of many of the human actors cannot be understood without taking into account the important roles of the information systems or instruments they are closely connected with. The PBL had had the ex-ante ecological rules-set developed to include them in their own instrument, the Waterplanner. Alterra had STONE, basically the only instrument to tackle the issue of diffuse pollution. Specific consultancies were connected to their specific tools (the ex-ante rule-set, for instance). The use of Delwaq, NHI and SOBEK was also a result of the existing connections between the various human and non-human actors.

In the development process, there was an ever-increasing focus on the technical content of the instrument, while the attention given to both the WFD implementation process and the development process of the instrument decreased. In addition, the influence of actors oriented towards the national level grew, which can be seen in the number of actors with that background and the amount of funding they provide. Furthermore, the WFDE became more and more connected to other information systems. This reflects the increased focus on content, as it allowed for the use of acknowledged data and knowledge of processes in the water system. At the same time, it increased the prospective users' trust in the instrument and improved the efficient use of the limited funds. Another influential change for the WFDE was the broadening of the issues of WFD implementation from water management measures only to taking measures regarding agricultural practices as well, be it only voluntary.

The management of the development project itself was hindered by a number of issues. First of all, the financing was unreliable throughout the development. At the start it was conditional, later extensions had to be negotiated every year. More and more, small amounts of money were assigned either to fund the development of specific elements of the instrument, or to the performance of specific calculations that required additions or modifications of the instrument. This caused haphazard development that presented much uncertainty for the developers. It also resulted in a hard to manage project for the steering board. Second, there never was a clear description of what the end-product was supposed to be, as the discussion about the terms of acceptance of the instrument demonstrates. Third, the WFDE-2 project team was led by a Deltares project leader, who had no authority over the contributing partners. The project team worked on the basis of mutual goodwill, respecting each other's expertise, time and resources. The control on all of these was not with the project leader, but the partner institutes' managers, and was therefore quite hard.

Even so, the experts in the project team for the WFDE-2 worked well together. They critically assessed each other's ideas and continuously tried to achieve the best that was possible from the point of view of the expertise they had. It was a continuous peer review process in the project team meetings. There was, however, a matter of who was represented in the project team. The expertise represented in the PT was in the fields of modelling, hydrology, water systems and water quality (chemical processes, emissions, nutrients). No ecologist was part of the WFDE-2 team, although the main innovation in the project was the ecological modelling. Likewise, there was no-one with expertise in the field of any social sciences. The WFDE-1 team did have both an ecologist and a social scientist at the start, but only in the first phase. In the WFDE-2 project team, the interests of the involved research institutes were well represented. The national government had similar interests and was strongly influential through the financing of specific elements. The interests of the regional water managers were indirectly represented through STOWA as financer and member of the steering board. No funding could be acquired for the regional pilot for WFDE-2 which reflected, but also strengthened, the shift in emphasis to national policy and research institutes.

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Chapter 5

A decision support system for the implementation of the Water Framework Directive in the Netherlands: process, validity and useful information

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Abstract

This paper discusses the development and use of the first version of the WFD Explorer (WFDE), a decision support system (DSS) for the implementation of the Water Framework Directive in the Netherlands. The paper's aim is to increase our understanding of the development process of DSSs and the impact the development process has on the perceived validity and usefulness of the DSS; in other words, whether the DSS is seen as representing reality correctly and as fit for purpose and user-friendly. Contrary to the expectations, the WFDE was not used much. Tensions in the development process over the intended users, the level of analysis, the level of ambition and the type of expertise to be included have contributed to doubts over its usefulness and validity. These tensions reflect general tensions in river basin management: different actors will prefer different approaches, and none of these is objectively the best. Whereas guidelines for the development of DSSs can increase awareness of these tensions, resolving these tensions is beyond the power of the developers to control. Guidelines have their use, but also their limitations, simply because they are general and circumstances differ from case to case.

5.1 INTRODUCTION

This paper discusses the development and use of a decision support system for the implementation of the European Union's Water Framework Directive (2000/60/EC; WFD). This directive requires the Member States of the EU to reach a "good water status" by 2015. For surface waters, this includes a good chemical status and a good ecological status. If it is technically not feasible or disproportionately expensive to reach a good status by 2015, deadlines may be extended to ultimately 2027 and objectives may be lowered. The objectives for individual water bodies have to be specified in river basin management plans (RBMPs), which have to be developed involving all interested parties. Moreover, programmes of measures have to be developed to reach the objectives.

The WFD posed new challenges for river basin management and made existing ones more pronounced. They include both institutional challenges, such as the interplay between the different authorities involved (e.g. Junier et al., 2011; Moss, 2004), and technical challenges, such as the definition of 'good status' of a water body, how to measure and monitor the status, and what measures can lead to achieving this status (e.g. Mostert, 2003). When the WFD was being developed, technical experts involved were well aware that the knowledge required to implement it was not yet available (Lagacé et al., 2008). In the Netherlands, for instance, a lack of expertise existed concerning ecological quality elements and the impact of measures (Raadgever et al., 2011). Moreover, existing expertise was not always accessible. The scientific knowledge could not be directly applied in policy while policy makers may not have the time or the expertise to perform the required translation (Quevauviller at al. 2005, Willems and Lange, 2007).

The implementation of the WFD requires what McNie (2007) calls 'useful information', that is information that would "improve environmental decision-making by expanding alternatives, clarifying choice and enabling decision-makers to achieve desired outcomes" (McNie, 2007 p1). Decision support systems (DSSs) and other modelling instruments can assist in providing such information. Gorry and Morton (1971, quoted in Turban and Aronson, 2001, p. 13) define DSSs as "interactive, computer-based systems, which help decision-makers use data and models to solve unstructured problems." They can support the analysis of the present status, provide predictions for the future (Gourbesville, 2008), or both. Moreover, they can support discussions, stimulate learning, contribute to institutional capacity building, and store data and models (De Kok et al 2009, p1784, 1785). They are also viewed as valuable for participation processes (Bots et al., 2011; Horlitz, 2007; Welp, 2001).

This paper aims to increase our understanding of the development process of DSSs and how this impacts the validity and usefulness of the information the DSS provides. Validity can be defined quite broadly, overlapping with McNie's (2007) definition of useful information (e.g. Van Daalen et al 2002). We, however, view validity as the ability of a model to represent reality correctly. To be used, information should be seen as useful (fit for purpose, accessible and user-friendly). This in turn requires that the information is perceived as valid. We aim to show in this paper that validity, just like usefulness, is not just determined by technical parameters. In the end, the perceptions of those who work with a model or DSS, both developers and users, determine whether it is seen as valid or not.

The case discussed in this paper is the development and use of the WFD Explorer (WFDE) in the period 2005-2009. The WFDE was specifically designed to support the WFD planning process in the Netherlands at (sub) basin level. It was meant to support discussion among policy-makers and their political superiors by enabling an exploration of the effects of possible measures and presenting the results in a visually attractive way. The versions of the instrument discussed here are no longer available, due to shortcomings that will be elaborated later. A completely new release is available as of March 2013.

The research conducted for this paper focussed on the development process and the way this shaped the actors' perceptions of the validity and usefulness of the instrument. It consisted of an analysis of policy documents and scientific papers on the implementation of the WFD in the Netherlands, and of documents on the development of the WFDE, such as project plans, newsletters, minutes of user groups and steering group and project presentations. The first author also attended two public meetings concerning the development of the instrument. Furthermore, 14 people were interviewed: five developers, four users, four funders of the WFDE, and three civil servants involved in the implementation of the WFD; some interviewees belong to more than one category. The interviewees were sent the minutes of the interview and were asked to comment on both the minutes and the draft case study report. The full case study report is available online (Junier, 2010).

This paper will first give a brief literature review on the use and usefulness of DSSs. Next, it describes the development process of the WFDE, the parties involved, their objectives and the output. Subsequently, it describes how the WFDE was used in developing RBMPs. In the following section a more detailed analysis of the tensions that arose in the development of the WFDE is presented. The final section offers some reflections on the case and the literature.

5.2 THE USE AND USEFULNESS OF DSSS

Many authors discuss how DSSs and other modelling tools can contribute to environmental policy (Fassio et al., 2005; Gourbesville, 2008; Jakeman et al., 2006; Mysiak et al., 2005; Rekolainen et al., 2004; Van Daalen et al., 2002; Volk et al., 2010). Environmental decision making is described as complicated; "involving multiple decision-makers, a myriad of stakeholders, a web of constraints, and competing objectives" (Pyke et al., 2007 p 612). Because of the inherent complexity of the system dynamics and the social and physical interrelationships that characterise environmental problems, Van Daalen et al (2002 p 222), conclude that computer models are very appropriate for supporting environmental policy as they can provide insight in this complexity that cannot be obtained by other means.

So, on the one hand there is support for the notion that when problems are complex, modelling tools in general or more specifically DSSs can be useful. On the other hand several authors comment on the limited use of DSSs (e.g. Borowski and Hare, 2005; De Kok and Wind, 2003; Gourbesville, 2008; Horlitz, 2007, McIntosh et al., 2011, Van Delden et al., 2011). Van Delden et al (2011 p 266) sum up a number of reasons mentioned in literature: "a lack of transparency, inflexibility and a focus on technical capabilities rather than on real planning systems". They continue by stating that a DSS needs to correspond with "the perceptions, experiences and operational procedures of the policy makers" and should enhance existing practices rather than replace them.

Technically speaking, there are three vital elements for the success of a DSS: the usefulness of the instrument itself (fit for purpose, ease of use), the knowledge base of the model (replication of reality), and the data available for the processing. Scientific papers can be found on all these elements, from different perspectives. Jakeman et al (2006) present a ten step iterative process for the technical development and evaluation of such a DSS. McIntosh et al (2011) devote a paper to reviewing the literature regarding user interfacing, usability and the embedding of models into DSSs. They distil a list of recommendations on the themes ease of use, usefulness, trust and credibility, promoting acceptance, and starting simple and small. In the theory developed by Eiermann et al (1995), the 'performance' of a DSS is determined by the quality of the technical elements as well as environment (or context), implementation strategy (including process of development of instrument), user characteristics and user behaviour.

Borowski and Hare (2005) studied a group of water managers and researchers from different European countries, comparing their requirements for DSSs. They conclude that the two groups have different perceptions on DSS development and use. Janssen et al (2009) arrive at similar conclusions. According to Borowski and Hare (2005), water managers prefer DSSs that fill a specific gap; are simple, data-rich and spatial; and support decision making but not to provide a decision. This implies that all-encompassing instruments may be viewed as less useful.

Also important for the use of DSSs is trust in the outcomes of the instruments. One of the criteria for useful information that McNie (2007) refers to, is credibility: information needs to be accurate, valid and of high quality. Borowski and Hare (2005) record two main suggestions from water managers for improving trust in DSSs: a solid scientific basis and providing sensitivity and statistical analyses. The degree of uncertainty and how uncertainty is represented are important factors contributing to trust in the quality of information provided (Maxim and Van der Sluijs, 2011).

The development process itself can help to nurture trust. Bots et al (2011) note that a model can be rejected completely when its validity is contested. They recommend to involve stakeholders in the development process in order to increase transparency, and to determine the 'rules of the game', that is to agree beforehand on how to use models in the decision-making process (cf. McIntosh et al 2011).

Stakeholder involvement in the development process is in fact a common recommendation for improving use (e.g. Jakeman et al., 2006, Mysiak et al. 2005). So much so that a field of participatory (or "collaborative") modelling has developed, in which users are actively involved in developing the model itself (e.g. Evers et al 2012; Hare et al 2003; Hoppenbrouwers and Rouwette (2012). Borowski and Hare (2005), however, point out that water managers are loath to spend much time on participation. McIntosh et al (2011), in addition, state that from a developers' point of view, the cost related to intensive participation may drain the resources for development and may therefore endanger other essential elements of DSSs.

Several case studies on the development of DSSs exist, mostly written by the developers themselves. Examples include the mDSS in the MULINO project (Fassio et al., 2005; Giupponi, 2007; Mysiak et al., 2005) and the Elbe DSS (De Kok et al., 2009; Lautenbach et al., 2009), both of which were developed to support the implementation of the WFD. An interesting aspect of the mDSS is that users can include their own qualitative evaluation criteria, such as aesthetics, local support for measures or ease of implementation. Volk et al (2010) compared four DSSs for river basin management, including the Elbe DSS. Although all four were seen as relatively successful, they share a number of shortcomings: limited technical quality (such as insufficient data, model integration, and uncertainty propagation), insufficient involvement of stakeholders, and lack of insight in the specific wants and needs of the end-users.

In conclusion, this review shows that modelling tools are seen as potentially providing useful information, but they are used less than you would expect. Much literature is available on what would be good practice in developing these tools. Validity is linked to both technical parameters and the process. User involvement is seen as vital, but also as problematic. The complexity of balancing the various elements of developing a successful DSS will be the subject of the next sections.

5.3 Development of the WFDE

The development of the WFDE can be described in five phases (table 1). In May 2004, RIZA, a research department of the State Water Management Agency of the Netherlands, and Delft Hydraulics, an applied research institute, filed a research proposal to develop the WFDE at 'Leven met Water', a Dutch national funding programme to stimulate knowledge development on water management issues. Funding to develop and test a prototype was granted early 2005. Two further partners in the consortium were a regional division of the State Water Management Agency and a regional waterboard. In addition, the research institute for rural areas, Alterra, and the Delft University of Technology had a minor part in the research, as well as two consultancies, Witteveen + Bos and Royal Haskoning.

Table 1 Phases in development WFDE

	When	*Phase*	*Activities*
1	Late 2004 to 2006	Exploration	First prototype consisted of one water body type, eight measures; one pilot was performed. Then extension of prototype to include all types of water bodies and more than forty measures. This prototype was piloted in four projects in the Netherlands, one in Belgium.
2	2006 to 2008	Elaboration and Implementation	Release basic version, release patches, improvements, training courses, information meetings
3	2009	Evaluation and improvement	Internal evaluation, evaluation visits to all waterboards. Evaluation report (Reeze and De Vlieger, 2009). Development of new ecological knowledge rules. Development of vision documents. Discussion of redesign.
4	January 2010-2011	Redesign	Redesign process based on insights previous development.
5	2011- March 2013	Testing	Development of the national pilot application followed by the release of the WFDE-2 in March 2013.

Until the end of 2006, the project was mainly funded by 'Leven met Water'. STOWA (the waterboards' research institute) and the ministry of Transport, Public Works and Water management co-funded the project. The participating water management organisations and Delft Hydraulics contributed in kind. From 2007 onwards, the Ministry, RIZA and STOWA together financed the continued development of the WFDE, now with Delft Hydraulics as contracting partner.

The official English title of the project was "WFD Explorer, a planning kit to support policy development and communication on ecological objectives of (sub) river basins for the Water Framework Directive" (Consortium development WFD Explorer, 2006). At the start, the objective was to develop an instrument that could support the decision-making process by visualising the effects of different measures on the ecological quality elements required by WFD. The intended users were decision-makers and their staff at the waterboards, soon extended to regional divisions of the State Water Management Agency. The WFDE was intended to support communication between water managers and other stakeholders in interactive sessions at the sub-basin level. The consortium also expected that the use of a shared body of knowledge incorporated in the instrument would help to standardise the WFD planning process in the Netherlands. Moreover, using the same methodology and terminology would enhance the transparency and the efficiency of the decision making process. In addition, it would help to justify to the European Commission any extension of deadlines or lowering of objectives and the selection of measures (Consortium development WFD Explorer, 2005b).

The WFDE consisted of a calculation core, a knowledge database and an area-specific database. The basis of the calculations was a 'bucket' model representing the water system as a number of 'buckets' to which characteristics such as water volume, slope type or emission sources can be linked. The simplified water quantity and quality modelling was based on existing practices in those fields. The knowledge database contained rules that relate key variables, such as flow velocity, volume and nutrients, to outcomes in terms of the WFD, such as the EQR, the Ecological Quality Ratio, which was developed to describe the ecological status as required by the WFD. The area-specific database needed to be filled by users to make a complete model valid for the area. This determined the boundaries and properties of the system. To prevent confusion, in this document the WFDE is called a DSS or instrument and the area-specific model on which it performs its calculations is called the application.

The interface allowed users to see the status of water bodies on maps of the area, using the colour schemes belonging to the EQR method. Users could choose measures from a list, apply them to a water body, and then see whether this measure would improve the EQR score of the water body. The WFDE did not claim to predict the effects exactly, but to quantify the effect roughly. In addition, it would give a rough estimate of the costs involved, allowing the selection of the most promising measures which could then be studied in more detail, by other means. The WFDE would be the first instrument to encompass all ecological quality elements to determine the effects of measures on the ecological status. The software was, and is, free.

In the early project documents, the team of developers demonstrated awareness of the difficulties of developing a useful DSS that is actually used. The project plans drafted late 2004 and early 2005 have specific paragraphs on the state of the art of DSS development. The 2005 plan, for instance, refers explicitly to the need to know the policy process in order to be able to contribute to it; to the importance of user participation in the development process; and to the development of a policy tool as an incremental process involving joint learning (Consortium development WFD Explorer, 2005a). The developers wrote a report on the planned WFD policy process. Moreover, the project plans also include a 'process plan', detailing the process of developing the instrument involving users through pilots, consulting them through user groups, and informing them through newsletters and other means. The developers complied with many requirements mentioned by Borowski and Hare (2005). The WFDE was intended as a simple to use spatial instrument, incorporating a large body of knowledge that would be used for the specific task of assessing potential measures for the implementation of the WFD. Moreover, it would support decision making by providing options, not a single decision.

During the development process the WFDE objectives were extended to accommodate the wishes of other users. The WFDE was to become a 'single DSS' for WFD implementation (cf. Gourbesville, 2008), integrating different models (hydrodynamic, water quality, ecology) to support the assessment of the current chemical and ecological status of water bodies, the setting of objectives, and the assessment of measures to achieve these objectives. Presentations of the WFDE suggested that it was 'one tool that would answer all questions'. The reasons for these changes to the first version of the WFDE will be discussed more in detail in section 5. The second version of the WFDE, released in 2013, will be discussed in a later publication.

5.4 USE OF THE WFDE

Early 2007 a full version of WFD was released for use. The developers had started with the idea to support WFD planning at the sub-basin level, but the specific water system analysis and the development of programmes of measures did not take place at that level, but at the level of the individual water management organisations. At the sub-basin level they did coordinate with other stakeholders, but without the use of modelling instruments. For the Meuse sub-basin a WFDE application was set up, but abandoned when they realised they could not have it up and running on time.

For their own analysis, the water management organisations used different tools, complemented with expert judgement. About three quarters of the waterboards started developing their own application of the WFDE, but in the end most of them hardly used it and then only to answer specific questions. A notable example is waterboard Brabantse Delta in the south-west of the Netherlands. They developed an application to answer the question whether the Volkerrak-Zoommeer, a former sea-arm turned into a fresh water lake, would benefit from a return to salt water conditions. The instrument provided them with interesting insights in the causes of the algae bloom in the lake, the sources of the nutrients, and the management consequences of having fresh or salt water. Furthermore, a few waterboards used the WFDE for an internal analysis of the chemical quality in their area, using only the hydrodynamic and water quality models.

The State Water Management Agency used the WFDE to support the development of the management plan for the State waters. For this, the agency studied chemical balances and the potential effect of measures on chemical quality. The results were used in the assessment of the programmes of measures for State waters.

No organisation used the instrument for communication between policy-makers and political decision-makers or for interaction with other stakeholders. The ecological model, which was the main innovation, was not used. All in all, the actual use made of the instrument in the development of the river basin management plans has been limited and was not in accordance with the original aims.

5.5 Tensions in the development of the WFDE

The limited use of the WFDE reflects a number of related tensions in the development process. Although they are related and partly overlapping, we distinguish them here for reasons of clarity.

Decision-makers or specialists?

The first tension concerns the intended users. The main users that the consortium envisaged for the WFDE at the start were the regional waterboards and regional divisions of the State Water Management Agency, as they would be the central players in the implementation of WFD (for more information on WFD implementation in the Netherlands see Junier and Mostert, 2012; Liefferink et al., 2011). The developers' assumption in the early phases of development was that these water management organisations would select promising measures for a (sub)river basin unit as a whole. Therefore, the objective was to make an instrument that could be used by water management organisations in group sessions with other stakeholders at the sub-basin level. The users within those organisations would be the policy-makers: those who have general water management expertise and who would integrate the different contributions by specialists, together with the results of stakeholder consultations, into a comprehensive plan. The second category of users would be the political decision-makers.

The first actual users were the water management organisations that hosted the pilot studies. From autumn 2006 onwards, more were involved. As specific expertise was required to develop a good application and upload the data required, development and testing of the application was in the hands of a diverse group of specialised experts such as hydrologists, water quality experts, waste water treatment experts and ecologists. They were, however, not passive data-processors: they wanted to understand how the WFDE worked. They challenged the validity of results when they were surprising and counter-intuitive. As the knowledge rules were not transparent, the specialist-users could not trace the source of these results. Under these circumstances they did not advise policy-makers to use it, let alone apply it in interactive meetings with decision-makers or other stakeholders.

The first users asked for changes in the WFDE such as more transparency in the knowledge database, new functionalities for analysis at a more detailed level, and a higher reliability of results. The developers implemented a number of changes to accommodate the users' wishes, but these changes made the tool slower and more complex, so less suitable for policy-makers and decision-makers to use as a communication tool in interactive meetings. Gradually it became a tool for specialists, but the user-interface had not been designed for them. For instance, it catered well for visualisation of output, but not for easy uploading of large amounts of data, while the specialists wanted to work with more data on more nodes ('buckets') than planned.

The consortium did study the role that the WFDE could have in the WFD-implementation process and based their design on it. However, it turned out that the actual planning process was different from expected. In addition, the internal work-flow in individual water management organisations proved vital. The developers had focussed on the decision-making process at the (sub)river basin units, but they had not foreseen the important role that the specialists would have and how their opinion would influence the acceptance of the new policy instrument.

What level of analysis?

Connected to the issue of intended users is the level of detail of the analysis. The WFDE was developed to approximate the effects of measures for applications with a limited number of nodes to enable an exploration of options. This turned out to be useful for the State Water Management Agency that controls the large waters, as they judged it possible to describe the water bodies they manage with a limited number of nodes and they had other tools for detailed analyses. However, many waterboards developed applications with more nodes and they required more precise calculations for the detailed analysis they intended to perform.

Another important issue was whether to down-scale from a basin-level application to the sub-basin and the local level, or to up-scale from the local applications and integrate them to create applications at higher levels. The developers saw the sub-basin as the starting point and analysis at the individual water body level could possibly be implemented later. However, the first users at the waterboards were specifically interested in the water body level. Some ecologists from waterboards clearly stated that the sub-basin level was useless if not grounded on local information. Local abiotic and biotic conditions that shape ecology can differ even within an individual water body. In their view, aggregating to a higher level of abstraction could make sense, but disaggregating was seen as unacceptable. In contrast, an expert from the national level expressed his concern that if you develop a model from the local level up, you will never get a 'balanced model' because each waterboard will want to do things differently. Furthermore, he assumed that the developers would never be able to get all the waterboards to join in, so the model would have gaps.

Another scale-related problem concerned the knowledge rules. These rules were developed for general exploration at a fairly abstract level. Different water body types were lumped together and a limited amount of steering parameters were included. Using them at a water body level produced unreliable results.

In conclusion, several specialists at the waterboards tried to use the WFDE for detailed analysis. This was partly due to a lack of other tools and partly due to ambiguities in the communication on the WFDE. Although the developers stressed the fact that the WFDE could only give general insights in the effects of measures, the communication regarding the instrument also suggested it would be a tool to answer all WFD-related questions. According to one developer, users projected unrealistic expectations on the instrument and then held the developers responsible for something they had not promised to deliver.

Ambition or realism?

The developers showed a great deal of ambition in the development of the WFDE. They stated that the instrument would provide valuable input in the decision-making process and fill a gap in the available tools. The information to the steering committee, the presentations that were given at various moments, all breathe optimism about fulfilling these ambitions. Several interviewees mentioned that expectations were high, too high even. Others remarked that you need to be ambitious and optimistic to get funding and also to get potential users interested.

The development process of the WFDE took place as if in a pressure cooker. Funding was on a yearly basis. In the first year the consortium had to provide a proof of concept. Next year they had to develop a full working prototype. As the focus was on ecology, a basic 'bucket' model structure was developed for water quantity, assuming a fairly low number of 'buckets'. This limited possibilities for later modifications.

Users, funders and the developers themselves suggested including more parameters, such as more information on cost-effectiveness, more detailed analysis of sources of pollution, water bed properties, and more reporting tools. The level of ambition increased while the first users in pilots and the early adopters were still struggling to get the basics working. In a user meeting mid-2007, the developers admitted that they had not achieved everything they had wanted to, but continued development would solve these issues. Optimism still reigned. In August 2007, the steering group decided to promote the use of the WFDE abroad and the steering group members requested the ministries involved to recognize the WFDE as the Dutch standard tool to support the WFD-implementation.

In 2007, when support was at its height, the water management organisations increased pressure to deliver the product as they wanted to apply it for the analysis of the water bodies and the development of the programme of measures. The developers were aware of the time constraints in the policy process and assessed the risk of being too late as more serious than providing a provisional version. However, the waterboards that had started using the instrument before it had been fully finished were disheartened by the number of patches. In 2008, optimism gradually changed into scepticism. Some said the instrument did not work and would never work and many users abandoned it. The height of the expectations contributed to the depth of the disappointment.

What expertise to include?

The original intention was to use existing expertise and make this available to everyone who wanted it, through the WFDE. No complete ecological model for all quality elements and all types of water bodies was available, but the developers brought together the existing knowledge in different institutes. The focus was on describing causal relations between physical conditions in water bodies and the ecological quality indicators. However, the first set of knowledge rules did not perform well and was incomplete. In addition, they were not transparent as they were based on widely different methods. In an expert-meeting, specialists of various research institutes and water management organisations expressed their disapproval.

Because of this, the consortium decided to start a parallel process to search for more expertise in the field of ecology in other research institutes and at the waterboards. Meanwhile, the development of the WFDE continued. The parallel process yielded more rules, and a manual was needed to keep track of how they were derived. A second expert-meeting demonstrated that there was no consensus among the specialists. Judgements on specific rules that had been developed varied significantly, and only part of the set was accepted. The knowledge gathered was judged either incomplete or too area-specific; data collected did not concern the same parameters or was not collected in the same way. The conclusion was that no complete set of rules could be established.

The developers then abandoned the idea of causal rules and eventually used a different set of ecological knowledge rules, developed for a modelling instrument for the national ex-ante evaluation of the draft programmes of measures (Planbureau voor de Leefomgeving, 2008). These rules were developed using a neural network method, based on data collected for assessing the present status of water bodies. As the developers judged the neural network to be insufficiently transparent, the rules were transformed into easier to understand decision-trees. Though some users applauded the transparency of the decision-trees, they were also disputed. Both in the developing institutes and among users the critique concentrated on the limited data-sets that the rules had been derived from, the purely statistical basis as opposed to a causal basis, and the strict and discontinuous pathways of the decision trees. Yet, this was the only complete set of rules available, and an incomplete instrument was judged to be worse than a coarse one. Moreover, these rules (in the form of the neural network) were used at the national level and at that level the predictive quality was considered acceptable.

Although many efforts were made to improve validity, the perception persisted that the ecological modelling in the WFDE was insufficiently valid. In spite of this, both the developers and various users stated that a very positive result of the WFDE development was the discussion on the expertise needed for WFD implementation, on the quality of the available expertise, and on the need to develop more expertise. Therefore, funders of the WFDE have continued to support the development of the instrument, resulting in a new release in March 2013, allowing for more sophisticated modelling of large applications to evaluate present or proposed policy.

5.6 DISCUSSION AND CONCLUSION

The aim of this paper was to increase our understanding of how the development process of a DSS can impact the perception of the validity and usefulness of the DSS, using the WFDE as an example. The WFDE was hardly used, although the project team was clearly aware of the common pitfalls and applied the recommendations in the literature to avoid them. They did involve users, tried to provide useful and valid information, and considered user-friendliness, at least for the originally intended target group. Knowing what is conducive to a successful development process may increase the chance of success, but it is certainly no guarantee. The vagaries of the real world, such as different (and changing) interests of the parties involved and limited knowledge, data, budget and time, shape the process as much as applying good principles.

The involvement of specialist users caused the redirection of the development from general to more detailed analysis and from a communication to an analytical tool. The end-product was not quite suited for either purpose and so no user-group was fully satisfied. Many authors advise an iterative or evolutionary development process to ensure uptake (e.g. Giupponi, 2007; Jakeman et al., 2006; Volk et al., 2010; Van Delden et al., 2011) and the development of the WFDE can be seen as such. But again, awareness is no guarantee for success.

The users differed on what information was viewed to be useful: general explorations at a (sub-) basin level or detailed analysis at the level of individual water bodies. Interestingly, this tension corresponds with general tensions in river basin management between top-down management and bottom-up interactive management. Both types have advantages and disadvantages. Whereas starting at the river basin level can result in a broad overview and well-integrated solutions, starting at the very local level can result in detailed and tailor-made solutions. Politically, the first approach may strengthen central government, whereas the latter may empower local stakeholders. Consequently, this tension cannot be solved by demonstrating the superiority of the one over the other.

The tensions regarding expertise and ambition both influenced the users' trust in the instrument and therefore its perceived validity. Whereas Bots et al (2011) refer to users being decision-makers and stakeholders that would trust the work done by the modellers, in our case the only users were the experts involved in the applications, who judged the validity of the model themselves. Their distrust resulted largely from a disputed knowledge base. No accepted body of knowledge existed to enable ecological modelling at the start of the development of the WFDE. As mentioned in the introduction, Raadgever et al. (2011) reached the same conclusion, but for the project developers that was not obvious at the time. The choice to develop a set of statistically derived rules to be able to do calculations for all waters and all measures was understandable, but the validity of these rules was also disputed. In addition, the high ambitions that were communicated led to high expectations that could not be met.

The case also demonstrates that different groups of experts have different notions of validity. For some, representing causality was the main requirement, for others statistical methods were acceptable. Everyone wanted transparency, but some knew how to work with neural networks and therefore judged them as sufficiently transparent, while others did not. The developers realised that they had to deal with different types of knowledge (causal, statistical, rules of thumb) and managed to cater for many types to be used in parallel, but the inconsistency this entailed was then held against them.

The picture that arises from this discussion is that developers may have the expertise to develop a DSS or another modelling tool, but there are many forces are at work shaping the outcome that they cannot control. These forces may differ from case to case. General guidelines on how to develop an instrument may be helpful, but they are never sufficient, simply because they are general and circumstances differ from case to case. Acknowledging this may be a way forward. Future research could focus on increasing flexibility and reflexivity in the development process as a way to improve the uptake of a DSS.

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Chapter 6

Shifting targets, or The construction of a successful instrument

In the previous chapter, the development of the WFDE was analysed in terms of a number of tensions or dilemmas that had remained unresolved in the development process. In this chapter, I extend my analyses in two ways. First, I will include not only the development of WFDE-1, but also of WFDE-2. Second, I will apply another theoretical lens, actor-network-theory, which will also be used in the next chapter. In chapter 4, the preliminary work in the form of detailed descriptions and actor-network snapshots was presented.

6.1 INTRODUCTION

The original purpose of the WFD Explorer (WFDE) was to support the participation of stakeholders in the Water Framework Directive (WFD) planning process. The software instrument was intended to provide input in stakeholder meetings. The stakeholders would be able to digitally explore what could be the suitable measures to reach the WFD objectives - based on the modelled effects of measures, their own assessment of the information and their own priorities. Nine years after the start of the development process, the WFDE does nearly the opposite. Although the instrument can calculate the effects of measures (if not to everyone's satisfaction), it is not suitable for use in interactive sessions and is too complicated to be handled by anyone but the specialised experts. However, those experts do use and appreciate it. Interestingly, even in 2011, the old objectives were at times still referred to, in interviews and in some presentations (see for instance figure 1). This difference between intentions and outcome is remarkable and merits further investigation.

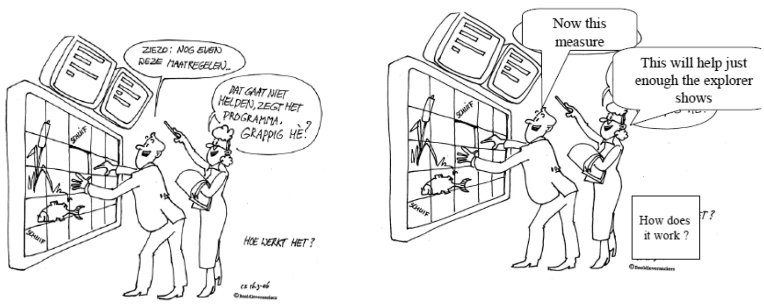

Figure 7 newsletter June 2006 and (international) presentation May 2011

The WFDE is an example of an information system (IS). These systems are studied in many fields, ranging from sociology, economics and political science to culture studies (Bijker and Law 1992). Although ISs are already all-pervasive in current society, how to improve their design so that they are used more, or more effectively, is still debated, as discussed in the previous chapter. As Orlikowski and Iacono (2001) state, information systems research focusses either on the context of the information system, its content, or its effects. What is missing is the integrated analysis of all three.

Such integration is all the more required, as the three foci are closely connected and cannot usefully be separated.

In Actor-Network-Theory (ANT), developed from the eighties by Latour, Callon, Law and others, it is self-evident that the ISs, their content and their effect cannot be separated. They are created simultaneously by the transformations that take place in the actor-network. In this chapter, I will show how ANT can provide a means to delve deeper into the processes related to information technology development and use (Mähring et al. 2004).

In an integrated study of an information system development and its impact, a key element is the active part technology itself has in the process. Importantly, ANT does not perceive technology as separated from the social world (Latour 2005), but as an interwoven part of society, as in a seamless web (Hughes 1986). Moreover, ANT studies technology (and non-humans in general) on equal footing with human actors (see for example Latour 1990; Law 1992; Latour 1996). Technologies in general “play an active role in the relationship between humans and their world”; technologies appear to “have ‘intentions’, they are not neutral instruments” (Verbeek 2006 p 365). These intentions are acted out through engagements between human and non-human agents. In these emerging relations, technologies “help to shape what counts as ‘real’ “ (Verbeek 2006 p 366).

This chapter will unravel the development process for the WFDE by analysing what objectives the different organisations and their representatives intended to achieve through the instrument. Furthermore, I will present how associations between actors and changes in the targets, or objectives, of the development were continuously (re)shaped. In the analysis of these changes, the strategies that the developers of WFDE used to make the ‘machine’ (in this case the software) work - in other words how they convinced the relevant actors that the machine works - are elaborated. This will be used to explain how the instrument changed over time and became what it was in 2013.

In the next section, I will introduce the ANT concepts as I use them in this chapter. Next, I will explain how I collected the data sets and how I analysed them (section 3). The rest of the chapter consists of three paragraphs, each presenting a different perspective: the involvement of individual actors representing organisations (section 4), the effect of the changes in actor-networks over time on the project objectives (section 5) and the artefact properties (section 6). These three perspectives are not mutually exclusive, but allow sketching the development process of the WFDE, including the many relations between the perspectives. This important notion of connectivity is discussed in the final paragraph of the chapter, with some concluding remarks related to the WFDE and the applied ANT analysis.

6.2 ACTOR-NETWORK-THEORY (ANT)[1]

The name Actor-Network-Theory is confusing; Latour (2005) ‘blames’ Callon. All the words in the name, including the first hyphen, have been debated over the years. Other names have therefore been proposed, such as ‘sociology of translation’ (Callon 1984; Law 1992) or ‘actant-rhizome ontology’ (Lynch in Latour 1999), but other than becoming commonly abbreviated to ANT, and gaining a second hyphen, the name has stayed and eventually has been embraced (Latour 2005). The

[1] Originally spelled Actor-Network Theory, with only one hyphen.

accounts of what ANT is have changed over time, with authors sometimes contradicting each other and coming to new insights (see for example Latour 1999; Latour 2005). Of necessity, I here present a brief and personal overview of how I interpret and use ANT, including how I deal with some frequently heard critique.

ANT is not a theory in the traditional sense (Latour 1999; Latour 2005; Law 2009) with a predefined set of explanatory concepts. It is descriptive rather than explanatory (Law 2009). Latour emphasises that ANT is a method that provides ways to connect with (he prefers not to say 'study') actors "without imposing an a priori definition" (Latour 1999 p 20). Though ANT does not provide a so-called "social explanation", through these descriptions it does intend to "explain society, of which the things, facts and artefacts, are major components" (Callon and Latour 1992 p 348). To do so, ANT provides the language that is to "allow an account, an empirical description, to be assembled" (Latour 2005 p 174). ANT is also a strand of philosophy that provides a grounding to the methods and the type of explications that ANT proposes (see Harman 2007; De Vries 2016).

The actors ANT refers to are not just human actors, but all those entities/actors that have an effect on other entities/actors, meaning also objects, machines and so on (Latour 2005). This should not be seen as a theoretical claim, but as a methodological starting point, introducing uncertainty about what the relevant actors are (Sayes 2014). An objection often voiced is that non-humans - things, artefacts - have no intentionality (e.g. Amsterdamska 1990) and therefore cannot be 'actors'. The simple answer is that ANT does not see intentionality as necessary for agency (Callon and Latour 1992). Non-human actors perform actions such as making coffee or delivering messages that release people from having to do so, but their agency goes beyond that (Latour 2005; Sayes 2014). These non-human actors also have an effect on other actors because: "…things might authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid and so on" (Latour 2004b in Sayes 2014). The coffee machine prescribes what coffee to use: either ground or whole, in pads or capsules. The fact that the coffee machine on the first floor serves better coffee than her colleagues on other floors encourages some people to walk there. The fact that that this coffee machine only works if your debit card allows contactless payments blocks some people from using the machine.

Besides this specific interpretation of actors, there is the word 'network'. Networks in ANT should not be seen as mere means to pass information without change, such as a telephone network. On the contrary the network means a "… series of transformations –translations…" (Latour 1999 p 15). People and people, people and objects, objects and objects, they all make associations, meaning they form bonds with other actors, "they inter-act, shaping relations and being shaped by relations" (Venturini 2010 p 266). As networks are made up of human and non-human actors they are called 'heterogeneous' or 'hybrid' networks (Latour 1987; Law 1992).

Moreover, "…webs of relations simply form more complicated actors. An army as a whole acts in ways that an individual soldier, not to mention his kidneys or eyeballs, cannot" (Harman 2010 p4). "Actors are always composed by and components of networks" (Venturini 2010 p 266). That is reflected in Latour's discussion about the hyphen between actor and network: these two words are necessarily connected, as neither can exist independently. Therefore, although the term actor-network seems to refer to it, ANT does not take a position in the debate regarding the dominance of either structure or agency, but bypasses it (Latour 1999). There are similarities between ANT and the social construction of technology (SCOT) school within science and technology studies (Pinch and Bijker 1984; Bijker 1997). However, ANT is different because it takes into account the continuous shifts in actor-networks and it conceptualizes the engagements of human and non-human agents. In the SCOT approach, social groups are typically depicted as stable throughout the development process of a technology and these groups are not affected by that technology

As a result of these key conceptualizations, an important starting point of ANT is the concept of irreduction (Latour 2005; Harman 2007). It signifies that the distinction between 'society', 'technology' and 'nature' is not useful, as these are hard to distinguish and offer no explanation in themselves. They are not causes of anything, they are the effect. Developments cannot be explained by referring to the 'social' or 'social forces' or the like, as the 'social' is not an explanatory force that operates in society (Latour 2005).

Interestingly, ANT has been critiqued for its nature determinism, attributing too much to nature, (Collins and Yearley 1992) and for being social constructivist and therefore attributing too much to human activities (Callon and Latour 1992). Callon and Latour (1992) counter this by claiming that ANT is neither and is also not a way to overcome this dichotomy. The dichotomy is irrelevant for their approach as they strive to "obtain nature and society as twin results (…) of network building (…)" (Callon and Latour 1992 p 348).

According to ANT, what is required in every investigation is an explicit and detailed enquiry into the actor-networks that shape the development of study. This enquiry cannot be based on fixed categories, but a detailed study of the case at hand will lead to uncovering of the relevant actor-networks and the translations that have taken place through these. Actor-networks change over time, but can become stabilised and taken for granted. They can take on the form of accepted facts, institutions, instruments and so on (Law 1992). Once challenged, the actor-networks become visible again. Therefore ANT emphasizes studying processes that are unstable such as conflicts or new developments (Latour 1987; 1996; 2005).

For this chapter, Science in Action (Latour 1987) is a key publication, as it describes in detail the translation processes that lead to scientific knowledge and the incorporation of knowledge into technology. Actions, ideas, concepts, plans, laws etcetera are translated in networks, as with every passing of information this information is transformed, like in a whispering game. Translations to enrol actors may include appealing to joint interests, or claiming that achieving one goal will ultimately lead to what the other wants as well. A typical translation Latour refers to, that is applicable in the WFDE case, is reshuffling interests and goals by reframing goals by inventing new goals; activating new targeted groups by broadening the goals to accommodate them; and making it appear that there is only a small shift from the original objectives (Latour 1987 p 114-116).

In Science in Action, Latour uses the metaphor of the Janus heads to characterise science and technology ("machines") in paradoxes. For this chapter, the third dictum of Latour's Janus heads will be of special relevance: "once the machine works people will be convinced / the machine will work when all the relevant people are convinced" (Latour 1987 p10). As long as a machine is under debate, it tries to make connections with established facts, instruments, human actors, etc. Once these connections are strong, in other words the actors are convinced, they are enrolled, the discussion is closed and a new fact or a new instrument is established. This becomes a black box that is closed as long as there is no discussion about it, but can be reopened if and when its connections are weakened.

Latour's (1987) elaboration of the enrolment of heterogeneous actors has been interpreted as claiming that scientific facts are merely the effect of scientists' Machiavellian actions to convince others (e.g. Shapin 1988) . This is a misrepresentation of his claim that a fact cannot be verified by nature, as we have only a mediated knowledge of nature. ANT does, however, recognise the value of scientific facts, because they are the result of hard work to establish strong associations between, among others, instruments that do measurements, data bases that hold the data, scientists that apply scientific methods to construct facts that form the basis to construct new facts, and other scientists who cooperate, peer review and cite papers (Latour 1987; Law 1992).

For instance, people in the Netherlands accept without thinking the weather report in degrees Celsius. Measuring temperature in degrees Celsius is an example of a black box. This scale is so established that we forget there once was a debate concerning with what instrument and on what scale to measure temperature. At the same time, it is possible that at a certain point the black box is reopened and following a debate another scale is set as the standard, as temperature scales are a human construct. In fact, other scales are used in other countries; while in the sciences, the Kelvin-scale is commonly used.

While Science in Action focusses on laboratory science, Latour extends his analysis to technology in his work Aramis (1996). In this book, Latour reconstructed the actions that led to the abandonment of a new public transport system, Aramis, after a lengthy development process. In Aramis, Latour used the literary device of a detective novel to trace back what motivated parties to support the development and either to continue or to withdraw their support. Latour treated the contributing technology in the same manner as the human actors: he continuously asks the question whether the technology supported the realisation of Aramis. He went as far back from actor to actor as was necessary to explain why this technological development was supported over a period of many years, but was abandoned before it could materialise.

Following the methodological approach of Science in Action and Aramis, I have built my account on translations through actor-networks and how they left behind their traces, such as documents, instruments, drawings, objects, etc. These traces are also called 'inscriptions' (e.g. Latour 1987; Law 1992; Latour 1996), in which the actor-networks become both visible and frozen in the act. The development of the networks continues, but in these documents and other traces they are revealed like in a snapshot. These snapshots show the network at a moment in time, but become part of it as well. They are referred to in the continuous actions of actor-network-construction, they are taken as a point of departure for further action, they are a source for discussions and so on, as will become clear below in paragraphs 4, 5 and 6. First, I will briefly explain how I collected and analysed my data.

6.3 METHODS

A detailed description of the methods can be found in chapter 2. The empirical basis of this chapter consists of interviews, observations from meetings and collected documents of the development of the WFDE. In the period of January 2009 to March 2013, I interviewed 37 individuals, some of them more than once. In addition, I attended internal project meetings and public meetings with prospective WFDE users, including demos of the instrument where prospective users - and I - could try out the instrument. Observations of these meetings (30), all interview reports (43) and minutes of project team meetings (43) were coded in Atlas.ti (see Friese 2012).

The interviews and observations of public meetings provided rich material to analyse who were the relevant people (those that needed to be convinced), what were their objectives and why were they (un)satisfied with the outcomes (to analyse when the machine works). Observations of internal meetings added some additional detail. The minutes yielded basically nothing in this respect. They did provide information on the changes in instrument properties over time and the developments process, but the justification of choices, if reported, mostly concerned the technical requirements of the developers. The more general purpose of the instrument, for example the role it was to play in policy planning, was basically not referred to. To ensure the anonymity of the interviewees, the analysis will not detail the different perspectives within the organisations involved.

As I was interested to see the difference between the objectives mentioned by individual interviewees, those chosen by the development team, and those that were manifested in the instrument properties, I decided to go through the project documents to see if they could inform me on this. I looked for statements of objectives and descriptions of the developed instrument. Through this purposive sampling (Guest et al. 2006), 16 key project documents were collected that covered the development process of the WFDE. The earliest documents date to late 2004; the last report was a study on WFDE use in late 2012. The full list can be found in the annexes.

These key documents were coded in Atlas.ti as well. In the first level coding, two pre-defined category codes, 'objectives' and 'targeted users', were assigned to relevant fragments (quotes) of the documents. Besides these two codes, a list of other issues that influenced the development of WFDE was developed inductively. The main issues that were found included the 'scope' (what is included in the models) and 'scale' (what level of detail the calculations are performed on and therefore predictions made) of the instrument. Furthermore, the categories 'development process', 'parties actively involved' (in the development process) and 'resources' were defined. At the same time, the two predefined codes were specified while coding. This second level coding captured more detail and was used to identify different groups of users and different objectives. The full list of codes, code frequencies (the number of times a code is assigned) and word frequencies (the number of words per code) can be found in annexes.

To unravel how the nature of the instrument changed, the stated objectives, targeted users, scope and scale of the instrument were looked at in detail. The content - the quotes - of each consecutive document was compared with earlier documents and the results were collected in memos per code. Together with the results of the earlier coding, I arrived at an overview of the development process and detailed insights in the changes in the objectives over time.

6.4 CHANGING INVOLVEMENT OVER TIME

Chapter 4 provided an elaborate description of the development of the WFDE and in the annexes you can find a glossary with all organisations involved in the WFDE-development. This section will discuss the motivation of the various actors to be involved in this development. To start with, figure 2 provides an overview of the different actors and their involvement over time. This paragraph will subsequently reflect on why they became involved, and remained so or not. I have organized the overview in terms of engagement over time: starting with those actors that were there at the start of the development and stayed on, followed by those who joined later. Next are actors that withdrew partly or entirely from the development.

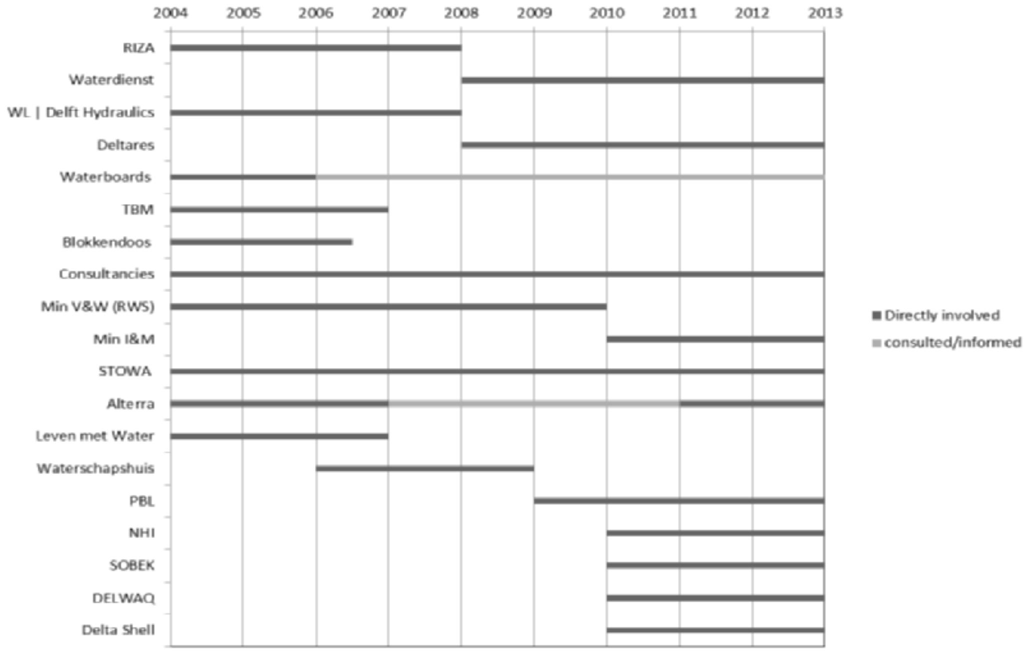

Figure 8: involvement with WFDE over time

Organisations involved continuously

The research institute that was part of the national water manager Rijkswaterstaat, RIZA (later Waterdienst) and the water research institute WL | Delft Hydraulics (hereafter WL, later integrated in Deltares) were involved throughout in the development of the WFDE, each with their specific expertise. RIZA had an interest in WFD implementation, supporting both the Rijkswaterstaat regional divisions and the national level reporting with their expertise. RIZA thought the waterboards should welcome an instrument that would serve as a joint ecological knowledge base, and would support them in dealing with the new responsibilities in the fields of ecology and participation that the WFD planning process entailed. RIZA were worried that not all waterboards would have enough expertise to perform the ecological analysis and that the methods the waterboards applied would be too diverse, making it hard to compare the different plans and to justify the chosen measures. WL had recently developed an instrument that provided insights in the effects of measures on river flood risks, the Blokkendoos, which, if transformed into an instrument for ecological analysis, could be a very useful solution to RIZA's worries.

The Blokkendoos shaped the planned features of WFDE. It was used to demonstrate the effects of a selected number of measures by presenting the results of model runs (or simulations) performed beforehand. In meetings, the parties involved could quickly compare and assess the effect of measures that were being discussed. Doing the same for implementing the WFD required a list of measures, algorithms to calculate the effects of these measures and a water system model to apply these calculations on. When the developers realised that presenting the results of earlier model runs was not feasible because there would be too many options, they decided that the simulations would have to be done real-time. This meant that calculation speed became essential, as use in meetings required instantaneous results. For reasons of speed they decided to develop coarse-grained models that would only provide an indication of the effects of measures. Lower quality predictions than those the Blokkendoos provided were deemed acceptable: being able to use the instrument in policy planning sessions was paramount.

In January 2008, WL and part of RIZA merged to become the applied research institute for delta areas, Deltares[1]. The other part of RIZA merged with (parts of) other research departments of Rijkswaterstaat to form the Waterdienst, the water-related knowledge institute within Rijkswaterstaat (for the transition at Rijkswaterstaat see Van den Brink 2009). Many Rijkswaterstaat technical experts ended up in Deltares. The new Waterdienst supported the policy development at the Ministry, while much of its expertise was now being out-sourced, for instance to Deltares.

Although these changes were substantial for both WL and RIZA, for the development of the WFDE they were comparatively small. Deltares took over development from WL, while the Waterdienst took over RIZA's role in the steering group and in representing the regional divisions of Rijkswaterstaat. For the WFDE, the input from the Waterdienst became more indirect. The Waterdienst was not involved in the daily running of the project, as RIZA had been. Its input in the steering board became more process-oriented than content-oriented. This was strengthened by the fact that for WFDE-2 the end-result had been described in very general terms as a consequence of the 'agile' design process (see for example Paasivaara et al. 2009; Da Silva et al. 2011) and would only gradually become more detailed. For the Waterdienst, the project involved both a fully functional instrument, capable of calculating the effects of all types of measures on ecology, and an application at the national level. When the WFDE-2 project team became aware that the Waterdienst expected an application, the developers argued that this was not included in the budget.

Just as WL did, Deltares viewed itself as an applied research institute. It was also a consultancy company that developed new instruments and models, trained people to use the instruments and advised clients on complex water-related issues. Furthermore, it employed professional software programmers and managed and maintained software products. Deltares had a strong focus on extending and applying the latest knowledge, which was evident in how important the quality of the knowledge incorporated in their models was to them. So when users expressed their disappointment

[1] The merge also involved the research institute GeoDelft, parts of the research institute TNO and parts of other research institutes of Rijkswaterstaat

over the model quality, this struck a chord. It had to be remedied, even though they felt part of the critique was unwarranted. The (technical) quality of the instrument remained the main concern for Deltares over the years.

Deltares sees its niche in development and wanted to use the WFDE for various studies. The WFDE-2 development was decoupled from the continued development of an ecological model to include in WFDE-2. The WFDE-2 project team did keep close contact with the developers of the ecological model and any alternatives that became available. The team enabled the use of various types of algorithms. Applications of the WFDE were not viewed as deliverables, although pilot applications were planned. A pilot, however, is normally a means to test the instrument, not a fully working application.

For more routine consultancy work, other parties were thought more suited than Deltares. Therefore, Deltares involved consultancies who would contribute to the development of the WFDE and would in the end also be users, applying the instrument for example on behalf of a water authority. Deltares (and WL before) had established abundant contacts with other research institutes and consultancies over the years. For instance, in developing the deterministic ecological model for the WFDE, part of the work was commissioned to a consultancy. This consultancy also developed the neural network based ecological model for the Environmental Assessment Agency (PBL). When external experts judged the WFDE ecological model as unsatisfactory, the consultancy knew that an alternative was close at hand.

The project team for the second WFDE was also subject to the internal Deltares standards. It had, for instance, become Deltares' policy to have all programmes developed at Deltares comply with the platform standards of Delta Shell. This would make all Deltares software compatible and encourage coupling and reuse of modules, which explains much of the 'look and feel' of the WFDE in 2013. Other Deltares' information systems such as Delwaq and SOBEK also shaped the WFDE: the first because the water quality processes in the WFDE were based on Delwaq and the second because, although after a fierce debate SOBEK was not chosen as the instrument for the water quantity model, it remained the standard to compare with and the project team devised a tool in SOBEK to convert a SOBEK model into a model suitable to use in the WFDE.

In 2011, the steering board commissioned a consultancy to elaborate an operation and maintenance plan. They concluded that the project deliverables were insufficiently clear to determine when the development was finished and the operational phase would start.

Organisations involved structurally but starting at later date

The Environmental Assessment Agency, PBL, first became involved in the WFDE development through the ecological model that was developed as a module for their own instrument, the 'Waterplanner'. The PBL was, and is, an independent research institute. The PBL instrument the Waterplanner was used to perform the WFD ex-ante evaluation of the programmes of measures in the River Basin Management Plans in the first round of the WFD planning.

However, in 2009, development of instruments was no longer viewed as the PBL core business, due to budget cuts, and the PBL was searching for alternatives. For the second round the PBL intended to use the new WFDE. The PBL experts in the project team were keen to ensure that the instrument complied with the needs for national policy analysis and the transparency of the calculations to justify the results. The PBL expected the WFDE to deliver results at least as good as the Waterplanner, with better operation and management through the Deltares professional in-house ICT services. The ministry of I&M was also in favour of merging the instruments, as (indirectly) they provided funding for both. Furthermore, they favoured consensus instead of having competing, and sometimes contradicting, instruments associated with the different ministries.

I&M's predecessor, the Ministry of V&W, was the coordinating ministry for the WFD implementation. They were at first not very interested in WFDE. Later they recognised that it might be used by many waterboards and could help harmonise the planning processes at the waterboards, increasing the comparability of the programmes of measures. When V&W became I&M, another representative became a member of the steering board. I&M then started to provide funding for the WFDE as such, but also to separate projects to develop specific modules or to do specific calculations by means of the WFDE components. I&M funded Alterra to enable a connection with STONE and to calibrate the WFDE by comparing it with calculations done in the Alterra instrument ECHO. I&M was mostly interested in the national level policy issues. In addition, as they were interested in the role of agricultural measures in the WFD implementation, they funded the national pilot with a specific focus on calculating the effect of different programmes of manure measures on WFD objectives.

For this national pilot, the National Hydrological Instrument (NHI) was used as a basis, as the parties developing the NHI had successfully presented it as likely to become the standard hydrological data tool. The NHI provided nation-wide hydrological data describing volumes and flows. However, the NHI did not know the concept of water bodies. The data was aggregated in separate systems representing different levels of abstraction, but bringing these together to make a fully connected model required much effort from the WFDE-2 project team, as gaps appeared and water seemed to get lost in places. The project team judged the final schematisation sufficiently reliable for national evaluations, but viewed that at higher resolutions the problems in the underlying data became apparent. Therefore, the project team preferred not to provide it to regional water authorities.

Organisations involved discontinuously

While RIZA and WL, or Deltares and the Waterdienst, were involved throughout and the PBL became a long-term partner, for some parties continuous involvement was not relevant. The TU Delft faculty TPM for example withdrew after the prototypes had been developed, as the connection with the policy process was no longer a central concern. The same goes for the funding by LmW, which is only granted for research, so in the operational phase the funding ended.

The waterboards were represented by STOWA, but some boards were specifically invited to participate through pilots, while others were consulted in meetings. The waterboard staff that participated early on had different backgrounds, but most were ecologists with an interest in modelling tools. Hearing about and seeing the prototype, more and more waterboards became interested as they thought they could use it in the first WFD planning process. When it turned out that there were too many problems, their interest declined and quite a few of them started looking out for alternatives.

Waterboards are not a homogeneous group at all, so different needs were voiced and different alternatives were chosen. For the developers of WFDE, they were a hard group to work with as no representative spoke on behalf of all. Some waterboards agreed with the WFDE-focus on the effects of measures, but many did not. They complained that WFDE did not allow a careful analysis, or diagnosis, of the water system. As an interviewee said: "It is like having a doctor subscribing medication without first diagnosing what is ailing the patient." Especially the waterboards that developed a schematisation for WFDE-1 were not pleased with the suggestion that to use WFDE-2, they would have to switch to SOBEK. Some waterboards used SOBEK, and this group increased over the years of WFDE development, but some had no intention to use it. Waterboard staff were always invited to demonstrations and tests of WFDE-2 modules and a few performed tests, but they were not a member of the project team where the design decisions were made.

Ambiguous involvement

STOWA's main motivation to join the WFDE development was and remained the lack of a joint knowledge base on ecology for the waterboard. STOWA continued its support after the research phase, as in its view especially the ecological model needed more research. When STOWA realised that WFDE-2 would not become the envisaged ecological tool for waterboards, it started looking for alternatives. One of the waterboards, together with a consultancy and a department at Deltares, developed an information system for ecological analysis at water body level, the V&S; STOWA decided to support, and co-fund, this development. STOWA stayed involved in WFDE, judging it would become a useful tool for national parties and research institutes, but less so for waterboards.

Funding the operation and maintenance costs of WFDE would be up to the Waterschapshuis. It joined the steering group in 2006 to ensure the waterboards a smooth transfer of the operational instrument. It agreed to contribute a quarter of the yearly funding, indicating that most waterboards were expected to use the WFDE. The waterboards, however, responded negatively to being charged for an instrument they did not use. In the redesign phase, the Waterschapshuis therefore would stay represented in the steering group, but would suspend funding until a version was released that was truly taken up by waterboards.

For other actors, the situation was even more ambiguous. For example, Alterra left the project before the WFDE-1 was quite finished in 2006. The initially fruitful cooperation, with Alterra bringing in ecological expertise, evolved into a debate over the use of the STONE instrument. RIZA and WL viewed it as the best available information on nutrients and manure scenarios. Alterra argued that STONE was incompatible with the WFDE, because of the great differences in set-up, which would lead to unreliable results. WL and RIZA actually agreed with this, but pragmatically reasoned that no viable alternative was available, so they simply had to make it work. The discussion over STONE continued after Alterra left the consortium. Eventually Alterra agreed on a solution to include the STONE data in an indirect manner that was realised in 2008.

As said, Deltares had kept in touch with Alterra over STONE. In the WFDE redesign phase, Alterra re-joined the development. Alterra's contribution was welcomed by Deltares and the PBL, but never became as self-evident as that of the PBL. Alterra received some funding from the Ministry of I&M for specific tasks within the larger project, but not enough to cover all their efforts. Furthermore, sensitive issues such as retention of nutrients in the water and the use of STONE were treated with care. STONE remained incompatible with the WFDE, so specific conversions were needed to apply any data and developed scenarios in the WFDE. Although the Alterra representative was personally very willing to contribute, it was understood that too many demands might make Alterra retract. Alterra again contributed to the calculations regarding agricultural impacts on the water system, but also to general water quality issues.

Alterra, like PBL, had its own instrument to evaluate WFD measures: the Water ECHO, focusing on the impact of WFD measures on rural areas. Some actors involved in WFD implementation, amongst others some of the waterboards and provinces, urged a merger between all three WFD related instruments, but Alterra and the Ministry of Agriculture, later Economic Affairs, were not eager. The ministry of I&M funded Alterra to do a validation of the WFDE by comparing it with the outcome of their instrument. Alterra suggested they would be open to using the WFDE if the results were as good as their own instrument and would provide insights on a finer scale. The renewed cooperation opened the path to further intensify working relations which might eventually lead to a merger of instruments, but at the start of 2013 this was still being discussed.

The cooperation between the parties in the redesign phase were not only seen as contributing to the success of the undertaking, it was also seen as a success itself. Several interviewees specifically mentioned that the fact that Alterra had returned to actively take part in this development was an important achievement in itself.

6.5 Changes in the joint objectives over time

This section starts with an exploration of the objectives as represented in the key documents. These objectives represent the objectives that the parties involved agreed upon, that they communicated to funders, the steering board and others. Coding these objectives shows that at the start of WFDE development more objectives were mentioned in the documents than in later stages (see annex 4c). Not only is the total number of mentioned objectives higher, more different objectives are mentioned as well. The reason may simply be that at the start of a project there is a greater need to justify the project and specific choices. The period of evaluation of the first WFDE and planning the redesign shows a second spike in the number of objectives, another unsurprising signal: in the evaluations, the results are assessed in relation to the set objectives and then the objectives for the redesign are specified. After that the mentions of the objectives become rare. The last two documents, reports of studies that apply the WFDE, only briefly introduce it as the model instrument that was used for the study, without detailing why or for whom it was developed. It is simply an instrument that can be applied, a black box.

The objectives that the partners in the WFDE development communicated can be categorised in three types:

1. The role the instrument was to have in the policy planning process
2. The things the instrument should be able to do, technically - which includes the scale and scope of the instrument
3. The targeted users

From the numbers of quotes I found in the research data, a shift in the WFDE objectives emerges. The project plans and reports in the initial phase described at length the objectives for developing the WFDE. The policy planning objectives were discussed elaborately, including for instance the value of applying scientific knowledge in policy development and bridging the gap between science and policy. The consortium remarked that policy makers did not have easy access to scientific knowledge, so an objective was to provide this access through a joint knowledge base. Furthermore, it should enable communication between stakeholders on the exploration of the effects of possible measures. The precise location of measures or the precise extent of the changes to the water system would have to be analysed by other means.

Over time, the number of objectives related to the policy process that are mentioned in the key documents becomes smaller. Increasingly, the WFDE was briefly described as supporting the (WFD) policy process, without specifying in what way, and the technical objectives became more prominent. The objectives related to the interactive or participatory aspects of the policy planning process had in practice been abandoned. As the technical objective - calculating the effects of measures - remained unchanged, and the instrument could indirectly provide input for the policy process, the developers claimed this represented only a minor change in focus of the instrument.

At the start, the main users that were mentioned were the regional water managers, meaning the waterboards. A year later, the key users included other authorities taking part in the regional planning teams and other stakeholders interacting with these teams. The report on the first prototype extended the targeted users to include all member of the teams of respectively civil servants and politically responsible board members of all the authorities involved in WFD at the (sub)river basin district level, the RAO1 and RBO (see chapter 3). Clearly the original focus was on the level of the regional WFD planning process. The later WFDE documents referred to both regional and national water managers, or simply water managers, without specifying which.

Furthermore, "funders" were introduced as a category of interest, separate from users. All funders apart from STOWA were national users. A lasting legacy of the public funding is that the resulting instrument has to be available for free. The continued development, operation and maintenance could not be paid from licence fees, so other funding schemes were required. This funding was uncertain and fragmented, as different partners promoted specific modules or functionalities of the WFDE by earmarked funding or commissioning certain deliverables.

As in the first years the focus was on the regional level, the water system schematisations were made at the sub-basin scale, allowing a possible national analysis through aggregation. With a bigger interest in river basin and national level analysis, the redesign also had to include the link between the national and the regional. At the end, the scale WFDE-2 shifted to a national or river basin focus, although very detailed schematisations were enabled too.

[1] The RAOs and RBOs were specifically established to be the platform for collaboration concerning the development of River basin management Plans (RBMPs) as required by the WFD. All four river basins in the Netherlands are international, therefore, four river basin districts have been defined. The Rhine district was subsequently subdivided into four sub-districts. The seven (sub)districts were the organisational units for the national WFD implementation.

Beside a shift in users and scale, there was also a change in scope. Originally, the scope mentioned in the documents was limited to ecology. Later, water quality and quantity were included as background models, as these factors influence ecology. Then, water quality and quantity became important by themselves. The WFDE pilots applied these two models and not the ecological model. According to the WFDE redesign documents, ecology remained the focus, but in fact WFDE-2 only facilitated applying an ecological model within the WFDE model instrument, without providing the ecological model itself. Developing the ecological rules-set was reserved for another project, while water quantity and quality were directly developed in WFDE-2. The first applications with the WFDE-2 were on manure policy and the dispersion of specific chemicals in the water system. The ecological model for the national waters was still incomplete; the ecological model for the regional waters was complete but disputed. In any case, neither ecological model was applied.

6.6 Changes in the instrument

Not surprisingly, as the objectives changed the instrument properties changed too, though not always simultaneously. As elaborated in the previous section, the WFDE was meant to mirror the Blokkendoos. As it ensued that it was not technically feasible to have the instrument present a pre-calculated set of measures and effects, as did the Blokkendoos, the WFDE required models that could perform the calculations quickly, and therefore relatively simply, for policy makers to use in interactive settings. However, another interested group, the waterboard specialists, wanted to perform more detailed analysis and required more detailed models. The ecological knowledge base of the prototype was viewed as incomplete, incoherent and insufficiently reliable, and needed to be improved. Furthermore, the specialists required the uploading of large quantities of data, which was not facilitated at first. Accommodating these wishes slowed down the instrument, making it unsuitable for use in discussion sessions. In this way, the instrument transformed from an instrument for decision-makers and general policy makers for use in interactive settings, to an instrument for specialists to use at their desk.

In the redesign documents, the objective of using the instrument in interactive settings was no longer mentioned. This reflected a change that the WFDE had already realised. The new project team proceeded to make the instrument perform better, which to them meant improving the reliability of the predictions. The aforementioned issue of uploading data was quickly resolved and the speed was improved significantly. The instrument was coupled to different instruments, either to extract data or to use simulations or algorithms. Improving the quality of the predictions at large scales such as the national scale or maybe river basin scale was technically more feasible, as the reliability of the water models was higher at a more aggregated level. The basin or national level was also more directly useful for the partners in the project team, so that became the focus. By dedicating the pilot project to a national evaluation of the manure policy, this was strengthened.

Another shift is in how the developers perceived the role of decision makers (ultimately politicians at the different levels of authority) and policy developers/advisors. In the original development plans, both groups were the main target groups. They were implicitly seen as competent actors, though they were not expected to be specialised in the various fields relevant for the WFD. Prototypes testing and pilot application projects, however, involved specialists within the user organisations.

There, they had the status of the true experts and when they did not approve of the WFDE-1, the instrument was never even tried out by the other groups. For the redesign, the developers focussed more heavily on these specialists because they were viewed as the gatekeepers that needed convincing before anything else. This was justified by stating that they would be able to assess the information and then pass on reliable results to policy planners. This translation was rationalised by the developers by framing the decision makers as requiring clear-cut advice and policy developers as not able to deal with the complexity of the information.

The WFDE instrument shifted from being a communication instrument for non-experts to explore effects of measures on ecology on a regional level, to a knowledge instrument allowing experts to calculate effects of measures on water quality on a basin or national scale. Although a schematisation could be made and run for any level of detail, the uncertainties in the modelling were thought to be too high to actually apply the instrument at water body level or for even more detailed assessments. The instrument was downloadable free of charge, open to everyone, but not everyone could use it as it required specialised expertise. The enrolment of experts was so successful and gradual that they replaced the user groups of policy makers and decision makers without making it appear a major change.

The initiators saw the waterboards as the party in need of an instrument and the developers as the experts who could provide them with such an instrument. Gradually, the waterboards' role became more ambivalent. Several waterboards employed experts who interacted with the developers as equals. While the prototypes of the first WFDE enticed many waterboards to join, the disappointment of actually using the WFDE-1 endangered the fragile connection. Some waterboards sought alternatives for WFDE, others hoped for improvements, some actively promoting them, others simply waited to see what would be the result of the redesign. STOWA represented the ecologists at the waterboards. STOWA retracted, but never completely severed the ties as the instrument lost much of its value for that group. It funded the alternative for WFDE, the V&S. As the V&A gained momentum it was reframed by actors involved in both instruments, namely the ministry of I&M, STOWA and Deltares, as being the 'complement'. Again the objectives shifted. The WFDE would be the instrument for experts performing evaluations at the national level, while the V&S would be the tool for water system analysis by ecological experts at waterboards.

Whether the regional water authorities could have been a powerful actor in shaping the instrument to satisfy their needs, we will never know. Simply put, the waterboards were never key actors in the actor-network, for several reasons. They were not united; they were funded indirectly, through STOWA; they were not represented in the developers' team, and never present when specific decisions about the instrument were made. Even so, had it been easier to develop a 'working' ecological model, it may have been possible that waterboards would have gained a larger role in WFDE development. Many waterboards were at one point eager to start. Had the WFDE instrument 'worked' for them, they would have used it and the WFDE outcome as I have sketched it could have been different. As it was, the WFDE failed to convince the waterboards.

Other potential users such as the PBL became enrolled at the time when the waterboards lost their interest. The PBL was interested because of the ecological model and the intention to find a replacement for their own instrument. As their investment in WFDE increased over time, this connection proved strong. In a similar way, the association with the Waterdienst and the Ministry of V&W/I&M proved strong: they invested time, money and reputation. It would cost them dearly to break the connection.

Broadly put, over time there was a stronger influence of national actors and research institutes which was reinforced by a lack of available, or easily realisable, tools that would facilitate developing an instrument that would satisfy the requirements of most waterboards. As the waterboards were not convinced by the WFDE, the connection(s) between waterboards and WFDE weakened. The more the instrument properties corresponded with the requirements of the national parties and research instruments, the more these parties become involved - the stronger the associations - and the more they influenced the continued development of WFDE in a way that suited them. The instrument, or in Latours' terms the machine, changed. Through those changes, other actors became enrolled.

Returning to the Janus's head third dictum "once the machine works people will be convinced / the machine will work when all the relevant people are convinced", one can see that once the relevant actors became convinced, the machine started to work. The WFDE itself had to convince others, and it did, as becomes evident through the first studies in which Deltares applied the instrument. These first applications were not done by the WFDE-2 team, but by others within Deltares, while the pilot study had not yet been completed. The resulting reports simply (and briefly) introduced the WFDE as the instrument used in the study. Without further ado the studied cases were described, the parameters of the study defined and the results discussed. The WFDE had convinced these Deltares users at a moment when the developers were not yet convinced that the instrument could do what the studies promised it had done.

For the original consortium partners, the water quantity model was simply a basis for the much more interesting ecological model and the user-interface that would be the innovations. As said before, due to the influence of various early users, with their own technical background, the fairly standard bucket model had to become more sophisticated. As this bucket model gained functionalities, the comparison with SOBEK became an issue. The bucket model could perform calculations that SOBEK could do better and as many waterboards had or were developing a SOBEK model, the developers and the consultancy that evaluated WFDE presented a change to SOBEK as the best technical solution. Instead of simply using a basic model as at the start, now the best technical solution was the objective. However, SOBEK blocked the transition as some waterboards did not use, and did not want to use, it. In addition, fees had to be paid for the use of SOBEK, which countered the free access that was a requirement related to the public funding. A new bucket model would be developed, but a conversion of a SOBEK model could also be used. At this point, the objective shifted to making a versatile water quantity model.

The objectives related to the scope of the WFDE also shifted. The original main scope was ecology, which was presented as the second main innovation in the original project plans. This turned out to be highly problematic. To arrive at an ecological model that represented the state of the art, several strategies were pursued. At first, the active gathering of existing knowledge was attempted, but the collected rules-sets collapsed in the confrontation with experts at the peer reviews. The statistical model based on the neural network analysis convinced some but certainly not all relevant actors, while the water quantity and quality model had already been used for some smaller studies. In the redesign phase, the developers of WFDE distanced themselves from the responsibility of the quality of the ecological model, by maintaining that they would only include the best available model at a given moment.

The WFDE-2 later facilitated the inclusion of all sorts of ecological models in the WFDE, starting with the available three for regional waters and one for state waters, proving that the instrument was independent of the ecological model. Even in 2013, preparations were made to facilitate the inclusion of yet another, more deterministic approach to ecology, based on the approach used for the V&S. However, the national pilot study and neither of the first two studies used any of the ecological models: only the water quantity and quality modules were applied. Again, the developers in no way signal that this was a significant shift. After all, ecology had not been abandoned; on the contrary, much effort had been devoted to facilitating ecological models, but it was not the developers' fault that no joint knowledge base existed while the other modules were ready to be used.

6.7 CONCLUDING REMARKS

The analysis above demonstrates how the WFDE became what it is now and why it is so different from what was originally planned. This chapter showed both the enrolling of new groups of actors and the reframing of objectives, or shifting of targets, in the development process of the WFDE. The continuous interactions between stakeholders, documents, instrument properties, etcetera, resulted in a redefinition of what the WFDE (the machine) should do: the WFDE shifted from being this explorative, interactive tool for exploring effects on ecology to a set of connected, versatile models (water quantity, quality and ecology) that could use a variety of ecological rule-sets and schematisations. In this way, the WFDE managed to convince a number of actors that became the most relevant ones, because they were willing, and able, to continue supporting the existence and further development of the WFDE.

The shift in WFDE goals and setup between the start in 2004 and the result as available in 2013 appears radical and perhaps hard to comprehend immediately. However, the reconstruction of the development process provides the explanation of what happened through detailed descriptions of the translations that took place. The WFDE objectives were continuously reshuffled. Some objectives were reframed and new objectives were added, though they were presented as minor changes in focus. New target groups were approached and new actors were enrolled. The WFDE became more and more connected to other information systems. As such, the actor-network grew: more actors took an interest and invested time and money in it. If the higher number of connections is a measure of success, the WFDE had become a viable technological product in 2013.

Changes in WFDE objectives were sometimes deliberate, justified by the developers as a result of new insights, such as focussing on experts when specialists at waterboards were acknowledged as important WFDE-users; or justified by funding, such as the funding for the WFDE-2 national pilot concerning manure policy. Some changes were justified by referring to a lack of accepted expertise, such as the ecological knowledge to make a comprehensive deterministic ecological model.

However, some changes were not deliberate. When the developers acknowledged the role of waterboards' specialists as gatekeepers, this unintentionally led to a focus on technical issues, leading away from the policy planning objectives that were central at the start. This was strengthened by the domination of technical specialists in the developing team. Policy issues later returned in another guise when the Ministry commissioned a pilot concerning manure policy. The project team focussed on how to calculate the effects of manure policies. No longer was the instrument to facilitate the planning process at the regional scale, it was a contribution to the policy debate at the national scale and the results of the pilot application might supply ammunition to the larger debate, possibly at the level of national politics.

Using ANT has allowed me to uncover how the WFDE managed to emerge from a continuous series of small, harmless or even trivial short-term decisions, both at the levels of the project team, that was most concerned with the 'technical' quality, and the funders and users, who were also concerned with policy implementation at the operational or strategic scale. For example, the gradually changing enrolment of experts resulted in replacing the user groups of policy makers and decision makers, but this did not appear a major change to funders and developers at the time. Furthermore, examining how the actors were connected demonstrated that some were connected through their discipline - for instance ecology -, and others through specific projects or previous employment. These relations can be stronger than the formal arrangements set on paper.

Were those decisions and the resulting changes in the instrument not simply made to improve the quality of the instrument? Certainly they were: the developers wanted to make the best possible instrument. The project team meetings and their minutes demonstrate that improving the technical quality was foremost in the mind of the project team, even when compromises were necessary on financial or practical grounds. According to the project team, the instrument would be better when it could predict the outcomes of measures more accurately and when more of the relevant processes were more adequately described. However, not all actors defined quality the same way, so what worked for the developers did not always work for other actors.

As a result, the WFDE has become an expert instrument, as the new instrument is not likely to be used anywhere else than in water-related research institutes and some consultancy firms on behalf of the water authorities. In terms of agency, the instrument also acts in relation to other (future) agents, who have to acquire appropriate skills and understanding to assess the working of the instrument in the first place.

Were these shifts in objectives translations caused by technology or by the influence of certain human actors? The origin of the changes cannot always be pinpointed, as this case demonstrates. ANT asserts that they were influenced by both; in terms of ANT the WFDE is an effect of the actor-network. The ANT-based analysis also reveals those changes that have come about unintentionally - though not accidentally. They were the result of the technology that was applied, or seemingly insignificant choices made in the development. Many changes were the effect of small steps at a time, but in the longer run they did lead to a fundamental change in the objectives of the WFDE instrument. This gradual shift is something that is often neglected in the analysis of development processes and can only became apparent by very detailed studies.

As a final remark, it has become clear that the technology itself is a major actor, influencing other actors, human and non-human, in the development process. The WFDE also mobilized the material world through its incorporation of a number of physical properties of the water bodies. For example, the retention of chemical substances was represented through several algorithms. However, in many ways, the material relations that were to be modelled did not cooperate. Many properties, for example invertebrates, refused to be standardized per water body. The assemblage of the WFDE could be understood as human agents trying to include the 'correct behaviour' of the non-human actors, with non-human actors refusing to be caught in scientific understanding or computer code and the computer code resisting the desires of the programmers.

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Chapter 7

WFD, harmonisation and expertise

The previous chapter concerned the way the various actors shaped WFDE over the course of about ten years. This chapter will focus on how one actor in particular, the WFD, realised harmonisation. The WFD affected regulations, policy and practices in water quality management, as I will demonstrate for the Netherlands. As such, the chapter reconnects the processes in the policy domain of the WFD - the main topic of chapter 3 - with the processes in the expert domain of the WFDE - the main topic for the chapters 4, 5 and 6.

7.1 Introduction

Harmonisation is defined as "the act of making systems or laws the same or similar in different companies, countries, etc. so that they can work together more easily" (Cambridge on-line dictionary[1]). Harmonisation is said to be a first requirement for cooperation within the European community: "An important condition for successful cooperation is that Member States should have the same points of departure, mainly concerning the way in which to deal with complexity and policy discretion, as well as ambitions and the legal value of obligations deriving from EC water law." (Van Rijswick et al. 2010 p131). Whereas European water regulation was patchy before, the introduction of the Water Framework Directive (WFD) increased the unity of European laws (Van Kempen 2012).

When searching in Google scholar (19 05 2016) for scientific articles regarding harmonisation in the European Union, most articles I found did not address what harmonisation is or why it would be desirable. Harmonisation is treated as something self-evidently positive. The articles were purely technical: how to attain this or that type of harmonisation in the field of law, health education, the environment, and so on. (Some examples for the environmental sciences: Heiskanen et al. 2004; Sandin and Hering 2004; Birk and Hering 2006; Buffagni et al. 2006; Borja et al. 2007; Kelly et al. 2009; Birk et al. 2013).

In the environmental sciences literature, harmonisation is typically discussed in relation to standardisation, two terms that are closely connected. For example, Köhl et al (2000 p363) define harmonisation as "the action or process which is undertaken to bring something into harmony, agreement or accord". They continue with the claim that "[h]armonisation or standardisation has its roots in technical applications" (p362)", for example the standardisation of electrical appliances and their plugs. When relating the two terms, harmonisation is defined as a process of making existing concepts more comparable, while standardisation means setting a common standard irrespective of what is already in place (Köhl et al. 2000). In other words, standardisation would set a new norm, whereas harmonisation would bring existing norms closer together.

The few other articles I found that did critically assess the issue of harmonisation, contrast it with decentralisation, portraying harmonisation as a feature of centralisation (Karl and Ranné 1997; Thomson et al. 2004; Scott and Holder 2006; Howarth 2009; Johnson 2012). Karl and Ranné (1997 p160) state that "[h]armonisation means the movement toward identical standards or regulations, and is therefore closely connected with centralisation" - note that this links harmonisation directly to

[1] http://dictionary.cambridge.org/dictionary/english/harmonization. Accessed 05 03 2016

standardisation too. Over the years, more and more decisions are referred to the EU level, though not everyone is pleased with this development (Johnson 2012 p83).The topic of European centralisation, unification or integration is strongly contested (Gualini 2004; Thomson et al. 2004; Johnson 2012). Britain's decision to leave the EU can be seen as a result of this contestation.

Johnson (2012 p88) discusses two principles in the European Union governance context. One is the 'acquis communautaire' or "the regulatory harmonisation across member states achieved by required adoption of European rules and regulations". This principle is balanced by the principle of subsidiarity: "the norm of governance that problems should be addressed at the lowest level possible to successfully address them" (Johnson 2012 p92). So, neither centralisation nor decentralisation would be the EU's objective, it depends on the problem at hand.

Whether harmonisation is related to standardisation or centralisation, in both cases it is contrasted with having a diversity of practices, suggesting that this diversity is a problem and harmonisation would be the solution. However, in other bodies of literature diversity is hailed as something positive in itself. In adaptive management theory, for example, diversity is seen as essential, because it allows for experimentation, both in policy and in physical measures. This would enable a process of continuous learning and adaptation that would improve society's capacity to cope with uncertainty and change (Huitema et al. 2009). Learning is in general seen as a requirement to increase the adaptive capacity of societies (Gupta et al. 2010). This relates to another type of diversity that would be valuable, which is the inclusion of different types of knowledge from different epistemic communities, such as different scientific communities or local expertise from inhabitants (Wynne 2011).

This brief overview suggests that harmonisation in policy making is seen as a process moving 1) from diversity to centralisation or 2) from diversity to standardisation. Either process can be initiated by national actors, but also by local or regional actors, or both, as will become evident later in the chapter. It is perhaps the ambiguity in the word harmonisation that makes it so much less controversial than standardisation or centralisation. The concept suggests the objective is to arrive at some kind of 'harmonious' compromise between the extremes of maximal diversity (or decentralisation) and standardisation (or centralisation); it is much more open ended - it even sounds friendly. In the European Union context, harmonisation means developing comparable policies, while allowing differences between member countries to provide them some room for manoeuvre that can facilitate the local implementation of directives.

In this chapter I will analyse the issue of harmonisation in the WFD process with a focus on the role of expertise, the general topic of this thesis. The word harmonisation as I will use it in this chapter stays close to that in the Cambridge dictionary, as my conceptualization of the term refers to a process to arrive at regulations, policy or practices that are, if not quite the same, at least comparable. The concept of harmonisation was mostly undisputed in the WFD implementation process and in the development of the WFDE, but what to harmonise, in what way and who gets a say in this were subjects for heated debates. I will elaborate for the Netherlands how harmonisation was also a struggle with existing practices that were replaced or incorporated. As will become clear in the following, expertise appears to be both a means of harmonising policy practices - for instance by developing methods and tools to be used by all stakeholders - and a locus of harmonisation processes in itself, as the experts involved had to reach agreement on what knowledge was to be the basis of the methods and tools.

In line with the previous chapter, I will apply an Actor-Network-Theory (ANT) approach, but now the centre of the actor-network - and attention - is the WFD, with the WFDE as another non-human actor. Harmonisation in ANT terms would be realized (or not) through interactions between various actors in the changing associations of actor-networks. Central to my understanding of harmonisation are the notions regarding performative society as developed in Strum and Latour (1987). They analysed the way in which societies are held together: “society is constructed through the many efforts to define what society is; it is something achieved in practice by all actors” (1987 p 785). Humans negotiate “what society is and what it will be” (p 789), with material resources and symbols serving as means of defining and strengthening the social bond. In this reasoning, technology becomes a resource in building society on a larger scale (p 796). Similar to how society is the effect of negotiations between actors, harmonisation needs to be performed as well. Rules, tools and procedures discipline actors, who are often distant in space and time, to perform in a certain way.

In order to trace these material components related to harmonisation, I describe the WFD in terms of a technological regime (Van de Poel 1998). The WFD, of course, is not technology, but it has instigated the development of technology and the technological regime concepts help describing how the WFD has done this. A technological regime contains “rules which are actively shared by the actors, enable coordination and so result in regular patterns of technological development”(Van de Poel 1998 p17). The centrality of rules in this concept is reminiscent of the policy arrangement approach (Arts et al. 2000; Santbergen 2013), but this approach lacks the material component of the technological regime.

As discussed in chapter 6, including the agency of non-humans is crucial in ANT. The reason to apply the regime concept here is that it connects ideas and rules with artefacts. The left side of the triangle (figure 1) represents the rules that emphasize the functions of the technology, whereas the right side stresses the configurations the technology takes. My discussion will show that for an analysis of the implementation of the WFD, the right side mostly represents the role of the WFD-text and the left

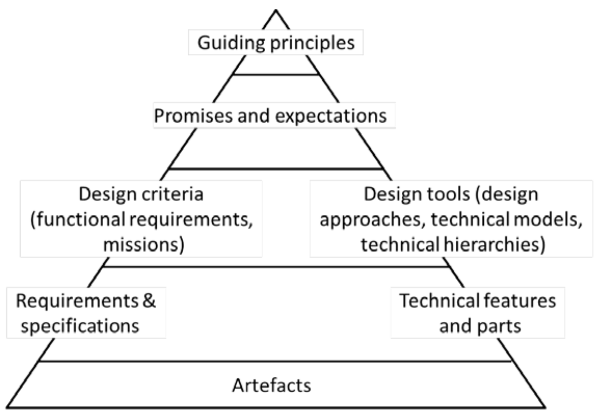

Figure 9 Technological development triangle (Van de Poel 1998)

side mostly the role of the experts and expertise. Obviously, many actors, especially policy planners and artefacts, navigate between the two sides. In the diagram, artefacts - in this case the WFDE and other WFD-related tools and instruments - form the entire base.

This chapter will be organised as follows. After briefly describing some specifics of the methods that support this chapter, I will describe how the WFD affected water quality management in the EU and in the Netherlands. Although this has already been discussed this in chapter 3, revisiting the issue now in terms of the technological regime allows me to explicitly relate the WFD text to the artefacts that are developed. Next, the effects the WFD planning process had on the instrument WFDE will be discussed. I will show that many of the harmonisation effects of the WFD can be traced in the WFDE. In the concluding remarks, I will elaborate upon the relations between 1) expertise and harmonisation of policies, 2) the harmonisation effect of expertise through an instrument such as the WFDE, and 3) the harmonisation of expertise itself that takes place within expert communities.

7.2 METHODS

In chapter 2, my methods were described extensively; here I will only add a few specifics relevant for this chapter. To analyse the issue of harmonisation in relation to both WFD implementation and expertise, the results of a number of specific codes were assessed (see annexes for code books). The main codes of interest are 'harmonisation' and the 'role of expertise'. In addition, some codes are analysed that do not refer to harmonisation as such, but issues such as the common implementation strategy (CIS), intercalibration, reporting standards and monitoring standards, as these all have to do with expertise and are arenas where harmonisation can be expected to play out.

As written in chapter 2, the analysis presented is qualitative in nature. Furthermore, as anonymity has to be guaranteed, I cannot always be as explicit as I would like. Although it would be possible to count how many people remarked upon a certain issue or expressed a certain opinion, this is often not as informative as it would seem. In many cases, not every interviewee had something to say on the issue, for example because they had no opinion on, or no experience with, the matter. Some issues were not explicitly addressed in the questions, but came up in a number of interviews and were worthwhile to report about. In this chapter, this leads to using to 'some', 'several', or 'most' interviewees, which roughly corresponds to less than a third, a third to two-thirds, and more than two-thirds of the (mentioned group of) interviewees, respectively.

7.3 WFD AND HARMONISATION

The Water Framework Directive came into being due to contributions of many actors over a period of quite a few years (see for example Kaika and Page 2003; Page and Kaika 2003; Lagacé et al. 2008; Howarth 2009; Santbergen 2013). With the transformation of the directive from a proposal to a law, it became immutable (Latour 2005); the discussion that led to its adaptation was closed. However, when implementing the directive, other deliberations ensued, constantly referring to, and (re)interpreting, what was written down in the directive.

This section will deal with the WFD implementation process and how effects of harmonisation were created through interactions of the various actors. I will start with a description of the WFD, applying the concepts of technological regime depicted in figure 1, signalling their use by printing them in italics. Next, I will provide an analysis of how the WFD affected other actors, as well as how actors shaped various interpretations of the WFD. Lastly, I will analyse how these interactions resulted in a common language to support an implementation that was specific for the WFD, but sufficiently open to interpretation to facilitate the uptake by various actors.

The text of the WFD contains a number of *guiding principles*, such as “[w]ater is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such.” (2000/60/EC; WFD, consideration 1). The river basin is the appropriate level for the coordination of the management of this special commodity (2000/60/EC; WFD, art.3). In addition, the ensuing policy needs to be evidence based (2000/60/EC; WFD, consideration 12).

The WFD *promises* that through its implementation, the quality and ecology of the waters in the EU will return to a (nearly) pristine condition. The *expectations* are that water management in Europe will be transformed into an integrated, transparent, river-basin-based process. The WFD instates concepts *(or functional requirements)*, such as water bodies, and values, such as protecting or preserving the pristine conditions of water bodies. Some authors doubt the validity of those concepts, such as the reference conditions to describe pristine conditions - as these are hard to define, given that natural variability and the effects of anthropogenic activities on ecosystem functions become harder to distinguish (Bouleau and Pont 2015). Some authors agree with the underlying ideas of the WFD, but question the way these ideas are operationalised for the implementation (Moss 2008) - for example because the main characteristics of thriving ecosystems are replaced by simple counts of species’ abundance. Moreover, the WFD promotes practices such as stakeholder participation (eg Newig et al. 2005; Howarth 2009; Behagel 2012; Kouw 2014), river basin management (eg Moss 2004; Van Rijswick et al. 2010; Santbergen 2013; Hüesker and Moss 2015) and cost-effectiveness analysis (Heinz et al. 2007; Engelen et al. 2008; Balana et al. 2011).

The WFD specifies various procedures that provide standards *(or criteria)* for the implementation process, ranging from reports to be submitted to the EU - such as the assessment of the current state of the water- to the setting up of monitoring networks. All member states must develop River Basin Management Plans (RBMPs) with a programme of measures and a cost-effectiveness analysis. In case of an international basin, a joint RBMP has to be developed as well as plans at the national level. The specific reports have to be handed in at specific times. However, how actors shape these procedures in practice can lead to interesting differences between member states, as comparative research demonstrates (Van Rijswick et al. 2010; Junier et al. 2011; Liefferink et al. 2011)

In the annexes, the WFD provides many *requirements or specifications* that define the activities in the implementation process: what chemicals need to be assessed, which biological quality elements and in what way, etcetera. These requirements as well as other procedural standards of the WFD, such as participation, were clarified and operationalised by EU staff and experts, and stakeholders, from all member states in the CIS that resulted in guidance documents. Although these guidances are not legally binding (Howarth 2009), they do provide “(provisionally) settled practices, and (provisionally) settled normative expectations” (Scott and Holder 2006 p 49).

The CIS was not only a locus of harmonisation, but also of (re)interpretation. Santbergen (2013 p 119-120) describes, for instance, how over time in the CIS meetings, the exemptions mentioned in article 4 of the WFD were no longer “considered as derogations but as an integral part of the WFD systematic for a staged compliance”. This interpretation of the WFD did not lead to a revision of the text itself, but it does shape the implementation (Van Rijswick and Backes 2015).

Based on the directive and the CIS documents, the member states have each developed methods and tools for WFD implementation. Many of those have later been assessed and compared in the hundred-plus intercalibration exercises, in which experts from the member states were (again) involved. Furthermore, the WFD has been a stimulus to scientific research to fill in gaps in knowledge and to make existing and newly developed knowledge available to practitioners. This was partly funded through the EU (Hering et al. 2010).

Experts and their expertise have had a substantial influence on the implementation of WFD, both in the European Commission and the Netherlands, which is not surprising in view of the rather technical nature of many concepts in the directive, such as the 'good ecological status' or 'good ecological potential' that are to be achieved. In every country, these concepts had to be operationalised into tools (*artefacts*) through the interaction of the various relevant actors. The WFD itself provides ways to minimize the demands of achieving the good status (Moss 2008; Howarth 2009). The existing practices - including *artefacts* in the shape of tools and procedures - can also be seen as actors, resisting or allowing new practices.

Harmonising Dutch water quality and ecology policy and management practice

Concerning this struggle between existing practices and WFD-related practices, Brian Moss remarks: "My thesis is that the Directive is becoming mired in political compromises, through the conservatism of water management bodies that have been unable to change their approach from practices that the Directive was intended to displace." (Moss 2008 p 33). Indeed, the WFD brought new water management practices, but the field of water quality and ecology was not new and existing practices would not immediately yield to new ones. Ecologists did feel that the WFD was a boost for the recognition of ecology. It was the first time that ecologists had a vital role in policy planning and was not 'just an interesting addition'.

In the Netherlands, the regional water authorities, the waterboards, were important players, as were the national authorities (see chapter 3). The national authorities' initial attempts to control the WFD process were rebuffed by the regional actors. Before the pragmatic implementation brief, the national authorities had already developed an approach for WFD implementation, but this was never implemented. It was regarded as being developed by the ministries without the proper involvement of other relevant actors(for more detail see Santbergen 2013). After this incident, the national WFD coordinators focussed on timing, reporting and other administrative procedures, leaving the content to the regional authorities and the research institutes. Later, the national parties started benchmarking exercises to come up with best practices (most cost-effective measures), that could then perhaps be transformed into standard practices.

The WFD required a harmonisation of regulations between the member states, by transposition of the WFD into national legislations. In chapter 3, the transposition into Dutch law and the ensuing pragmatic implementation strategy have been discussed. Overall, the Ministry's ambition brief stressed that no more changes would be made than necessary. The responsible authorities remained the same, river basin commissions would only coordinate and have no decisions-making authority. The measures would be along the line of existing policies and would not cost the agricultural sector anything extra. The classification of water bodies would ensure the maximum of political room for manoeuvre (Staatssecretaris van Verkeer en Waterstaat 2004). The implicit expectation of the brief was that the Netherlands could comply with the WFD without fundamentally changing Dutch agricultural and water management practices.

This was in complete opposition to the outcome of the Aquarein report (see also post-script to chapter 3), that prompted the pragmatic implementation brief, saying that WFD compliance - without using derogations - would require the reduction of current agriculture by two-thirds (Van der Bolt et al. 2003). Aquarein provided the agricultural sector with the justification for its wariness towards the WFD. The pragmatic implementation brief enforced this by exempting the agricultural sector from taking measures beyond those required for the implementation of the nitrate directive (91/676/EEC). The pragmatic implementation brief had a notable effect on the WFD implementation in the Netherlands (Uitenboogaart et al. 2009; Ten Heuvelhof et al. 2010; Santbergen 2013). Wherever the WFD was discussed, the brief's motto of 'affordable and achievable' was mentioned. Furthermore, the brief contained the principles for the procedures of defining and classifying water bodies, as will be elaborated later in this chapter.

In my study of WFD implementation in the Netherlands, I found no arguing on the usefulness of harmonisation. Leaving aside the formalities of the transposition in national regulations that my interviewees did not comment on, the WFD requires the development of River Basin Management Plans that many authorities have to collaborate on, while many other parties have to be consulted. My interviewees agreed that, in view of cooperation in this WFD planning process, there are undisputable advantages in having a common language, common practices - such as for monitoring - and a shared knowledge base. These were the terrains where harmonisation should and did take place, while the WFD measures would be a matter for each board individually - something that was self-evident for most interviewees.

Many interviewees referred to harmonisation through a shared knowledge base as an important goal of the development of the WFD Explorer - which I will return to later in this chapter. In the interviews, harmonisation was usually mentioned in relation to practices such as river basin management and participation, but also to developing procedures of data collection, processing and reporting. Some interviewees used the Dutch word 'harmonisatie (literally harmonisation) as a euphemism for the word 'standardisatie' (literally standardisation, which would mean a higher level of control and unity). Standardisation, however, is much more contested. Several interviewees at the national level remarked that they could never standardise practices top-down, as that would be unacceptable for the waterboards, but they could make regionally developed practices the standard after consultation with other regions.

From the interviews, it became clear that the national actors did actually want a higher degree of harmonisation - actually quite often closer to standardisation. Although they regarded regional water managers as capable and reliable authorities, national actors also qualified the regional managers as not always easy to deal with, due to their high level of autonomy and the diversity in approaches. The WFD harmonisation process provided a window of opportunity to do something about what was viewed as the undesirably arbitrary nature of some regional water management practices. The national water managers felt justified that - as they were the ones to explain and motivate choices made by the regional water managers to the national government and the EU - they should have some control of the decision-making process that should result in cost-effective measures to reach the WFD objectives. As I already touched upon in chapter 6, the WFDE could be an instrument to achieve this.

The diversity amongst the waterboards was remarked upon by several interviewees. Both in formal interviews and informal talks at various meetings, my questions on what the waterboards did think of 'this' (whatever 'this' was I asked about) would frequently be answered with a sigh. The speaker would remark on a lack of agreement, on never getting a single answer from the waterboards, on the waterboards all being different, and the like. Some developers of the WFDE expressed frustration at developing an instrument for waterboards who do not speak as one: you satisfy one to later find out that other waterboards want something else. The fact that the waterboards were diverse and had no single representative was often mentioned as an obstacle to goal achievement, not just for the WFD.

This section discussed the important influence of expertise on policy through Aquarein and the subsequent harmonising effect of the pragmatic implementation approach. The WFD implementation brought out (again) the waterboards' diversity while, at the same time, WFD implementation provided an opportunity for national actors and knowledge institutes to try to reduce this diversity.

A harmonisation of practices starts with a shared vocabulary

From a more general discussion of the WFD, this section specifically develops the WFD as instigating a new vocabulary (see chapter 3). These new terms were not 'just new words'; they required operationalisation specifically for the Netherlands and through this specific interpretation, specific practices were developed. Some words such as 'water body' seem obvious, but the related procedures have far-reaching implications that I will elaborate below. Other terms, such as 'R1 type', 'MEP', 'GEP', 'article 5 report', mystify outsiders, but are nowadays casually used by the community of WFD implementers. The WFD provided the implementers with a common language, something that the interviewees generally remarked upon as being a good thing, because it facilitated the exchange of knowledge and experiences between the water authorities involved in the implementation, both nationally and internationally. The directive, as well as the CIS and national guidance documents, provided definitions of the new terms and elaborated how to apply them, but the terms themselves were continuously assessed and made more specific in the implementation process itself.

An example of this process of reinterpretation of concepts in the Netherlands regards the concept of 'water body'. Long before anything like the WFD, different types of waters were already distinguished, but the WFD introduced a new distinction. A water, whether lake, canal or river, salt or fresh, state or regional, would - or would not - become a water body according to the definition in the directive. The criteria to categorise a water as 'water body' (2000/60/EC; WFD, art 2), that are specified in the WFD annex V, included a minimal size of flow, surface, or drainage area; small waters need not become a water body. This appears to require no more than an application of a technical procedure, but the classification as a water body is much more than a technical issue, as the EU requires reporting on water bodies only. The 'other' waters do not need reporting on. Although the WFD refers to 'all waters', this distinction could be used in a strategically beneficial way to exclude certain waters from the category 'water bodies'.

In practice, the classification of water bodies led to issues such as what to do with the network of drainage canals in Dutch polders. Each small canal was too small individually. Taken together as a network, they could be a water body. In the Rijn-West planning process, the RAO postponed the choice for a long time. In this period, two maps of water bodies were used side by side as a basis for preparatory reports in the planning process, one with and one without the drainage canals. In the end, only the belt canal was defined as a water body and the smaller drainage canals were not. Each river basin (sub) district or even waterboard made these choices independently. Currently, the waterboard Friesland is the only board where polder drainage canals are classified as (part of a) water body, demonstrating that, although harmonisation was strived for in defining water bodies, some diversity was allowed. Several interviewees involved in the WFD implementation feared that the 'other waters' would not receive the same level of protection or restoration.

The classification of water bodies, furthermore, anticipated the next step, which was to classify each water body as 'natural', 'heavily modified' or 'artificial'. The pragmatic implementation brief explicitly stated that by separately classifying vulnerable waters, even if they were small, authorities would avoid that those small waters became the norm for large waters. In addition, the brief instructed the authorities to classify water bodies wherever possible as artificial or heavily modified, as this provided authorities more leeway in formulating objectives (Staatssecretaris van Verkeer en Waterstaat 2004 p 27). Natural water bodies were thought to have more restrictions in their use and would have to comply with higher quality standards. As a result, for instance, the Waddenzee is not one water body. The main part of the Waddenzee became a water body that was later classified as natural, while the areas around harbours were categorized as separate water bodies, later classified as heavily modified to accommodate the human activities already present in that area.

Furthermore, each water body would be assigned a type, such as 'lake' (M), 'river' (R), 'transitional water' (O) and 'coastal water' (K), and a subtype referred to by adding a number: 'slow flowing brook on sandy soils', for instance. This typology was developed specifically for the Netherlands in working groups with experts from research groups and water authorities. The typology was based on the WFD and the CIS guidance and became the national standard. As the typology needed to be based on natural waters, however, a shipping canal or drainage canal would have to be described according to the natural type it resembles most closely. In this way, the European language was reinterpreted for the Netherlands. After this national typology was made available, each waterboard interpreted the classification to accommodate the situations they encountered in their own area.

The classification imposed an ideal on a water body that could be very far from its current condition. An example is the Donge in the area of the waterboard Brabantse Delta. This water changes character many times along its course, from wide and nearly stagnant - due to earlier 'restoration' to a 'natural' appearance - through narrow and meandering as the brook it supposedly is, to straight and lined as a canal. The water is directed under a train track through a syphon and further along, part of the water is diverted to a drainage canal to dilute the effluent from a waste water treatment plant. What remains of the Donge drains into a shipping canal. Even though the Donge is entirely man-made now, long ago the water would have had the characteristics of a brook. The waterboard Brabantse Delta therefore classified the Donge as a brook, even though restoration to even resemble a brook along its whole course, let alone reintroduce the corresponding ecosystem, is basically impossible.

The characteristics of the type of water body would determine the standards *(requirements* in regime terms*)* to be met for biology and hydro-morphology. For each type, experts defined the reference conditions, meaning the conditions the water body would have had, if it had not been changed by human action, as the WFD-text specifies. This posed a dilemma for the Dutch experts because of many hundreds of years of human intervention in the Dutch water systems. Eventually, the experts decided to define the pre-industrial state as the reference, in this way widening the meaning of the reference state beyond a 'pristine' state.

The elaboration of the Dutch Ecological Quality Ratio (EQR) method, a *technical feature* to determine the quality status of a water body, required defining the meaning of each of the categories in the EQR range, going from high to bad, and establishing the upper and lower boundaries of each category for each of the four ecological indicators. This required observations of these conditions in the different types of water bodies. However, in the Netherlands, only very few water bodies represented the best or the worst status. The gaps in data were filled in by using foreign waters bodies, historical records (for instance data from the 1960s or 1970s for the bad status) or expert judgement.

The methods of classification and assigning quality status affected the monitoring programmes that had to be developed according to the WFD. The WFD introduced new parameters (or *requirements*) that needed to be monitored. An appropriate monitoring programme needed to be in place at the latest in 2006 (art 8, 2000/60/EC; WFD). This meant that for a number of parameters, there was no data available prior to the first monitoring. The water authorities and various committees of experts had quite some discussions on what to monitor and where. These discussions also took place within the authorities' own organisations, especially between ecologists and managers, and between ecologists and policy planners from different authorities and research institutes. Some of these new (mostly biological) parameters could perhaps be best measured on other locations than those that were monitored now. Changing the monitoring location would disrupt the collection of time-series data; continuing with existing ones and adding locations would cost extra money, however. The interviewees indicated that to reduce costs, most authorities chose to focus only on those parameters required by the WFD and only on WFD water bodies. This meant that some parameters and locations would no longer be monitored.

Let us consider this for a moment, as this provides an interesting insight in water quality measurement. Apparently something that has been an important water quality indicator for many years can suddenly cease to be one, whereas a water quality indicator that was never monitored can suddenly become essential. It is not the case that the implementation of WFD happened to coincide with new scientific insights. The change in parameters to be monitored was not based on scientific, but on policy requirements: first, the requirements in the WFD and second, the financial limitations set by the regional authorities.

The WFD terminology, including terms such as 'water body', 'good status', 'river basin management plan', that had itself been developed in the process of negotiating the adoption of the directive, further developed in the national implementation processes, affected by both the legislative process in 'Brussels' and the joint sense making in the development of CIS guidance and later in the intercalibration exercises. Furthermore, water quality experts and policy planners at research institutions and water authorities negotiated on how to translate the terms for use in the

Netherlands and how to operationalise and measure them. The application in water management practice continued to shape the terms' meaning. Both political motives and expertise-based motives gave direction to the meaning these terms acquired over time.

The harmonisation the WFD brought consisted of a common language; the use of the same terms in all Member States of the EU, although the assessment methods and the exact meaning differed between and even within countries. That an intercalibration process was deemed necessary in itself signals that different interpretations of concepts and different operationalisations were possible, as the goal of the intercalibration was to assess whether and how these were comparable.

7.4 Harmonisation and the WFDE

Chapters 4, 5 and 6 have already discussed the development of the WFDE in some detail. For this chapter, it is relevant that developing a joint knowledge base - the harmonisation of knowledge - was a main staple of the WFDE development process from the start. To achieve this goal, the collection of the available ecological knowledge rules for the ecological model was one of the three pillars of the WFDE-1 development. Another pillar was to actively engage with the people who were preparing the WFD planning process, in order to quickly take up any procedures or standards that were relevant - such as the standardised list of measures that was not yet available at the start of the WFDE development.

Some national stakeholders wanted the WFDE to be not simply *a resource* for regional water authorities, but *the* instrument used by all regional water authorities, not only as a joint knowledge base, but also as an instrument to structure the decision-making process. If all waterboards would use the WFDE to select measures from the standardised list and perform a standardised cost-effectiveness analysis, the selection of measures to achieve the WFD objectives would be highly standardized - which was what some within the national authorities were hoping for.

The choice for a measure would depend on the cost-effectiveness analysis.The cost module never became an important topic in the development of WFDE. Both the WFDE-1 and the WFDE-2 offered some basic functionalities to do a cost analysis, although the developers never viewed it as a priority and regarded it as beyond their expertise. Many prospective users and the steering board stressed the importance of assessing the cost-effectiveness of the potential measures. This assessment was, however, very difficult as there was no available record of costs for measures in the field of water body protection or restoration. In addition, cost comparisons were highly complicated because costs greatly depended on the local situation. The lack of insight in costs was also a reason for the PBL opting for an ex-ante evaluation (Planbureau voor de Leefomgeving 2008; Planbureau voor de Leefomgeving 2015), instead of the cost-effectiveness analysis (see Engelen et al. 2008) required by the WFD. In other words, the PBL compared the budgeted total costs of planned measures with the estimated results of these measures and did not analyse what would be the most cost-efficient measures to achieve the WFD objectives.

Although in the development of the WFDE-2, the focus was no longer on directly supporting the WFD planning process, its effect was still discernible. Though no one had the task to monitor the WFD planning process, there was always someone in the team, in the steering board or the users group who had heard about relevant WFD implementation changes that needed to be taken into account, such as the changes in the EQR metrics for the second round of WFD planning. Otherwise, the planning process was not referred to in the project meetings.

An enduring effect of the WFD is the use of its concepts in all versions of the WFDE instrument, for instance ‘water body’. Non-water bodies had to be included in the model as well to complete the water balance. They had to be both recognisable and ignorable, because the WFD(E) reporting was to be based on water bodies only. Although the WFDE-2 could have included the procedures for calculating the EQR according to Deltares programming standards, a software tool called QbWat[1] was integrated in the WFDE, including its idiosyncrasies, to ensure users that the national standards for calculating the EQR were applied. QbWat is an interesting example of a tool that becomes the standard. A small consultancy developed a simple, stand-alone programme that provided nothing more than automated calculations of the EQR according to the official manual. The national authorities later recognised it as a tool that calculates the scores accurately, then paid the license fees to make it freely available; now it is the default tool.

Harmonising expertise: modelling versus expert judgement

Harmonisation is not only something that comes from the WFD. An example is the drive to use models instead of expert judgement, which was not a WFD requirement, but a preference of the national policy planners and the expert communities, particularly the hydrologists and system engineers - some of whom were also ecologists. In the development of the WFDE, this model-preference was present from the start. A model would “relieve” the waterboards from using expert-knowledge as a basis for decision making. Many ecologists at the waterboards did in fact use models to support (parts of) their analysis, but the rhetoric was that ecologists shied away from models.

Although expert judgement was perceived as the most used means for ecological assessments at waterboards, all the interviewees who had an opinion on the issue were in favour of using modelling as a basis of policy decisions over expert-judgement, where possible. An important reason to prefer models was the fact that they would provide a standardised knowledge base. However, the interviewees differed on whether modelling ecology was possible and on what would need to be included in the model. All interviewed funders have some experience with models, some have even developed them; others have used them or used the model results. All developers and (prospective) users (from here on simply users) had experience in modelling, at least in applying existing models, but most of them also had experience in developing models themselves.

Expert-judgement was viewed as suited for situations where an experienced expert predicted the effect of measures on a specific water (s)he knew well. The problem many interviewees (including ecologists) have with this kind of judgment is that the knowledge behind the judgement is hard to transfer to other regions, to trace back and to replicate. Asking another expert to do the same assessment may lead to a different result. This leads to problems in explaining the measures to the public, the board and the regulators, because measures will differ from region to region without an ‘objective’ justification. Furthermore, when an expert leaves, (s)he takes her (his) knowledge with her (him).

Modelling, on the contrary, would support replication, standardisation and retracing the logic behind the results, which would contribute to the transparency of the decision-making process. Knowledge captured and inscribed in models would make it available to others. Models are fixed and therefore modelling results would be the same for everyone who runs the model. Using the same model would

[1] (http://www.roelfpot.nl/)

mean no more discussion about the ‘facts’, but only discussion about what actions to take. The dichotomy of expert-judgement versus modelling was often mentioned as an important reason for starting and continuing WFDE development.

Rereading the fragments of the interviews regarding this discussion reveals that models can provide this harmonisation of knowledge only to a limited extent. In fact, what the interviewees said, was that *modelling results are the same for everyone who runs the model, only if the same settings and the same data sets are used and the model output is interpreted in the same way.* However, the interviewees also explained that this is rarely the case. The model is used for different situations, regions, questions, requiring different data sets and different settings of variables. Replication of the earlier results basically does not come into it. I will further analyse the modelling practice for a more detailed understanding of why the interviewees arrive at this conclusion.

First, it is the nature of the model that determines the result. A model is a specific representation of reality suited to answer a specific question, though once distributed to users, models are often applied to other questions as well. The transparency of model instruments in general is hindered by the fact that they quite often consist not only of new code produced specifically for a specific problem, but also existing code, or even data bases or instruments, that are set up to serve other needs. The thoughts that were the basis of these modules are often poorly documented and can be retraced to a limited extent. The WFDE had connections to many other software products and databases, made for other purposes, as detailed in chapter 4. Even modellers active within the WFDE-2 project team informed me that they were not cognisant of all parts of the WFDE-2; they simply relied on the expertise of other members of the team or on the developers of connected software. This is what Matthijs Kouw (2012, following Humphreys 2009) refers to as the epistemic opacity of models: models (or more specifically simulations) that are too complex and insufficiently transparent to for humans to fully understand what it is they do.

Furthermore, my study of the WFDE development suggests that the supposed ‘neutrality’ of models is a result of hard negotiations between those involved in model construction. During the development process of WFDE, different experts had different views on what knowledge to represent in the model, but only one specific representation was finally selected to be the best, most valid, representation of the issue at hand. The WFDE-2 model reflected the expertise of the developers and the issues they were interested in.

Second, the validity and completeness of the data affect the validity of the outcome. Model users have to collect and prepare the data for every new case and translate them into terms the model can work with. This can require quite some pre-processing (see for instance the schematisation for the national pilot study for WFDE-2 in chapter 4). This is what Paul Edwards (2010) calls data friction.

Several interviewees - users and funders as well as developers - explained that in some cases the data available was too poor for a valid analysis, but as better data was not available, the choice was to either use the data anyway or to not use the WFDE at all. In addition, certain parameter settings depend on the specific case and have to be chosen with care. An example is the decay of certain chemicals, which depends among others on temperature. The temperature can be set to a yearly, seasonal, or monthly average, depending on the situation.

Third, there is the interpretation of the model output. All interviewees who talked about that aspect represented all groups; they stressed that this interpretation is vital and cannot be done by those who do not fully understand the model, the data and their background. Even the best model results contain uncertainties. The WFDE does not inform the user of the sources, types or size of uncertainties in the model, data and outcome. The developers explained that these uncertainties occur in too many parts of the system and are of too diverse a nature to translate them into simple uncertainty ranges. Interestingly, the PBL, one of the developers of the WFDE-2, did have a system to assess the various uncertainties in a modelling instrument (Kouw 2012; Petersen 2012), but this was not applied for the WFDE-2. As much as the building, the use of models requires knowledge, experience and craft (Edwards 2010; Kouw 2012; Petersen 2012).

The above provides some nuances to the claim that a model is much more standardised than expert judgement. One could say that a model does certainly standardize, but is at the same time typically a specific version of (a series of collected) expert judgement(s). Although there may not be such a strict dichotomy between expert judgement and the practice of modelling, modelling does have harmonising effects. The instrument dictates the terms in which the users will have to translate their questions, their data, their measures. The terms in which the results are expressed are also inscribed in the instrument. The next subsection deals with the last issue of this chapter: whose representation of reality is included in the WFDE?

Developing a standardised ecological model

The main principle of the ecological models developed for WFDE (see chapter 4) was that they all translated the physical-chemical conditions of a water body into an Ecological Quality Ratio (EQR) score. Obviously, before the WFD came into force, there had been no need to develop these relations. The development of the EQR metrics themselves started as late as 2004, which made including them in the WFDE model not straightforward, as one could imagine. So when the developers of WFDE were elaborating the rules-sets for the ecological model, they encountered gaps in knowledge as well as a lack of data regarding existing conditions and ecological quality. This lack of expertise affected any rules-sets the model was to be based on. In this section I will discuss the different views regarding ecological models in relation to the WFDE and which of them was eventually adopted. Although the groups are not that easy to define - given overlap between the groups - it is still useful to distinguish groups of people that hold different views.

The first group had no preference for a specific type of ecological model. Any model would do, as long as it worked. And it worked if it was complete and could calculate the effects of measures in terms of the EQR, with a reasonable predictive value. The members of this group were most often associated with the research institutes or were (ecological) experts at water authorities with a deep understanding of the different types of models. Most members of the project team for WFDE-2 belonged to this group. They favoured a good statistical comparison of the various models in order to choose the one with the highest prediction value.

The second group specifically required a model that was analytical. The members were mostly (ecological) experts at water authorities, but also ecological experts at research institutes and universities. They strongly criticised the choice for the statistical model based on neural network analysis, because - as they argued - this model was incapable of assessing the causes of a current unsatisfactory state and therefore useless. “You cannot prescribe medication without a thorough diagnosis", some said. In addition, the cut-off points in the decision trees were very sharp, which - in a counter-intuitive way - could lead to a minor difference in the input having a huge effect on the outcomes. This group was disappointed with the direction chosen in the WFDE and looked for other instruments. This view was the basis for the development of the competing model instrument, the V&S (see chapter 4), that would facilitate an analysis of the current situation.

The third group required transparency as a main feature of any acceptable ecological model. This group overlapped to some extent with the other two groups and was prominent in the steering group for WFDE-2. As long as the model provided reasonable predictions and it was transparent how it arrived at its conclusions, this group was satisfied. They argued that transparency was key, because to advise policy makers it was necessary to communicate the uncertainties as well - something that would be impossible with opaque instruments. Some people rejected the neural network based model for being incomprehensible, but accepted the tree based model derived from it because, although the cut-off points seem arbitrary, at least a user could understand how the result had come about. Others argued that only models based on causality could be transparent.

Parallel to the WFDE-2 development, three variations of a statistical ecological model for the regional waters were developed and a causal one besides, initially for the V&S, but in time possibly also for the WFDE. The funders of the WFDE promoted the choice for one ecological model and then moved on. Continued maintenance and development of a model cost money, and comparisons of results of different models divert attention from the political choices. Likewise, the ministries preferred to merge existing instruments, such as the WFDE (Deltares, first min of V&W, later min of I&M), the Waterplanner (the PBL, first min of VROM, later min of I&M) and the Echo (Alterra, Min of LNV, later EZ), to have only one instrument to inform policy on WFD related measures. In this as well, there is a tendency towards standardisation over diversity.

The default ecological model, chosen on the basis of a marginally higher predictive value, was the Product Unit Neural Network (PUNN, see chapters 4 and 6). The PUNN method was viewed as fairly transparent as the result is an 'understandable' equation, but is a purely statistical representation of the relation between physical-chemical conditions and EQR. The project team suggested that the causal method developed in the V&S project may - when completed - be included as well, as they had no objection to a causal model. Those who did object to the statistical models - as many ecologists did - would, for now, have to find models elsewhere.

7.5 Discussion

The implementation of the WFD in many ways harmonised the practices of Dutch water management regarding water quality and ecology by imposing a new vocabulary and specific practices. In the implementation of WFD, existing practices, concerns and tools play a role as well as the WFD text itself. Specifically in language used, harmonisation has reached not only the superficial level of reporting standards, but meaningful daily practices in monitoring and management of water bodies. The meaning of specific concepts may not be exactly the same everywhere, but that in itself shows that the concepts were important enough to translate them into local practices. Santbergen (2013) already concluded that the WFD has resulted in multilateral harmonisation. In this chapter, I confirm this conclusion for the Netherlands. I provided several examples that showed why the term to be used is harmonisation, not standardisation: differences remained in how water authorities translated concepts into practices.

A comparable case of policy changes that affect expert practices was studied by Waterton (2002). She performed an ethnographic study regarding two classifications of nature, one national (in her case British), the other European. The European CORINE Biotopes classification aimed at creating “a ‘common reporting language’ for natural habitats and species” (Waterton 2002 p 180), related to the EU Habitats and Species Directive. Waterton demonstrates how the introduction of the European classification system in the UK created new practices to deal with the differences in the two systems and at the same time do justice to the local conditions, needs and debates. The European classification was applied, but locally grounded, leading not to European standardisation, but, in my words, a harmonisation of practices: although the categories of the European standard are used, they come to have different meanings depending on the practitioners and the situation they are in.

Waterton follows Bowker (2000) in saying that a classification, such as the habitats, or a biodiversity database such as Bowker studied, creates a future world where those phenomena that are counted become valuable in themselves. My results suggest that what Waterton says about the “performative nature” of classifications is applicable to other policy-relevant expertise such as models or model instruments - the practices that I studied. Consider the WFD: water bodies become more important than non-water bodies, as much as those species that are tallied in the EQR metrics become more important than those that are not. As Moss (2008) argues, the way the WFD is implemented focusses no longer on the ecosystem as a whole, but on the individual species that are the indicators of an certain ecosystem in the WFD instruments. Practitioners will develop a bias towards the sanctioned species, habitats, conditions or measures. This bias will find its way into a classification or is included in another type of instrument. In this way, instruments can act both as harmonising and reducing agent.

The performative nature of classification in Waterton’s work resonates with the performative nature of society as posed by Strum and Latour (1987). Another thing Strum and Latour posed is the role of non-human actors in keeping society together. This chapter showed how artefacts (such as the WFDE, other specific tools and technical procedures) contributed to the harmonisation the WFD instigated. Experts developed the design tools and the technical features (the right side of the regime triangle), applying the functional requirements and specifications (the left side of the triangle) to produce the artefacts that incorporated the WFD principles. The WFDE shows the persistency of this incorporation: even though WFDE-2 became a more versatile instrument that could be, and was, used for other studies than specifically the WFD-planning it was originally designed for, the use of WFD specific features such as the EQR metrics and QbWat, and terms such as water body, remained.

The analysis presented in this chapter demonstrated that harmonisation is valued in the policy domain as well as in the expertise domain. The communities in the two domains reinforce each other, it suggests. Harmonisation, however, is not the same as standardisation. Standardisation sets new norms and makes building blocks to build new things on. Harmonisation can be defined as the process towards standardisation, but it can also be a goal in itself to make things comparable while still allowing differences. This is useful, because on the one hand, the comparability allows policy enforcers in the EU to assess member countries’ compliance and organise benchmarking processes to stimulate the uptake of best-practices. On the other hand, member countries to some extent retain their autonomy in policy development as is consistent with the principle of subsidiarity.

That harmonisation is promoted in both domains can be illustrated by the development of the WFDE. The guiding principles of the WFD were translated into procedures, monitoring and reporting requirements, and other methods for managing water quality and ecology. With that, the guiding principles moved to the background: the procedures, methods and requirements became goals in themselves. These came together in the development of the WFDE. The first WFDE was substantially influenced by the policy planning requirements of the WFD. Gradually, the goal of supporting the WFD by using the WFDE changed to developing the models in the WFDE as a goal in itself, but many of the WFD values and concepts remain inscribed in the WFDE-2, through the use of water bodies as reporting units, the objectives per water body and the use of EQR to express the result of measures. The WFD did not influence the algorithms or the equations, but it did determine the choice of indicators, the set-up of the schematisation and so on.

Developing a shared knowledge base was one of the objectives of the initiators of the WFDE. The WFDE was be to a vehicle to collect knowledge on ecology and then make this available to all parties involved in WFD implementation. The assumption was that in the political process of WFD implementation, decisions would be of better quality if they were based on this shared, scientifically sound, objective knowledge base. Implicitly, the claim was that there is such a thing as the best expertise and that this could be gathered and made available in such an instrument. Added to that, at the start, the claim was also that this best expertise could be presented to comparatively 'lay-people' so they could form their own opinion on possible solutions based on this information. This claim was abandoned when the WFDE became more complex.

The search for the best expertise, however, continued throughout the WFDE development. This exemplified how the domain of expertise is also a locus for standardisation. Specific examples are the development of one ecological model that would encompass all relevant ecological knowledge, the standardisation Deltares strove for through Delft Shell and the development of the NHI (see chapters 3 and 6).

I explored the claim - which was shared by many of my interviewees - that using modelling instead of expert judgement was better for policy, because of the inherent standardisation which would allow replication and retracing the logic of the results. In the case of the WFDE, transparency was hard to achieve, as retracing the steps of model-builders and model-users was hardly possible and replication was rarely done. Especially the funders and users perceived this as virtually impossible, while developers described this as requiring time and expertise. The caveats the interviewees themselves presented demonstrated how models were themselves a product of expert-judgement and that the use of models again requires expert judgement. Although the information models provide may be different from what experts would otherwise provide, the prerogative of expert to provide and interpret information for policy remains.

I do not mean to disqualify the use of models; I want to clarify the discourse that surrounds models. One of the developers explained the value of the use of models: 'Simple questions, I answer from the top of my head. When it becomes harder, I write down some calculations on paper. For even harder questions, I may develop a spreadsheet. If that doesn't help my understanding, I make a model, because that forces me to define the relevant parameters and look at all their relations and reflect on what is missing to make the model represent reality, as well as what is necessary to answer the question at hand.' This corresponded with what many practitioners - both in the research community and the water management community - said: they use models to help them understand the system they work in. They did not take the model for granted, nor did they unquestioningly accept the results they produce. Models can help the understanding of complex systems. As such they are useful tools experts apply to improve their understanding. Models are an integral part of expert judgement, as much as they are the result of expert judgement.

As the experts have this preferred position, it is relevant to look at the role of experts. The WFDE developers defined themselves as applied - in contrast with fundamental - scientists. They were providing expertise for policy, but did not see themselves as involved in policy development. In their view, they only provided the best possible instrument to calculate the effects of physical and chemical changes in the water system on the water quality and ecology; how it was used was not their responsibility. This position can be called providing 'truth to power' (i.e Hoppe 1999; Van Bommel 2008). However, the experts not only develop the best possible expertise, many other interests affect the expertise they provide, as this chapter showed. Among other things, they are at the same time subject to the tendencies towards standardisation in the expertise domain and towards harmonisation in the policy domain.

7.6 CONCLUDING REMARKS

The WFD has clearly (and not very surprisingly) had a harmonising effect on water quality management in the Netherlands, but I hope you agree that I have shown that the ways in which harmonisation took place were more surprising. As in the previous chapter, ANT allowed for an analysis that breaks down the processes in actions by various actors. I shifted the centre of the actor-network here from the WFDE to the WFD. The WFDE in that perspective is only one of the actors, albeit obviously an important one for my specific study.

The chapter provided examples of how the WFD prompted the experts to develop knowledge and tools that incorporate the values and concepts of the WFD. The extent of the harmonisation and the exact shape it takes depend on existing practices and the resistance or acceptance by actors. Harmonisation by WFD goes beyond the mere harmonisation of regulations; it has reached daily practices of water managers.

The WFD was an actor in the development of the WFDE as well: due to the WFD, the instrument includes certain functionalities. The WFDE exemplified the inscription of policy into an instrument. The other way around, it is hard to say what effect the WFDE had on the WFD. The WFDE had been used only to a limited extent until 2013, but through the various debates in which also the WFDE in its development took part, it has likely had some effect on the way the WFD took shape in the Netherlands - although I did not study this in detail.

The case also demonstrated that different experts - though they all strived to arrive at the best approach - favour different approaches. The different views on ecological models and expert judgement were not confined to specific, well-defined groups, such as policy makers versus developers, or ecologists versus water quantity experts. Incorporating the best available knowledge in the WFDE was impossible, as there was no agreement on what was the best approach. An option was to include different approaches, but that would have defeated the purpose of providing a joint knowledge base. Eventually, the instrument enabled the use of various ecological models as a compromise.

The inscription of WFD values and concepts in the WFDE is similar to what one observes in the implementation process of the WFD as a whole. Other tools in for example QbWat or the EQR metrics are specifically inscriptions of the WFD. Moreover, with the development of these tools, the main goal of the WFD was reduced from the protection or the restoration of the water-ecosystem to reaching the required EQR score. While a common ground was constructed, the diversity of relevant practices and knowledge (in terms of content and sources) was reduced. Again, this reduction in itself is not surprising, as policies in general tend to do that; what is new, however, is to recognize the way this reduction is reached through negotiations within actor-networks.

Although subsidiarity is a principle that states that the lowest possible level should be responsible for a problem, a directive such as the WFD has an effect on management practices at all levels, from the individual who reads the monitoring data of the instruments to the individual who reads the reports of the Member States to compare the efforts of the members to comply with WFD. Even the lowest level cannot quite escape the effects the WFD has on policy and management practices.

This observation relates to the normative discussion of whether harmonisation is always positive. As remarked in the introduction, harmonisation in general was undisputed within the WFD debates. It was viewed useful to have a common ground for collaboration; it was likewise useful to be able to compare practices so best practices could be promoted. I would just like to suggest that too much harmonisation hinders developing tailor-made solutions that might suit a specific situation best. Harmonisation could also hinder innovation, as much is invested into a current standard. As Waterton nicely phrased it:

"… too little flexibility means insensitivity to local exigencies. However, too much flexibility may weaken the authority of the system needed to defend European protection policies" (Waterton 2002 p 197). Harmonisation is performed as a continuous balancing act.

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Chapter 8

Discussion and conclusion

The previous chapters elaborated specific aspects of the implementation of the Water Framework Directive (WFD) in the Netherlands and the development of a modelling instrument to support the WFD, the WFD Explorer (WFDE). In this final chapter, the different strands of discussion will be woven together to elaborate and evaluate the contributions of the thesis to its overarching topics: first the concept of evidence based policy making, more specifically the relation between the policy and expertise domains, and the role of DSSs as an intermediary between the two, and second the contribution of Actor-Network-Theory to policy analysis and policy support tools.

8.1 A BRIEF RECAPITULATION

The thesis started with an institutional analysis of the implementation of the WFD in the Netherlands. Regulations, politics and the chosen organisational structure favoured vertical integration of water quality management: cooperation between regional and national water authorities and to some extent the municipalities and provinces. What was lacking was horizontal integration: cooperation between sectors. Although most stakeholders acknowledged the importance of sectors other than the water sector, these sectors were not made an active part of the WFD planning process. At the national level, Parliament decreed that the WFD was not to lead to extra costs for the agricultural sector. Regional water authorities had no instruments to impose any measures on agriculture or industry and focussed on what they could do themselves.

The implementation of the WFD was executed simultaneously with the development of metrics, tools and instruments to accommodate the new requirements the WFD had introduced. The highly technical nature of the WFD planning process limited the input of stakeholders in the participation process that was duly and extensively organised. Ultimately, the institutional arrangements reflect how the ambiguous ambitions (Santbergen 2013) concerning WFD implementation became a matter for the experts in the water sector. They navigated between the extremes of allowing water ecosystems to develop their full potential and pragmatically choosing easily attainable and low-cost solutions. Useful as the insights from the institutional analysis were, they did not explain how in specific cases water boards developed plans with agricultural organisations or teamed up with managers of nature areas to implement the WFD. The local practice was not part of the analysis.

Next, the development of the WFDE to support the WFD implementation process was described. The first WFDE was analysed using the literature on the design of Decision Support Systems (DSSs) and other ICT tools. This analysis demonstrated how the development process contributed to users' perception of the usefulness and validity of the information the instrument provided. Whereas a large part of the literature in this field focusses on improving the design process to develop more successful ICT instruments, chapter 5 argued that a better understanding of the many tensions that shape the development is needed. Many sensible guidelines exist on how to design DSSs, but success does not lie in developing (and applying) the perfect set of guidelines. The process of development is messy and hard to manage. Guidelines can only cover all situations if they are made so general that in practice they provide little guidance.

As with any instrument one uses, users of the resulting WFDE accepted the validity and usefulness of the instrument. This acceptance depended on professional needs, prior experiences and expertise of users, and trust in the developers. The stakeholders that actually used the WFDE did have prior experience with DSSs or modelling instruments in general, although to various degrees. For users without appropriate prior expertise the use of an instrument would have had to depend entirely on trust.

To understand the WFDE development and how it is connected with the policy domain in more detail, chapters 6 and 7 used an ANT approach. ANT provided a vocabulary and a philosophy that stimulated a different type of analysis than the earlier chapters. Applying ANT to the development of the WFDE brought new insights for the field of policy support through software instruments. As ANT rejects the a-priori setting of category boundaries, such as between the domains of expertise and policy, the analysis started by placing the object of study in the centre and exploring its connections in all directions. This made it possible to identify the various actors that shaped, or 'enacted' (Mol 2002), the WFDE and changed its objectives over the years.

Were the changes in objectives caused by human actors or by technology? The origin of the changes cannot always be pinpointed exactly, as this case demonstrates, but the analysis shows that they were influenced by both. In terms of ANT, the WFDE is an effect of the actor-network. Many changes were the effect of small steps at a time, but in the longer run they did lead to a fundamental change in the objectives of the WFDE. The ANT-based analysis revealed changes that have come about unintentionally, though perhaps not accidentally. This unintentionality is often neglected in the analysis of development processes and can only become apparent by very detailed study.

The WFDE exemplifies the manner in which a policy - the WFD - can be 'inscribed' into an instrument. The instrument took on board properties derived from the WFD. The WFD itself represents a specific ontological position concerning ecosystems. This involves the idea that the natural state of ecosystems is static and that this state can be known and can be protected or restored (Bouleau and Pont 2015). After the WFD came into force, the debate on this position was largely closed and much research was dedicated to how to restore or protect this natural state of ecosystems.

8.2 Expertise and policy

This thesis provided analyses of different aspects of evidence-based policy making related to water quality management in the Netherlands. The in-depth study of the WFDE and the WFD implementation process provided insights in the evidence that was gathered and the policy that was developed. What light does this shed on the idea of evidence-based policy making?

The development of the WFDE was described as emerging from a continuous series of decisions, many of them small, harmless or even trivial. These decisions were the result of many interactions between the actors involved. The explanation of what happened over this extensive period was provided through detailed descriptions of actions by human and non-human actors that together translated objectives into an instrument.

One of the issues dealt with in this way was how to construct a 'successful' instrument. Generally, success is defined as attaining the objectives strived after. Adjusting objectives along the way can be a means to deal with new insights or set-backs in the development, but it can also be a means of ensuring 'success'. The WFDE development demonstrated that as long as the objectives change with the instrument, it is possible to develop an instrument that does something different than was initially intended.

The choices regarding what to include in the WFDE, and what not, were made by the project team, based on their position as WFDE developers and experts in their respective fields. In the meetings of the project team, many instances of boundary work (Gieryn 1983) occurred to demarcate the difference between experts and non-experts. For instance, the project team claimed that they - as experts - had to choose the best ecological model for the second version of the WFDE. The users - specifically the waterboards' ecologists - could not be relied on as being able, and inclined, to choose the model that was objectively best. 'Objectively best', according to the project team, was the model that overall, for all measures and ecological indicators, scored highest on predictive performance (see chapter 4). The WFDE-2 was released in 2013 with a default ecological model. Two other models could be made available on request. In that way, the developers assumed they could control the 'judicious' use of the models.

My analysis of WFDE development allows making three (related) observations on the role of experts, relevant expertise and policy-relevance. To start with, the WFDE case showed that, although the intended use of the WFDE by the stakeholders was a main selling point in the early stages, the actual use of the WFDE turned out to be an expert-practice. Experts were required to develop the models, to apply them and to interpret the outcomes. These experts were located at universities, research institutes, consultancies and the various water authorities.

The second observation concerns what counts as valid expertise. It was a source for long-running debates on what constitutes a good model to predict the ecological effects of WFD measures. Should the model describe causal relations, or would statistical relations be sufficient? Was transparency essential, or should the model with the best predictive performance be chosen? The issue of causal versus statistical was controversial enough for some waterboards' ecologists to start developing an alternative, causal, approach to ecological modelling. The validity of this approach was enhanced by STOWA and the Ministry of I&M, among others embracing it.

The third observation concerns what counts as relevant expertise. Disputes over what was the relevant expertise to include in the WFDE persisted throughout the nine years of WFDE development. Different views existed on what type of outcomes of the models in the WFDE would be valuable for the planning process. As investments in WFD measures would be high, the view of the WFDE developers was that providing insight in what measures were likely to improve the ratings of water bodies would increase the efficiency of WFD implementation. However, some practitioners challenged this. According to them, what was required was a far more detailed assessment than only whether the measures were 'likely' to have a positive effect. Their WFDE would be an instrument assessing specific measures for specific water bodies, not general options only. Most measures were only theoretically possible anyway due to political and financial constraints, and a rough assessment of the effect of measures was so easy that it didn't require any instrument. Many of these practitioners looked for alternative means to select measures, even though the WFDE developers did eventually promise to facilitate more detailed analysis.

The relation of instruments to provide evidence for policy with the policy domain itself was another main area of inquiry in my thesis. The case of the WFDE demonstrated how WFD values and concepts were inscribed in the instruments that were developed to support WFD implementation. In this process, the main goal of the WFD, preserving or improving the status of water bodies, was translated as high EQR scores. The EQR became a goal in itself. Although WFD implementation was inscribed in the WFDE, the WFDE was conceived and promoted as providing neutral, objective information to the policy process.

In the implementation process of the WFD, experts were as dominant as in the development of the WFDE. Experts at the various water authorities and research institutes were preparing plans and proposals that were of a technical nature and were often hard to dispute by non-experts. The national coordination team focussed on procedures and time-planning, specifically stimulating the deliverance of the various products required by the WFD, but without providing much guidance on how to do so. As the aforementioned experts themselves were also struggling to grasp the new and not yet operationalised concepts, they focussed their attention on the technical complexity of the WFD and based their authority in the planning process on their understanding of this complexity.

In struggling with WFD's complexity, policy and expertise were often so intimately entwined that they were impossible to separate. Evidence-based policy making suggests that the evidence base is developed separately from the policy, but this is very often not the case. This thesis has shown how policy can affect expertise development, for example through the pragmatic implementation brief. The influence of policy on expertise involved more than just prioritising issues that were relevant for policy: policy also affected the objects of analysis and the concepts applied in the analysis. Vice versa, a product from the expertise domain can also directly influence policy development, as the example of the Aquarein study has shown. In the process of determining WFD objectives for the water bodies, political choices, pragmatics and expertise all played a part.

Another example of the impossibility of separating policy and expert-evidence is the existing emissions database that was used as input for the WFDE. The industrial emissions in this database were included as diffuse sources - not as point-sources -, which would normally be done for agricultural emissions only. The reason was that no WFD measures for industry would be considered, so the exact location of the emissions did not matter. Due to this choice, the WFDE could not do an integrated analysis of all possible measures. That was considered acceptable as WFD measures in the Netherlands were considered a matter for the water authorities. However, accepting this entailed accepting that only assessment of the national programmes of measures would be reliable, while assessing the local effects of specific measures would be flawed as information on the location of industrial sources would be essential. This example specifically highlights how policy was embedded in an artefact, in this case a database used in the WFDE, and how this restricted the expert-evidence that can be provided.

In the implementation process of the WFD, expertise was generally perceived as neutral: the evidence would speak for itself, and what policy planners decide to do with it was their affair ('speaking truth to power'). Politics would determine what course to take. The case of the WFD implementation in the Netherlands shows, however, that experts and their expertise have an active role in shaping policy and the other way around. Although representatives of both the expert and the policy community stress that policy making and evidence gathering are separate activities, actually the two are intimately entwined. Policy developers come in different shapes and sizes, but nearly all have an academic degree. Water authorities employ staff who do research regarding the water system they are responsible for. These policy advisors have their professional standards and base their claims on the application of the scientific method as much as people in the expertise domain do. Similarly, people in the expertise domain make policy by pre-selecting options, providing advice, evaluating existing policy, and so on. In the introduction I discussed the STS literature, where this is well-established knowledge. As Zehr (2005) stated, however, this knowledge has in general not reached practice and, I would add, engineering.

8.3 EVIDENCE-BASED POLICIES AND REVERSIBILITY

My focus on the role of experts does not suggest that WFD implementation was only an expert-practice. The high number of participation meetings for the WFD indicated that there was an elaborate political process as well. Many parties certainly engaged in these political processes. However, evaluations of this process showed that the discussions on WFD implementation were often viewed as too complex and too technical to truly participate in. This entails a danger to the democratic process as issues are reduced to technical problems that can only be fruitfully addressed by experts. The dominance of experts marginalised the debate regarding the desired outcomes for society. There was no debate about what values 'society' strived for; for instance, no questions were posed regarding the value of ecological quality as opposed to the value of current agricultural practices. In that way, the implementation of the WFD was in effect as much as possible depoliticised.

The main question for me that arises from the thesis, however, is different. If producing evidence and developing policy are not separate activities, what does this mean for evidence-based policy making? I would say it means that evidence-based policy making is a difficult balancing act. It is necessary to produce the type of evidence that is useful for policy developers, so policy considerations can have legitimate influence on the evidence. However, the evidence also has to comply with scientific standards: it needs to be scientifically sound to maintain its credibility. This implies that policy planners and decision makers must also accept that the evidence produced may be different from what they would prefer.

Experts play a key role in supporting transformations in the policy domain. As generally in science, they build up a chain of evidence translating the phenomenon or process of interest into numbers, tables, graphs, etc., using all sorts of equipment (De Vries 2016). In order to be fully controllable – to be trustworthy – the chain needs to be 'uninterrupted.' It needs to be reversible: it should be possible to go back to the original measurements and assess how the evidence was produced. Reversibility is one of the key characteristics of science (Latour 1999). This does not mean that every chain of evidence is always assessed completely – much in science is taken for granted (black boxed) – nor that the conclusion based on the chain of evidence cannot be refuted. It does mean, however, that every step in the process is accounted for and can be retraced if needed, for example when controversies arise.

When it comes to models, like DSSs or climate models, however, this reversibility is challenged by some scholars. Kouw (2012) studied three different model (suites), amongst others the WFDE-1. On the basis of his analysis of the WFDE he follows Humphreys, who argues that a consequence of the increased computational powers, simulations are characterised by epistemic opacity: "no human can examine and justify every element of the computational processes that produce the output of a computer simulation" (Humphreys 2009 p618). As simulations cannot be completely retraced, reversibility is impossible. Therefore, simulations would have a nature different from other scientific methods and instruments. The argument is built on the premise that in simulations mathematical techniques are applied that are unpredictable, such as Monte Carlo methods and agent based modelling, and therefore the results cannot be retraced.

I would argue differently. Like random draws in lotteries are unpredictable - but not incomprehensible - these computational techniques are used deliberately to produce 'randomised' results. These techniques are far from easy to understand, but so is the use of the large Hadron collider at CERN. The scientists developing these techniques do understand what these techniques do and can justify their use; in that sense simulations are reversible. Being hard to understand is no reason to award simulations a specific ontological position, different from other instruments scientist use.

I would, however, agree that the WFDE is not transparent and is in that sense opaque. The techniques used are in themselves understandable, and theoretically reversible, but the composite nature of the instrument makes it so that even the developers cannot completely understand every operation or every calculation. The various parts are connected pragmatically without explicit justification of the validity of the connections.

For those who do not know all the details of the research and may not even understand these, reversibility is to a large extent a matter of trust in the experts involved. As Waterton (2002) demonstrates, reversibility may be challenged when products of science leave the domain in which they were produced. She describes an example of how a chain of evidence was broken. When in the UK a new European classification system for ecosystems was introduced, certain ecosystems were classified counter to the logic of this system in order not to change too much the protected statuses of areas that resulted from the classifications made under the previous national classification system. As a result, ecosystem classes became muddled and changed character, which made going back to the origin of the classes extremely difficult and prone to lead to dead-ends. This leads to the issue of trust: how can you trust a classification when some classifications appear to be random, or when an ecosystem due to the new classification loses its protected status?

Waterton argues it is the actual taking of the products of science out of the context in which it was developed – in this case the British policy regarding ecosystem protection – and introducing it in another context – in this case the European policy. The lack of stability of the categories, she argues, is related to the outwards reflection to the policy context instead of an inward reflection towards the chain of evidence it was based on. One could argue that this irreversibility is simply science gone wrong. The European classification system should have been developed in a way that avoids the breaking of the chain of evidence. This would be ideal perhaps, but Waterton shows that in the policy domain harmonisation of practices is more important than avoiding irreversibility.

A good – and obvious – question here is: what are the boundaries of science? They are often hard to draw. Is a classification for ecosystems – whether for UK vegetation or water bodies within the WFD – scientific? Certainly, scientists often develop classification systems as part of their analysis, which would make those classifications products of science. But is it still science if a classification is developed as a tool for policy? If the classification is developed according to the same scientific standards, it should still be a product of (applied) science. But if concessions are made to these standards to satisfy policy, at what point will the classification cease to be a product of science? I would suggest that as long as the reversibility holds, it is a product of science.

The WFDE was specifically intended as a means to make scientific knowledge accessible for non-scientists. Throughout the development process, the claim was that the science embedded within the WFDE is sound. However, the complexity of the instrument, including its composite nature, with parts that are based on different chains of evidence, makes it impossible to fully understand the computations, even for the developers. However, and this is a key argument, this opacity is not an intrinsic property of WFDE modelling or simulations in general. On the contrary, the opacity is a property of the WFDE because of the way the WFDE was developed. Like in Waterton's case, the use of instruments outside the original development context has caused this irreversibility.

8.4 Reflection on the research approach

Having applied different theoretic lenses in this thesis has made me aware of the importance of the choices in the research approach. I had not consciously made these choices at the start. I followed the needs of the i-Five project and the suggestions of my daily supervisor and when I perceived a lack in the approach, I searched for and found an alternative.

The main theoretical approach that enabled me to develop this thesis analysis is Actor-Network-Theory, a comparatively new approach in the fields of water management and modelling for policy support. ANT takes up the topic largely neglected by sociology of "how technology makes up a substantial part of the fabric of society" (De Vries 2016 p2). ANT explores society systematically through actor-networks and translations that take place in these actor-networks. As actor-networks by definition change and different translations can be and are made, this type of analysis allows for studying changes.

In an ANT approach, what actors do and how they affect other actors is essential for understanding the WFDE. The WFDE is not a thing just by itself, but it becomes a thing through the actions of other actors. At the same time, by becoming such a 'thing', the WFDE becomes an actor itself, with effects on other actors, for example because the interface or the database structure of the WFDE make certain actions possible and others not. My analysis of these complex agencies of people and things has shown that details matter. Who the relevant actors are, what they do and how meanings are transformed through action, can only be established by in-depth descriptions. Through an ANT approach, the many interactions of actors were traced and the entwinedness of policy and expertise were made evident. The policy domain and the expertise domain are institutionally separated in many ways. Policy makers and experts are to a large extent in different organisations and have to comply with different rules, both formal and informal, but my case study has shown that in fact the two are not separate – they co-emerge.

ANT requires that the question who the actors are is asked at the start of every exploration and cannot be determined a priori. ANT allowed me to show that the authority of experts and the instruments they develop are the result of different agencies of different actors. Authority or success are not given, but need to be produced, enacted or performed. This point of departure helps analysing why certain experts or certain instruments gain authority and others do not.

My actor-network snapshots illustrated the increasing number of actors involved and the growing complexity of the relations between the various actors in realizing the WFDE in relation to the WFD and its ontology. My snapshots also show that the involvement of many of the human actors cannot be understood without taking into account the important roles of the non-human actors, the information systems or instruments they are closely connected with, and of course the WFD implementation process. Non-human actors preserve the characteristics of the actor-networks that produced them. In this way, non-human actors stabilise societies, but can also hinder change. The way non-human actors affect other actors is not wholly predictable. Like human actors, non-human actors do not translate faithfully; they are not mere intermediaries, but every translation is also a transformation.

"Will other researchers come up with the same insights as you, if they study the data you gathered?" This I have been asked a few times. My answer has always been "that depends on their research interests". If the questions the researcher asks are different, the answers will be different as well. In my own treatment of the data, I showed that the material collected for this thesis can be 'read' in more than one way. The material can be used to construct an analysis of institutional or policy arrangements, of software design, or of actor-networks and maybe more. The choice of which lens to apply, which question to ask, depends on the theoretical interests the researcher has and the objectives of the study; they are not inherent to the data, although of course the data does set limits to what questions can be usefully asked. My analysis is robust – reversible – in the sense that the methods are transparent and retraceable. Another researcher, using the same code books and asking the same questions, would most likely confirm my results, but it is unlikely that anyone will ever do exactly that, as another researcher will most likely have other research interests. This type of work could well be done in teams of analysts, coding together and analysing together, which will increase the robustness of the result.

ANT requires very detailed analysis, but writing down all these details was a struggle for me. Some authors have developed an unusual writing approach to deal with this issue. Annemarie Mol (2002) separated the analysis of her case study from the analysis of the analysis, providing in this way a more profound analysis of the literature than I commonly encounter. Bruno Latour (1996) even wrote a detective novel revolving around the 'killing' of Aramis, the self-driving transport technology he studied. I regret not having been able to present a similarly stimulating format, but have stuck to the original plan of having four chapters that represent four (possible) articles.

8.5 On usefulness

Generally, the influence of policy on expertise and vice versa may be obfuscated, but the claim that the domains are separate is a myth. This non-existence of separation is not new, but apparently still not accepted (see also Zehr 2005). The entwinedness of policy and expertise is not wrong per se, it is simply a given. It is the expectation that policy and expertise are separate domains that causes disappointment and distrust when practice demonstrates their mutual influence. That does not make science a political endeavour, however. Precisely in the transparency controls and standards concerning how evidence is produced and discussed, we can see the difference between policy plans and scientific studies (Latour 2013).

With the new American president apparently dismissing climate change as a hoax, the discussion concerning the position of science in society is very relevant. Studies like this that demonstrate how science and policy are not separate domains and how both the construction and resolution of scientific questions are man-made, are said to question the value of science (Collins and Evans 2003; Jasanoff 2003; Collins et al. 2010). This does not mean that science is just an opinion like any other. It has authority because it is based on a scientific tradition that is valuable in itself (Latour 2013). However, science does not have the answer to every question and it should communicate gaps in knowledge and other sources of uncertainties. Furthermore, the matter of what questions to research and who determines these questions will always remain a matter for debate. Moreover, in any research there are further choices to make, concerning for instance the geographical scope or alternatives to include, and likewise these may be a matter for debate. Lastly, not every question is for science to answer, for instance questions regarding moral issues.

The scientific community thrives on disagreements to sift out the best available knowledge and this should not be suppressed by policy initiatives to uniform science. At the same time, the label 'science' does not guarantee good quality. The peer review process does not prevent bad quality research - and even at times research fraud - from happening, as we have seen. In the Netherlands over the past decades, governmental authorities have outsourced a lot of expertise to 'the market', see for example the privatization of the research institutes that were part of Rijkswaterstaat (Van den Brink 2009). However, without sufficient expertise of their own the authorities cannot critically assess the products provided to them by consultancies and scientists, let alone be partners in collaborative research.

All in all, the claims of what decision support systems – and other modelling tools – can contribute to policy, need to be reassessed. The models that are used and produced are not certain, neutral nor innocent.

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List of Annexes

1. Glossary of key terms, acronyms and abbreviations

2. Hermeneutic Unit ‘Minutes’
    a. List of Primary Documents ‘Minutes’
    b. Code Book ‘Minutes’
    c. Table Code Frequency ‘Minutes’
    d. Table Word Count ‘Minutes’

3. Hermeneutic Unit ‘Interviews’
    a. List of Primary Documents ‘Interviews’
    b. Code Book ‘Interviews’
    c. Table Code Frequency ‘Interviews’
    d. Table Word Count ‘Interviews’

4. Hermeneutic Unit ‘Key Documents’
    a. List of Primary Documents ‘Key Documents’
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    c. Table Code Frequency ‘Key Documents’
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5. Hermeneutic Unit ‘Field Notes’
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6. List of meetings attended regarding development of WFDE-2

Annex 1

Glossary of key terms, acronyms and abbreviations[1]

This glossary explains the acronyms and abbreviations used, as well as a number of key terms. Key terms included are those that a) are not used in ordinary language, or b) may cause confusion because they are used in a "technical" sense that differs from ordinary usage or c) because different authors use them in different ways.

Term	*Definition*
Actant	A party that 'acts', i.e. has an effect on others or on events, whether human or non-human. Actors have the potential to act, while actants are those that do act. The distinction between actors and actants is not always made and in this thesis the more common term actor is used, while actant is only used in quotations.
Actor-Network-Theory	Methodological and philosophical framework. See chapter 6.
Alterra	Wageningen Environmental Research. Dutch research institute on agriculture and nature, or as they say: our green living environment. Financed mainly by the Ministry of EZ, until 2010 by LNV. http://www.wur.nl/en/Expertise-Services/Research-Institutes/Environmental-Research.htm
ANT	Actor-Network-Theory
Art. 5 analyses	Three analyses that are required under WFD art. 5: (1) analysis of the characteristics of each river basin district, (2) review of the impact of human activity, and (3) economic analysis.
Artificial water body	a) "A body of surface water created by human activity" (WFD art. 2.8) b) Such a body of water that has been designated as an "artificial water body." Several additional requirements apply for designating a water body as "artificial" (WFD art. 4.3)
Atlas.ti	Computer software to assist with qualitative data analysis.
CAQDAS	Computer-Assisted Qualitative Data Analysis System.
Competent authority	National (or international: WFD art. 3.5) authority that Member States have to identify or newly establish as part of the "administrative arrangements" that they have to make for implementing the WFD on their territory (WFD art. 3.3 and art. 3.5).
Consultancies	Companies that provide engineering solutions and advice. Over time several different companies were commissioned to perform specific tasks in WFDE development. In addition they were represented as a group in the steering board for WFDE development as of 2006.

[1] Extended and adapted on the basis of I-Five report: Junier, S. J. (2010). Research Report No 2.1 I-FIVE: Innovative instruments and institutions in implementing the Water Framework Directive. Dutch case study: the WFD Explorer. Delft, Delft University of Technology.

Consultation	Level of *public participation*. It implies that the public can react to plans or ideas of government, either in writing or at a hearing, or that government actively seeks the comments and opinions of the public through for instance surveys and interviews (Ridder et al. 2005). Art. 14 of the WFD refers to written consultation only, but WFD Preamble (14) and WFD Preamble (16) refer to consultation more generally.
Decision Support System	An interactive, computer-based systems, that helps decision makers use data and models to solve unstructured problems" (Gorry and Morton 1971; quoted in Turban and Aronson 2001 p 13)
Deltares	Dutch research institute on water, soil and subsurface issues. Partly funded by the Ministry of V&W (until 2010), now I&M. http://www.deltares.nl/en
Delwaq	Model engine for water quality and ecology models. The processes library covers many aspects of water quality and ecology http://oss.deltares.nl/web/delft3d/delwaq. It is an open source Deltares product.
DG Water	Directorate General Water: water management policy department of the Ministry of V&W http://www.verkeerenwaterstaat.nl/onderwerpen/organisatievenw/organisatie_venw/025_organisatie-onderdelen/105_water/
DSS	*Decision Support System*
Epistemology	Philosophical term referring to the way we know things. Also "the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity" (Merriam-Webster)[2]
Expert	Person possessing *expertise*. This includes the "certified experts" with formal qualifications, usually within a specific scientific discipline, and "lay" or "local experts", who lack formal qualifications but still possess special skills and information.
Expertise	a) Special skills and information that are considered relevant for a specific issue ("expertise in…"). b) The products of expertise, such as research reports and advices.
Groundwater body	"A distinct volume of groundwater within an aquifer or aquifers" (WFD art. 2.12).
Harmonisation	"The act of making systems or laws the same or similar in different companies, countries, etc. so that they can work together more easily" (Cambridge on-line dictionary[3]).
Heavily modified water body	a) A surface water body that "as a result of physical alterations by human activity is substantially changed in character" (WFD art. 2.9) b) Such a body of water that has been designated as a "heavily modified water body". Several additional requirements apply for designating a water body as "heavily modified" (WFD art. 4.3, see section 2.2.1)
i-Five	Innovative Instruments and Institutions In Implementing the WFD. Research project that was the start of the research presented in this thesis.
Implementation	(European directives) Transposition in national law, followed by the application in practice.

[2] (https://www.merriam-webster.com, accessed 23-02-2017).
[3] http://dictionary.cambridge.org/dictionary/english/harmonization. Accessed 05 03 2016

Institution	All “humanly devised constraints that structure human interaction. They are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions and self-imposed codes of conduct), and their enforcement characteristics” (North 1990). Other authors use the term to refer to formal institutions or to organizations only.
Instrument	Artefact crafted by humans in order to achieve specific goals.
KRW	KaderRichtlijn Water: Water Framework Directive
Leven met water	Research funding organisation to stimulate innovate approaches for water management, funded by a number of authorities, among which the Ministry of V&W
LmW	Leven met Water
LTO	Dutch union of agricultural producers
Ministry of EL&I	Dutch ministry of Economic Affairs, Agriculture and Innovation. Merger between the former ministries of Economic Affairs and Agriculture, nature and Food safety (2010-November 2012)
Ministry of EZ	Ministry of Economic Affairs. (before October 2010, without agriculture, and from November 2012, as the new name for EL&I, with agriculture)
Ministry of I&M	Dutch ministry of Infrastructure and the Environment, result of a merger between the ministries of VROM and V&W in 2010.
Ministry of LNV	Dutch ministry of Agriculture, Nature and Food safety (until 2010)
Ministry of VROM	Dutch ministry of Housing, Spatial Planning and the Environment (until 2010)
Ministry of V&W	Dutch ministry of Transport, Public works and Water Management (until 2010)
Model	In this thesis computer model: a representation of reality in the form of mathematical relations that is run on a computer.
Ontology	Philosophical term referring to the nature of what ‘is’ (in Dutch ‘zijnsleer’). Also a “branch of metaphysics concerned with the nature and relations of being” (https://www.merriam-webster.com, accessed 23-02-2017)
PBL	See *Planbureau voor de Leefomgeving*
Planbureau voor de Leefomgeving	Environmental Assessment Agency. Dutch research institute in field of environmental studies, financed mainly by the ministry of I&M and until 2010 by the ministry of VROM
Policy maker	Those who develop and decide on policy, including politicians, senior civil servants and policy advisors.
Practitioner	Those who operationalise policies, generally staff at the authorities concerned. They also influence, and sometimes are, *policy makers.*
Programme of measures	“Basic measures” that are required under existing directives and “supplementary measures” that may be needed for achieving the environmental objectives of the Directive (WFD art. 11.3). According to WFD Annex III(b), Member States have to select the most cost-effective combination of measures, based on the economic analysis of water uses, but the basic measures have to be included in the programme of measures in any case.

Public	"One or more natural or legal persons and (…) their associations, organisations or groups" (Aarhus Convention, SEA Directive (2001/42/EC)). Cf. *Stakeholder*. Government bodies are usually not considered to be part of the "public".
RBMP	*River basin management plan*
Reference conditions	The natural or near-natural conditions of a specific type of water body. They form the basis for determining the "good ecological status" (WFD Annex V)
Rijkswaterstaat	Part of the Dutch ministry of V&W with specific national competencies concerning infrastructure management. Rijkswaterstaat is responsible for construction, maintenance and daily management of national roads and public works like large bridges, storm surge barriers and sluices, and the management of the national waters (the sea, Lake IJssel, main rivers)
River basin	"The area of land from which all surface run-off flows (…) into the sea at a single river mouth, estuary or delta" (WFD art. 2.13). In WFD practice, this term is often used to refer to the main management unit for implementing the WFD: the *river basin district*.
River basin district	Main management unit for implementing the WFD, consisting of one or more adjacent *river basins*, including coastal waters and the ground waters assigned to the district (WFD art. 2.13 and WFD art. 3.1).
River basin management plan	Plans required by WFD art. 13, following the procedure of WFD art. 14.1.
RIZA	Research Institute for integrated water management and waste water treatment. It was a research department of Rijkswaterstaat. In 2010 split into Waterdienst and a part that has merged with Delft Hydraulics and other research institutes to form Deltares.
RWS	*Rijkswaterstaat*
Simulation (model)	Model based on equations that cannot be solved analytically. In a broad sense simulation is the practice of developing, using and interpreting the outcomes of such models is called simulation as well (Frigg and Reiss 2009).
SOBEK	Software to simulate complex flows and water-related processes in one-dimensional networks and two-dimensional grids. It is a Deltares product. https://www.deltares.nl/en/software/sobek/
Stakeholder	Any person, group or organization with an interest or "stake" in an issue, either because they may be affected by the issue or because they may have some influence on its outcome (Freeman 1984). Stakeholder in this sense includes authorities, experts, the "general public" and organized interest groups. Other authors reserve the term for organized interest groups only.
STS	Science and Technology Studies
Surface water body	"A discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water" (WFD art. 2.10, WFD Annex II; see section 2.2.3)
STOWA	Stichting Toegepast Onderzoek Waterbeheer, literally foundation for applied research in water management. This Dutch foundation coordinates and commissions research on behalf of the waterboards. http://www.stowa.nl/Header/English/index.aspx
TBM	Technology, Policy and Society: Faculty of Delft University of Technology

Translation	In ANT the word 'translation' is used to signal that information, in a very wide sense, passes through a network. In the process the message changes, consciously (for instance to enroll other actors) or unconsciously. Callon (1984) defined it originally as "the mechanism by which the social and natural worlds progressively take form".
Technical expert	An *expert* with formal qualifications in a technical or natural science discipline.
Trust	1. (noun) the firm belief that an actor will act (or a technical system will perform) dependably, securely and reliably within a specific context. 2. (verb) acting on the basis of this belief.
Volg- en Stuur-systeem (V&S)	Software that supports the assessment of nine prerequisites for good ecological quality. It connects different data, or different databases, and provides calculations and models for the ecological assessment. http://krw.stowa.nl/projecten/KRW_Volg__en_Stuursysteem__VSS_.aspx
Waterboard	Authority for regional water management (safety, water level management, waste water treatment and water quality).
Water body	Smallest management unit for implementing the WFD. See *Surface water body* and *Groundwater Body*
Waterdienst	Part of Rijkswaterstaat, knowledge department for water management
Waterschap Vallei en Eem	Waterboard. Partner in the original consortium concerning the WFDE. Host of first pilot.
Waterschapshuis	The management and operational organisation for Information and Communication Technology (ICT) for the Dutch water-boards. http://www.hetwaterschapshuis.nl/algemene_onderdelen/english
WFD	Water Framework Directive (2000/60/EC). See chapter 3
WFDE	Water Framework Directive Explorer; software instrument for supporting the implementation of the WFD.
WL | Delft Hydraulics	Technical consultancy, specialized in hydraulics. Merged with a part of RIZA and other research institutes to form Deltares

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Annex 2a

Primary Documents Hermeneutic Unit 'Minutes'

Name {number of coded elements in PM }

P 1: 01. Verslag PT KRW-V 18 november 2009.doc {14}
P 2: 02.Verslag PT KRW-V 8 december 2009.doc {19}
P 3: 03. Verslag PT KRW-V 17 december 2009.doc {20}
P 4: 04. Verslag PT KRW-V 12 januari 2010.doc {13}
P 5: 05. Verslag PT KRW-V 3 februari 2010.doc {34} [
P 6: 06. Verslag PT KRW-V 16 februari 2010.doc {22}
P 7: 07. Verslag PT KRW-V 1 maart 2010.doc {14}
P 8: 08. Verslag PT KRW-V 2010 03 16 PT.doc {18}
P 9: 09. Verslag PT KRW-V 30 maart 2010.doc {22}
P10: 10. Verslag PT KRW-V 13 april 2010.doc {18}
P11: 11. Verslag PT KRW-V 27 april 2010.doc {14}
P12: 12. Verslag PT KRW-V 25 mei 2010.doc {17}
P13: 13. Verslag PT KRW-V 15 juni 2010.doc {28}
P14: 14. Verslag PT KRW-V 17 augustus 2010.doc {26}
P15: 15. Verslag PT KRW-V 23 september 2010.doc {32}
P16: 16. Verslag PT KRW-V 14 oktober 2010.doc {38}
P17: 17. Verslag PT KRW-V 4 november 2010.doc {21}
P18: 18. Verslag PT KRW-V 25 November.doc {28}
P19: 19. Verslag PT KRW 9 december 2010.doc {24}
P20: 20. Verslag PT KRW 6 januari 2011.doc {21}
P21: 21. Verslag PT KRW 27 januari 2011.doc {17}
P22: 22. Verslag PT KRW 15 februari 2011.doc {19}
P23: 23. Verslag PT KRW 8 maart 2011.doc {25}
P24: 24. Verslag PT KRW-V 19 april 2011.doc {23}
P25: 25. Verslag PT KRW-V 31mei 2011.doc {17}
P26: 26. Verslag PT KRW-V 28 juni 2011.doc {12}
P27: 27. Verslag PT KRW-V 15 september 2011.doc {24}
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P29: 29. Verslag PT KRW-V 8 november 2011.doc {14}
P30: 30. Verslag PT KRW-V 1 december 2011.doc {11} [
P31: 31. Verslag PT KRW-V 11 januari 2012.doc {18}
P32: 32. Verslag PT KRW-V 8 maart 2012.doc {30}
P33: 33. Verslag PT KRW-V 28 maart 2012.doc {20}
P34: 34 Verslag PT KRW-V 19 april 2012.doc {10}
P35: 35 Verslag PT KRW-V 22 mei 2012.doc {12}
P36: 36 Verslag PT KRW-V 13 juni 2012.doc {11}
P37: 37 Verslag PT KRW-V 1 augustus 2012.doc {16}
P38: 38 Verslag PT KRW-V 14 augustus 2012.doc {7}
P39: 39 Verslag PT KRW-V 9 oktober 2012-def.doc {11}
P40: 40 Verslag PT KRW-V 20 november 2012.doc {12}
P41: 41 Verslag PT KRW-V 11 december 2012.doc {9}
P42: 42 Verslag PT KRW-V 9 januari 2013.doc {15}
P43: 43 Verslag PT KRW-V 31 jan 2013.doc {16}

Annex 2b

Code Book Hermeneutic Unit 'Minutes'

Actions
Quotations: 210
Comment:
Both the named actions, with the person who is responsible, as lists of actions and results.

Application
Quotations: 23
Comment:
All references to actual use of the instruments

Attendees
Quotations: 39
Comment:
Who attended the meeting

Building team
Quotations: 10
Comment:
All references to the team of "builders", that is the programmers

---

Communication
Quotations: 29
Comment:
All references to communication with people not directly involved in the WFDE development, through presentations, website, leaflets etc

---

Costs module
Quotations: 7
Comment:
All references to including the factor "costs" (of measures) in the WFDE

Dynamic/static
Quotations: 5
Comment:
All references to static or dynamic calculations

Emissions
Quotations: 11
Comment:
All references to emissions

EQR
Quotations: 7
Comment:
All references to Ecological Quality Ratio, their calculations and the metrics used for this

---

Finances
Quotations: 43
Comment:
All references to finances related to the project of WFDE development

---

Functional design
Quotations: 5
Comment:
All references to the design of functionalities to be included in the WFDE. This is the detailed description of what will be developed.

Instrument properties
Quotations: 0
Comment:
Supercode lumping all categories dealing with instrument properties

---

Knowledge rules
Quotations: 36
Comment:
All references to the development of (ecological) knowledge rules or their incorporation in the WFDE

Measures
Quotations: 19
Comment:
All references to measures: what to include in WFDE and how etc. Measures merged with scenarios. They often overlap. Scenarios here are no more than running sets of measures.

NHI
Quotations: 25
Comment:
Nationaal Hydrologisch Instrumentarium. All references to the NHI: source of data on water bodies, location, connections with other waters, discharges etc

---

O&M
Quotations: 10
Comment:
All references to management operations and maintenance

Objectives WFDE
Quotations: 1
Comment:
What do they develop the WFDE for?

Parties involved
Quotations: 14
Comment:
References to who is involved is no longer involved and who the project memebers are trying to involve.

---

pilots, tests
Quotations: 60
Comment:
All references to use by means of pilots, including smaller test projects, or actual application

---

planning and progress
Quotations: 50
Comment:
project planning, deadlines, and progress of building (sprints) or any application

---

practical matters
Quotations: 8
Comment:
Minor practical details related to the project

Process
Quotations: 0
Comment:
Supercode for WFDE development process

PT
Quotations: 0
Comment:
Supercode for project team

PvE
Quotations: 11
Comment:
Programma van Eisen: all reference to the PvE: the specification of what the instrument is supposed to do. This should be the basis of the functional design.

Relations with other instruments
Quotations: 64
Comment:
All coordination with other instruments including those that have a specific code

---

Retention
Quotations: 16
Comment:
All references to retention related issues and solutions. Including underwater soil.

Schematisation
Quotations: 51
Comment:
Schematisation: determining how to schematise the water system and all its components as well as develop actual schematisations. The last will have a large overlap with pilot.

SOBEK
Quotations: 14
Comment:
All references to SOBEK: a hydrological modelling tool

Sprints
Quotations: 20
Comment:
All references to the method used for the actual software programming: an 'agile' technique that involves the use of sprints. And references to what was done in sprints

---

Steering group
Quotations: 22
Comment:
References to the steering group: reports from the meetings, preparations for next meeting, issues to be resolved etc.

STONE
Quotations: 11
Comment:
All references to STONE: the modelling instrument for nutrients in water. Includes data from measurements and data simulated through model runs.

Uncertainty
Quotations: 1
Comment:
All references to how to deal with uncertainty in WFDE

User story
Quotations: 11
Comment:
All references to user stories: the translation of user's wishes into short statements of the things they would like to see in the instrument: functions, screens etc.

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users
Quotations: 12
Comment:
references to users, their ideas suggestions etc . Does not include references to user groups, advice groups etc.

Users group
Quotations: 39
Comment:
All reference to the users groups: people included, comments or advice coming from, reports from. This includes the both working groups and the advice group for the national pilot

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VSS
Quotations: 7
Comment:
Volg & Stuursysteem: an instrument for water system analysis

WFD policy process
Quotations: 1
Comment:
References to the WFD policy process

Zoet zout
Quotations: 10
Comment:
All references to the issue of relating WFDE to the salt water instruments used for analysis of the North sea

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Annex 2c

Code Frequency
HU 'Minutes'

Code-Filter: All [38]
PD-Filter: All [43]
Quotation-Filter: All [812]

	Actions	Application	Attendees	Building team	Communication	Costs module	Dynamic/static	Emissions	EQR	Finances	Functional design	Instrument properties	Knowledge rules	O&M	Measures	NHI	Objectives WFDE	Parties involved	pilots, tests	planning and progress	practical matters
P 1: 18 Nov 2009	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
P 2: 8 Dec 2009	1	0	1	2	1	1	1	0	2	2	0	0	1	0	0	0	0	2	0	2	0
P 3: 17 Dec 2009	3	0	1	1	0	0	1	0	0	1	0	0	3	0	1	0	0	1	0	0	2
P 4: 12 Jan 2010	2	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	2	0	0	0
P 5: 3 Feb 2010	12	0	1	3	1	1	0	1	0	1	0	0	0	0	1	0	0	2	0	0	1
P 6: 16 Feb 2010	9	0	1	1	1	0	0	0	0	1	0	0	0	0	1	1	0	2	0	1	0
P 7: 1 March 2010	4	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1
P 8: 16 March 2010	2	0	2	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	1
P 9: 30 March 2010	3	0	1	1	1	0	0	0	0	2	1	0	0	0	2	1	0	0	0	1	0
P10: 13 April 2010.	4	0	0	0	0	0	0	0	1	2	1	0	0	0	0	3	0	1	0	0	1
P11: 27 April 2010	2	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0
P12: 25 May 2010	7	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0
P13: 15 June 2010	6	2	1	0	0	0	0	1	0	3	0	0	0	0	0	2	0	0	1	3	0
P14: 17 Aug 2010	3	3	1	0	1	0	0	0	0	2	1	0	1	0	0	0	0	0	2	0	0
P15: 23 Sept 2010	4	0	1	0	1	1	1	1	0	0	0	0	4	0	1	2	1	0	3	0	0
P16: 14 Oct 2010	5	2	1	0	1	0	0	0	0	2	0	0	2	0	0	4	0	0	12	3	0
P17: 4 Nov 2010	6	2	1	0	2	0	0	0	0	2	0	0	1	0	0	0	0	0	2	3	0
P18: 25 Nov 2010	7	1	0	0	2	0	0	1	0	2	0	0	1	0	3	0	0	0	2	3	1
P19: 9 Dec 2010	3	0	0	0	0	0	0	1	0	1	0	0	1	0	3	0	0	0	2	2	0
P20: 6 Jan 2011	9	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	2	0	0
P21: 27 Jan 2011	8	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	0
P22: 15 Feb 2011	9	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0
P23: 8 March 2011	11	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	2	0
P24: 19 April 2011	3	2	0	1	2	0	0	1	0	1	0	0	1	0	0	0	0	1	4	2	0
P25: 31 May 2011	4	0	0	0	3	0	0	0	0	2	0	0	1	1	0	0	0	0	4	1	0
P26: 28 June 2011	5	0	1	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0
P27: 15 Sept 2011	5	0	2	0	1	0	0	0	0	3	0	0	2	1	0	0	0	0	1	3	0
P28: 13 Oct 2011	2	0	0	0	2	0	0	0	0	3	0	0	2	1	0	1	0	0	1	3	0
P29: 8 Nov 2011	5	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	2	0
P30: 1 Dec 2011	3	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
P31: 11 Jan 2012	4	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	1	2	0
P32: 8 March 2012	15	2	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	2	1	0
P33: 28 March 2012	10	2	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	4	0	0
P34: 19 April 2012	3	1	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0
P35: 22 May 2012	2	1	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
P36: 13 June 2012	3	0	2	0	1	1	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0
P37: 1 Aug 2012	2	0	2	0	1	1	0	1	0	0	0	0	2	0	1	1	0	0	1	1	0
P38: 14 Aug 2012	2	0	2	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
P39: 9 Oct 2012	2	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1	0
P40: 20 Nov 2012	6	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	0	0
P41: 11 Dec 2012	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	1
P42: 9 Jan 2013	4	1	1	1	1	0	0	0	1	1	0	0	0	0	0	2	0	0	1	2	0
P43:31 Jan 2013	7	2	2	0	2	0	0	0	0	2	0	0	0	0	0	2	0	0	1	0	0
TOTAL:	210	23	39	10	29	7	5	11	7	43	5	0	36	10	19	25	1	14	60	50	8

Annex 2c

Code Frequency
HU 'Minutes'

Code-Filter: All [38]
PD-Filter: All [43]
Quotation-Filter: All [812]

	Process	PT	PvE	Relations with other instruments	Retention	Schematisation	SOBEK	Sprints	Steering group	STONE	Uncertainty	User story	users	Users group	VSS	WFD policy process	Zoet zout	TOTAL:
P 1: 18 Nov 2009	0	0	7	0	0	1	0	0	0	0	0	1	0	0	0	0	0	13
P 2: 8 Dec 2009	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	19
P 3: 17 Dec 2009	0	0	0	1	1	1	0	0	1	0	0	6	0	0	0	0	0	24
P 4: 12 Jan 2010	0	0	0	1	0	2	0	0	1	0	0	3	0	1	0	0	0	16
P 5: 3 Feb 2010	0	0	1	1	0	2	1	0	1	0	0	0	0	6	0	0	0	36
P 6: 16 Feb 2010	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	22
P 7: 1 March 2010	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	14
P 8: 16 March 2010	0	0	0	0	1	1	1	4	0	0	1	0	0	2	0	0	0	19
P 9: 30 March 2010	0	0	0	2	1	3	0	1	1	0	0	0	1	4	0	0	0	26
P10: 13 April 2010.	0	0	0	3	1	2	2	1	0	0	0	0	1	3	0	0	0	26
P11: 27 April 2010	0	0	0	2	0	1	1	1	1	0	0	0	0	1	0	0	0	15
P12: 25 May 2010	0	0	0	3	0	0	1	1	0	0	0	0	0	3	0	0	0	20
P13: 15 June 2010	0	0	0	4	0	5	0	3	0	0	0	0	2	0	0	0	1	34
P14: 17 Aug 2010	0	0	0	2	0	2	0	3	1	0	0	0	0	3	0	0	3	28
P15: 23 Sept 2010	0	0	0	7	0	1	2	1	1	2	0	0	2	2	1	0	0	39
P16: 14 Oct 2010	0	0	0	4	1	10	0	2	0	3	0	0	0	0	0	0	0	52
P17: 4 Nov 2010	0	0	0	1	0	2	0	0	0	0	0	0	0	3	0	0	0	25
P18: 25 Nov 2010	0	0	0	5	0	1	0	2	0	0	0	0	0	0	0	0	0	31
P19: 9 Dec 2010	0	0	0	6	2	1	0	0	0	0	0	0	2	0	1	0	0	25
P20: 6 Jan 2011	0	0	0	3	2	1	0	0	2	0	0	0	0	0	0	0	0	23
P21: 27 Jan 2011	0	0	0	2	1	0	0	0	1	0	0	0	0	0	1	0	0	17
P22: 15 Feb 2011	0	0	0	3	0	1	0	0	0	0	0	0	1	0	0	0	0	19
P23: 8 March 2011	0	0	0	3	1	1	0	0	0	1	0	0	1	1	1	0	0	27
P24: 19 April 2011	0	0	0	1	1	1	0	0	2	0	0	0	1	0	0	0	0	24
P25: 31 May 2011	0	0	0	2	0	1	1	0	1	0	0	0	0	0	0	0	0	21
P26: 28 June 2011	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	14
P27: 15 Sept 2011	0	0	0	1	0	3	1	0	2	0	0	0	0	0	0	0	2	27
P28: 13 Oct 2011	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	1	20
P29: 8 Nov 2011	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	1	16
P30: 1 Dec 2011	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	1	13
P31: 11 Jan 2012	0	0	0	1	1	0	0	0	2	3	0	0	0	0	0	0	0	19
P32: 8 March 2012	0	0	0	0	1	0	0	0	0	0	0	0	0	3	1	0	0	30
P33: 28 March 2012	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	22
P34: 19 April 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11
P35: 22 May 2012	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	12
P36: 13 June 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	12
P37: 1 Aug 2012	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	16
P38: 14 Aug 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
P39: 9 Oct 2012	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	11
P40: 20 Nov 2012	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	13
P41: 11 Dec 2012	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9
P42: 9 Jan 2013	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16
P43:31 Jan 2013	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	19
TOTAL:	0	0	11	64	16	51	14	20	22	11	1	11	12	39	7	1	10	902

Annex 2d

Word count per code
HU 'Minutes'

Code-Filter: All [38]
PD-Filter: All [43]
Quotation-Filter: All [812]

	Actions	Application	Attendees	Building team	Communication	Costs module	Dynamic/static	Emissions	EQR	Finances	Functional design	Instrument properties	Knowledge rules
P 1: 18 Nov 2009	67	0	31	0	0	0	0	23	0	0	0	0	0
P 2: 8 Dec 2009	115	0	36	43	23	23	27	0	59	82	0	0	25
P 3: 17 Dec 2009	151	0	22	85	0	0	56	0	0	21	0	0	92
P 4: 12 Jan 2010	146	0	31	0	0	0	47	0	0	17	0	0	38
P 5: 3 Feb 2010	551	0	27	185	47	23	0	6	0	42	0	0	0
P 6: 16 Feb 2010	441	0	30	37	22	0	0	0	0	13	0	0	0
P 7: 1 March 2010	294	0	33	0	0	0	0	0	0	45	0	0	42
P 8: 16 March 2010	409	0	43	0	0	0	0	0	22	0	175	0	0
P 9: 30 March 2010	354	0	29	93	57	0	0	0	0	98	93	0	0
P10: 13 April 2010	304	0	0	0	0	0	0	0	21	87	282	0	0
P11: 27 April 2010	268	12	30	0	108	0	0	0	172	0	18	0	0
P12: 25 May 2010	702	0	28	0	0	0	0	0	0	25	0	0	134
P13: 15 June 2010	528	42	29	0	0	0	0	77	0	183	0	0	0
P14: 17 Aug 2010	306	116	29	0	24	0	0	0	0	71	189	0	23
P15: 23 Sept 2010	425	0	22	0	36	180	95	14	0	0	0	0	198
P16: 14 Oct 2010	269	74	23	0	38	0	0	0	0	120	0	0	81
P17: 4 Nov 2010	370	51	30	0	51	0	0	0	0	81	0	0	86
P18: 25 Nov 2010	445	83	0	0	133	0	0	84	0	62	0	0	83
P19: 9 Dec 2010	194	0	0	0	0	0	0	65	0	56	0	0	48
P20: 6 Jan 2011	482	0	0	0	0	0	0	0	0	163	0	0	0
P21: 27 Jan 2011	322	0	0	0	0	0	0	0	0	0	0	0	0
P22: 15 Feb 2011	444	52	0	0	0	0	0	0	0	0	0	0	18
P23: 8 March 2011	628	0	0	0	0	112	0	35	0	0	0	0	79
P24: 19 April 2011	215	68	0	32	118	0	0	7	0	51	0	0	59
P25: 31 May 2011	187	0	0	0	190	0	0	0	0	455	0	0	205
P26: 28 June 2011	485	0	15	0	61	0	0	0	234	86	0	0	0
P27: 15 Sept 2011	258	0	35	0	13	0	0	0	0	481	0	0	90
P28: 13 Oct 2011	298	0	0	0	61	0	0	0	0	212	0	0	229
P29: 8 Nov 2011	204	0	0	0	0	0	53	0	0	61	0	0	46
P30: 1 Dec 2011	193	0	12	0	0	0	0	0	0	47	0	0	0
P31: 11 Jan 2012	100	0	3	0	0	0	0	16	0	0	0	0	43
P32: 8 March 2012	931	98	0	0	0	0	0	23	0	75	0	0	175
P33: 28 March 2012	743	88	3	0	0	0	0	0	0	0	0	0	89
P34: 19 April 2012	417	37	47	0	0	0	0	0	0	29	0	0	0
P35: 22 May 2012	288	15	40	0	22	0	0	0	0	0	0	0	222
P36: 13 June 2012	261	0	12	0	35	44	0	0	0	0	0	0	138
P37: 1 Aug 2012	187	0	9	0	54	32	0	22	0	0	0	0	66
P38: 14 Aug 2012	161	0	44	0	0	31	0	0	0	0	0	0	44
P39: 9 Oct 2012	74	0	3	0	55	0	0	0	0	0	0	0	97
P40: 20 Nov 2012	329	0	3	0	0	0	0	0	0	0	0	0	166
P41: 11 Dec 2012	58	0	14	0	0	0	0	0	0	0	0	0	0
P42: 9 Jan 2013	293	34	3	21	208	0	0	0	45	28	0	0	0
P43: 31 jan 2013	336	155	37	0	335	0	0	0	0	138	0	0	0
TOTAL:	14233	925	753	496	1691	445	278	372	553	2829	757	0	2616

Annex 2d

	O&M	Measures	NHI	Objectives WFDE	Parties involved	pilots, tests	planning and progress	practical matters	Process	PT	PvE	Relations with other instrumen	Retention
P 1: 18 Nov 2009	0	0	0	0	0	0	76	0	0	0	597	0	0
P 2: 8 Dec 2009	0	0	0	0	48	0	101	0	0	0	0	0	0
P 3: 17 Dec 2009	0	59	0	0	34	0	0	77	0	0	0	44	94
P 4: 12 Jan 2010	0	0	0	0	54	0	0	0	0	0	0	51	0
P 5: 3 Feb 2010	0	23	0	0	52	0	0	44	0	0	42	4	0
P 6: 16 Feb 2010	0	135	27	0	45	0	14	0	0	0	193	0	0
P 7: 1 March 2010	0	48	0	0	33	0	15	58	0	0	0	0	0
P 8: 16 March 2010	0	59	0	0	0	0	0	21	0	0	0	0	33
P 9: 30 March 2010	0	186	83	0	0	0	17	0	0	0	0	124	30
P10: 13 April 2010	0	0	358	0	33	0	0	54	0	0	0	257	43
P11: 27 April 2010	0	0	0	0	0	74	0	0	0	0	0	62	0
P12: 25 May 2010	0	58	0	0	0	0	33	0	0	0	0	156	0
P13: 15 June 2010	0	0	167	0	0	83	184	0	0	0	0	183	0
P14: 17 Aug 2010	0	0	0	0	0	89	0	0	0	0	0	88	0
P15: 23 Sept 2010	0	180	167	12	0	236	0	0	0	0	0	331	0
P16: 14 Oct 2010	0	0	425	0	0	725	230	0	0	0	0	396	50
P17: 4 Nov 2010	0	0	0	0	0	326	306	0	0	0	0	24	0
P18: 25 Nov 2010	0	152	0	0	0	363	137	16	0	0	0	351	0
P19: 9 Dec 2010	0	99	0	0	0	117	81	0	0	0	0	1072	411
P20: 6 Jan 2011	0	47	167	0	0	225	0	0	0	0	0	343	164
P21: 27 Jan 2011	0	14	69	0	0	0	187	0	0	0	0	440	31
P22: 15 Feb 2011	0	0	0	0	0	79	217	0	0	0	0	189	0
P23: 8 March 2011	47	0	0	0	0	100	92	0	0	0	0	424	35
P24: 19 April 2011	0	0	0	0	39	198	387	0	0	0	0	11	21
P25: 31 May 2011	93	0	0	0	0	357	151	0	0	0	0	74	0
P26: 28 June 2011	0	0	38	0	0	0	86	0	0	0	0	60	0
P27: 15 Sept 2011	99	0	0	0	0	86	433	0	0	0	0	109	0
P28: 13 Oct 2011	235	0	40	0	0	60	343	0	0	0	0	0	57
P29: 8 Nov 2011	0	0	0	0	0	135	118	0	0	0	0	0	0
P30: 1 Dec 2011	0	0	0	0	0	59	122	0	0	0	0	33	137
P31: 11 Jan 2012	32	0	0	0	15	129	49	0	0	0	0	25	34
P32: 8 March 2012	14	0	33	0	0	467	22	0	0	0	0	0	13
P33: 28 March 2012	0	0	67	0	0	482	0	0	0	0	0	14	0
P34: 19 April 2012	26	0	0	0	0	73	29	0	0	0	0	0	0
P35: 22 May 2012	0	0	0	0	0	61	0	0	0	0	0	0	0
P36: 13 June 2012	30	0	28	0	0	28	0	0	0	0	0	0	0
P37: 1 Aug 2012	0	24	56	0	0	183	59	0	0	0	0	0	0
P38: 14 Aug 2012	0	0	0	0	0	66	0	0	0	0	0	0	0
P39: 9 Oct 2012	0	0	0	0	0	99	39	0	0	0	0	31	0
P40: 20 Nov 2012	81	0	0	0	0	278	0	0	0	0	0	0	0
P41: 11 Dec 2012	20	0	0	0	5	0	184	119	0	0	0	0	0
P42: 9 Jan 2013	0	0	144	0	0	16	240	0	0	0	0	32	0
P43: 31 jan 2013	0	0	97	0	0	73	0	0	0	0	0	0	0
TOTAL:	677	1084	1966	12	358	5267	3952	389	0	0	832	4928	1153

Annex 2d

	Schematisation	SOBEK	Sprints	Steering group	STONE	Uncertainty	User story	users	Users group	VSS	WFD policy process	Zoet zout	TOTALS:
P 1: 18 Nov 2009	50	0	0	0	0	0	186	0	0	0	0	0	1030
P 2: 8 Dec 2009	0	0	0	0	0	0	21	0	83	0	0	0	686
P 3: 17 Dec 2009	14	0	0	35	0	0	293	0	0	0	0	0	1077
P 4: 12 Jan 2010	116	0	0	26	0	0	150	0	32	0	0	0	708
P 5: 3 Feb 2010	57	39	0	42	0	0	0	0	355	0	0	0	1539
P 6: 16 Feb 2010	47	0	0	0	0	0	0	0	0	0	0	0	1004
P 7: 1 March 2010	117	0	72	0	0	0	0	0	0	0	0	292	1049
P 8: 16 March 2010	108	69	194	0	0	22	0	0	122	0	0	0	1277
P 9: 30 March 2010	194	0	29	13	0	0	0	56	251	0	0	0	1707
P10: 13 April 2010	235	275	57	0	0	0	0	105	158	0	0	0	2269
P11: 27 April 2010	54	54	152	29	0	0	0	0	28	0	0	0	1061
P12: 25 May 2010	0	40	114	0	0	0	0	0	200	0	0	0	1490
P13: 15 June 2010	383	0	238	0	0	0	0	88	0	0	0	52	2237
P14: 17 Aug 2010	68	0	153	11	0	0	0	0	156	0	0	75	1398
P15: 23 Sept 2010	68	265	16	275	117	0	0	78	123	48	0	0	2886
P16: 14 Oct 2010	731	0	196	0	306	0	0	0	0	0	0	0	3664
P17: 4 Nov 2010	326	0	0	0	0	0	0	0	109	0	0	0	1760
P18: 25 Nov 2010	72	0	561	0	0	0	0	0	0	0	0	0	2542
P19: 9 Dec 2010	53	0	0	0	0	0	0	31	0	478	0	0	2705
P20: 6 Jan 2011	116	0	0	23	0	0	0	0	0	0	0	0	1730
P21: 27 Jan 2011	0	0	0	373	0	0	0	0	0	20	0	0	1456
P22: 15 Feb 2011	433	0	0	0	0	0	0	28	0	0	0	0	1460
P23: 8 March 2011	132	0	0	0	279	0	0	38	126	23	0	0	2150
P24: 19 April 2011	192	0	0	172	0	0	0	85	0	0	0	0	1655
P25: 31 May 2011	156	101	0	35	0	0	0	0	0	0	0	0	2004
P26: 28 June 2011	409	0	0	0	0	0	0	0	0	0	0	0	1474
P27: 15 Sept 2011	236	14	0	235	0	0	0	0	0	0	0	102	2191
P28: 13 Oct 2011	31	48	0	0	0	0	0	0	0	0	0	121	1735
P29: 8 Nov 2011	89	0	0	206	0	0	0	0	29	0	26	53	1020
P30: 1 Dec 2011	59	70	0	0	0	0	0	0	0	0	0	3	735
P31: 11 Jan 2012	0	0	0	67	26	0	0	0	0	0	0	0	539
P32: 8 March 2012	0	0	0	0	0	0	0	0	236	18	0	0	2105
P33: 28 March 2012	0	45	0	0	25	0	0	0	0	0	0	0	1556
P34: 19 April 2012	0	0	0	0	0	0	0	0	0	22	0	0	680
P35: 22 May 2012	0	0	0	24	0	0	0	0	9	17	0	0	698
P36: 13 June 2012	0	0	0	0	0	0	0	0	112	0	0	0	688
P37: 1 Aug 2012	32	0	0	41	0	0	0	0	151	0	0	0	916
P38: 14 Aug 2012	0	0	0	0	0	0	0	0	0	0	0	0	346
P39: 9 Oct 2012	0	0	0	22	0	0	0	0	0	0	0	0	420
P40: 20 Nov 2012	0	0	0	0	0	0	0	57	57	0	0	0	971
P41: 11 Dec 2012	0	0	0	158	0	0	0	0	0	0	0	0	558
P42: 9 Jan 2013	0	0	0	0	0	0	0	0	0	0	0	0	1064
P43: 31 jan 2013	0	0	0	0	18	0	0	0	0	0	0	0	1189
TOTAL:	4578	1020	1782	1787	771	22	650	566	2337	626	26	698	61429

Annex 3a

Primary Documents Hermeneutic Unit 'Interviews'

Name {number of coded elements in PM }

P 1	1. 19 Jan 2009.doc {8}
P 2	2. 11 March 09.doc {30}
P 3	3. 11 March 09.doc {23}
P 4	4. 26 Feb 10.doc {6}
P 5	5,6. 19 Oct 09.doc {48}
P 6	6. 20 Oct 09.doc {24}
P 7	7. 26 Oct 09.doc {33}
P 8	8. 05 Jan 10.doc {59}
P 9	9. 05 March 10.doc {52}
P10	10. 8 March 2010.doc {49}
P11	11. 08 Oct 10.doc {51}
P12	12. 12 Jan 10.doc {61}
P13	13,3. 26 Jan 10.doc {45}
P14	14. 01 March 10.doc {47}
P15	15,1 15 March 10.doc {80}
P16	16 24 June 2010.doc {66}
P17	17. 23 June 2010.doc {88}
P18	18. 25 June 2010.doc {79}
P19	19. 28 June 2010.doc {54}
P20	20. 28 June 2010.doc {81}
P21	21. 29 June 2010.doc {42}
P22	22. 28 June 2010.doc {34}
P23	24. 09 Feb 2011.doc {35}
P24	25. 11 Feb 2011.doc {75}
P25	26. 11 Feb 2011.doc {33}
P26	27. 28 Feb 2011.doc {61}
P27	28. 20 May 2011.doc {49}
P28	29. 1 Nov 2011.doc {95}
P29	30. 16 Nov 2011.doc {58}
P30	31. 03 Feb 2012.doc {64}
P31	32, 27. 17 Feb 2012.doc {51}
P32	33. 27 March 2012.doc {78}
P33	34. 6 June 2012.doc {53}
P34	35, 3 26 June 2012.doc {35}
P35	36,7 23 Oct 2012.doc {52}
P36	37. 13 Nov 2012.doc {68}
P37	38. 21 Jan 2013.doc {77}
P38	39. 22 Jan 2013.doc {70}
P39	40. 25 Jan 2013.doc {42}
P40	41. 29 Jan 2013.doc {51}
P41	42. 30 Jan 2013.doc {49}
P42	43. 13 Feb 2013.doc {99}
P43	44. 11 March 2013.doc {59}

Annex 3b

Code Book Hermeneutic Unit ‘Interviews’

---

0 role interviewee
Quotations: 114
Comment:
References to role, position, tasks of interviewee

---

1 harmonisation, uniformity
Quotations: 57
Comment:
all references to harmonising practices, creating uniformity of practices, methods, tools, etc

---

1 parties actively involved
Quotations: 32
Comment:
Reference to developers, funders, all parties represented in the consortium or later in the steering group or active partners in the pilots, also those who are talked of as possible parties to be involved

---

1 role consultancies
Quotations: 21
Comment:
references to what consultancies do, are expected to do etc

---

1 role of knowledge/ expertise
Quotations: 260
Comment:
references to the role of knowledge, experts and expertise, lack or availability of expertise, development of new knowledge etc

---

2 attitude towards WFD
Quotations: 36
Comment:
any reference to the views, expectations. thoughts and feelings on WFD or WFD implementation in the Netherlands

---

2 international context
Quotations: 68
Comment:
This includes international cooperation, the role of the EU and the CIS.

---

2 methods
Quotations: 108
Comment:
references to methods related to WFD implementation, used to set objectives, classify water bodies, determine present state, evaluate proposed measures etc

---

2 objectives and measures WFD
Quotations: 147
Comment:
References to the objectives achieved or to be achieved as part of WFD implementation as well as any measures proposed, planned or taken.

---

2 political context
Quotations: 53
Comment:
References to the role of national and regional politicians, political decision making, negotiations, decrees etc

---

2 relations with other policy areas
Quotations: 132
Comment:
all references to other policy areas related to WFD, such as environment, agriculture, manure.

---

2 resources for WFD
Quotations: 40
Comment:
References to budgets, manpower etc.

---

2 WFD as a policy/legal instrument
Quotations: 71
Comment:
Any reflections of the WFD as a policy instrument, the objectives of the objective proper and its contributions to water management. This includes the discussions on the obligation of result and the level of ambition

---

2 WFD planning process
Quotations: 314
Comment:
This includes planning process, procedures, coordination between parties and participation

---

3 development process
Quotations: 94
Comment:
All references to the process of developing WFDE. What is actually done? How?

---

3 objectives WFDE
Quotations: 61
Comment:
Objectives for the WFDE as stated by the interviewees, being their own opinion or that of others.
references to what WFDE is supposed to do: flexibility

---

3 obstacles
Quotations: 49
Comment:
What hinders the use or the continued development of the instrument?

---

3 stimulants/advantages
Quotations: 26
Comment:
What stimulates the use or the continued developments of the instrument?

---

3 use/pilots/apllications
Quotations: 67
Comment:
references to applications of the WFDE, whether pilots or actual use.

---

3 users
Quotations: 114
Comment:
any reference to involvement of users in design process, by attending meeting, by participating in a working group or pilot or by any other means and references to who are expected/actual users

---

4 complexity of model/instrument
Quotations: 13
Comment:
references to the level of complexity the instrument has or should have

---

4 diagnose/system analysis
Quotations: 41
Comment:
references to the WFDE providing, or being expected to provide, a diagnose or a system analysis

---

4 ease of use
Quotations: 8
Comment:
References to user-friendliness, ease of use etc of WFDE

---

4 ecological knowledge rules
Quotations: 138
Comment:
references to the development and application of ecological knowledge rules

---

4 effects of measures
Quotations: 45
Comment:
References to the WFDE providing, or should provide, insights in the effects of measures. This includes references to the predictions the WFDE can, or should be able to, do

---

4 provide insights in costs
Quotations: 10
Comment:
references to WFDE providing or being expected to provide insights in costs of measures

---

4 quality models
Quotations: 69
Comment:
references to model quality, does the model work sufficiently well? reliability, functioning, representativeness of models, calibration, validation

---

4 relations with other instruments
Quotations: 32
Comment:
all references to connections with other instrument by making use of models, data etc located in these other instruments

---

4 schematisation
Quotations: 16
Comment:
All references to how the water system was (to be) schematised

---

4 scope and scale
Quotations: 32
Comment:
What models to include and what level of detail is to be provided

---

4 transparency
Quotations: 27
Comment:
references to the transparency the instrument has or should have. Transparent as in the results can be traced back to the calculating procedures and data used in such a way that the user can understand the basis of the result.

---

4 uncertainty
Quotations: 20
Comment:
all references to the way the uncertainties of the calculations were dealt with in WFDE

4a advice groups
Quotations: 19
Comment:
References to the working groups that advice the PT: working groups ecological knowledge and schematisation, user groups, advice group national pilot

---

4a attitude parties involved
Quotations: 59
Comment:
any reference to ecologists' views and feelings

4a communication about WFDE/creating expectations
Quotations: 22
Comment:
All references to communication on WFDE, through public presentations, leaflets, website etc

---

4a cooperation between parties involved
Quotations: 8
Comment:
all references to the cooperation of the parties involved in the development process

---

4a data avalailability
Quotations: 33
Comment:
references to amount or quality of data that is available

4a programming
Quotations: 31
Comment:
How did they develop the code for WFDE? Techniques, practice

4a resources
Quotations: 56
Comment:
*** Merged Comment from: 4a resources for WFDE (2013-09-16T14:52:58) ***
money, time,

4a timing
Quotations: 15
Comment:
timing WFDE development as opposed to timing WFD

4b integration of instruments/models
Quotations: 16
Comment:
references to integrating the WFDE with the Waterplanner and Echo as well as specific references to either of the last two.

4b support WFD planning process
Quotations: 29
Comment:
All references to WFDE as instrument to support the WFD policy process

---

4b WFDE as instrument for communication
Quotations: 20
Comment:
All references to the WFDE as communication instrument, meaning an instrument to stimulate discussion, present quick results, use in interactive settings

---

4b WFDE as knowledge instrument
Quotations: 18
Comment:
References to the WFDE having the function to integrate existing knowledge and or making this available for all users and or stimulating the development of new knowledge to be included.

---

5 comparison old-new WFDE
Quotations: 11
Comment:
Answers to the question, what is the difference between the WFDE-1 and WFDE-2?

---

5 contacts
Quotations: 33
Comment:
Answers to the question: who do you have contact with regarding WFDE

---

5 DSS?
Quotations: 21
Comment:
Answers to the question: what is a DSS?

---

5 expert judgement
Quotations: 18
Comment:
expert judgement: all references to expert judgment as a means

---

5 expertise developers or their advisors
Quotations: 85
Comment:
Developer taken broadly: meaning both members of the project team, programming team, steering group. The references deal with specific expertise they contribute, both as seen by them as by others.

---

5 expertise in instrument
Quotations: 23
Comment:
knowledge rules, models, already incorporated or to be incorporated in the instrument.

---

5 Model?
Quotations: 30
Comment:
Answers to the question: what is a model? Includes other references to the nature of models.

---

5 modulair
Quotations: 15
Comment:
references to the modular design of the WFDE-2

---

5 objectives parties involved
Quotations: 43
Comment:
References about objectives of specific parties related to WFDE

---

5 operation and maintenance
Quotations: 4
Comment:
All references to management and maintenance

---

5 personal success/objectives?
Quotations: 21
Comment:
Answers to the question, when would you call your work successful?

---

5 requirements for good model/DSS
Quotations: 12
Comment:
Answers to the question What are the requirements for good model or DSS development.

---

5 steering group
Quotations: 18
Comment:
All references to the steering group.

---

5 user-story/functional specification
Quotations: 29
Comment:
all references to the development and use of users' stories

---

5 VSS
Quotations: 41
Comment:
Volg en StuurSysteem, which is another instrument that is developed to facilitate water system analysis.

---

5 WFDE Model or DSS?
Quotations: 13
Comment:
Answer to the question: is the WFDE a model or a DSS?

---

5 WFDE success?
Quotations: 30
Comment:
Answer to the question: when is the WFDE a success?

---

aquarein
Quotations: 66
Comment:
Automatic coding of each instance of the word "Aquarein"

Annex 3c

Code Frequency
HU 'Interviews'

Code-Filter: All [64]
PD-Filter: All [43]
Quotation-Filter: All [2314]

	0 role interviewee	1 harmonisation, uniformity	1 parties actively involved	1 role consultancies	1 role of knowledge/ expertise	2 attitude towards WFD	2 international context	2 methods	2 objectives and measures WFD	2 political context	2 relations with other policy areas	2 resources for WFD	2 WFD as a policy/legal instrument	2 WFD planning process	3 development process	3 objectives WFDE	3 obstacles	3 stimulants/advantages
P 1: 1. 19 Jan 2009	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	3	1
P 2: 2. 11 Mrch 09	1	1	1	0	1	6	1	2	5	0	1	0	0	6	0	0	2	3
P 3: 3. 11 Mrch 09	2	0	0	2	1	0	0	1	1	0	2	0	0	3	1	0	3	2
P 4: 4. 26 feb 10	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	1
P 5: 5,6 19 okt 09	1	0	0	1	3	0	1	2	0	0	0	0	0	6	0	3	6	2
P 6: 6. 20 okt 09	1	0	0	0	1	1	0	0	1	0	6	0	0	10	0	0	0	0
P 7: 7. 26 okt 09	1	0	0	0	2	0	0	0	0	0	0	0	0	0	3	3	2	1
P 8: 8. 05 jan 10	1	1	2	0	16	0	0	3	2	0	3	0	0	1	2	3	3	0
P 9: 9. 05 mrt 10	3	0	2	0	5	1	0	0	0	0	0	0	0	0	17	3	1	0
P10: 10. 8 mrt 2010	2	0	0	0	24	0	0	6	1	0	0	0	0	0	4	1	1	1
P11: 11. 08 okt 10	3	1	5	3	14	1	0	1	1	0	0	0	0	1	12	0	0	0
P12: 12. 12 Jan 10	1	1	6	0	2	5	0	3	6	0	3	3	0	39	0	0	0	0
P13: 13,3 26 Jan 10	0	1	3	0	3	1	0	11	10	0	1	3	0	17	0	0	0	0
P14: 14. 01 Mrch 10	3	0	2	3	6	0	0	2	0	0	0	0	0	1	7	1	3	2
P15: 15,1 15 Mrch 10	2	10	4	2	17	0	0	2	0	0	0	0	0	1	11	5	7	3
P16: 16 24 June 2010	1	5	0	0	18	4	14	9	3	3	6	0	13	32	0	0	0	0
P17: 17. 23 June 2010	4	0	3	0	4	2	5	1	18	7	19	3	11	33	0	1	1	0
P18: 18. 25 June 2010	2	6	1	0	11	0	3	6	15	3	3	0	7	27	0	0	0	0
P19: 19. 28 June 2010	2	1	1	0	7	3	8	3	8	5	6	7	4	11	0	1	0	0
P20: 20. 28 June 2010	3	1	0	0	8	0	22	10	21	4	10	0	13	10	0	0	0	0
P21: 21. 29 June 2010	1	0	0	0	5	1	7	3	3	8	10	1	5	4	0	0	0	0
P22: 22. 28 June 2010	3	0	0	0	4	1	2	0	4	0	11	2	3	12	0	0	0	0
P23: 24. 09 feb 2011	2	0	0	0	4	1	0	2	9	1	3	1	2	18	0	0	0	0
P24: 25. 11 feb 2011	3	9	1	0	7	3	1	17	5	3	8	7	2	18	0	0	0	0
P25: 26. 11 feb 2011	5	0	0	0	2	0	0	2	7	1	1	4	2	10	0	0	0	0
P26: 27. 28 feb 2011	2	3	0	0	7	0	1	4	8	5	10	3	4	21	0	0	0	1
P27: 28. 20 May 2011	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0
P28: 29. 1 11 2011	5	0	0	0	4	0	0	0	1	0	0	0	0	0	3	3	0	0
P29: 30. 16 Nov 2011	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
P30: 31. 03 Feb 2012	2	0	0	2	1	0	0	0	3	0	4	1	0	0	2	0	1	0
P31: 32. 27 17 feb 2012	1	0	0	0	7	1	2	1	5	7	6	3	0	15	1	3	0	0
P32: 33. 27 Mrch 2012	6	0	0	1	0	0	0	0	0	0	0	0	0	0	5	2	5	5
P33: 34. 6 June 2012	8	2	1	0	7	1	0	0	0	0	2	0	0	0	2	1	0	0
P34: 35,3, 26 June 2012	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0
P35: 36,7 23 Oct 2012	4	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0
P36: 37. 13 nov 2012	7	2	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0
P37: 38. 21 jan 2013	4	5	0	0	18	2	0	0	2	4	4	0	0	1	2	7	0	0
P38: 39. 22 jan 2013	3	0	0	4	5	0	0	3	2	0	0	1	0	1	0	3	2	1
P39: 40. 25 jan 2013	4	2	0	0	8	0	0	7	3	0	0	0	0	3	0	3	1	1
P40: 41. 29 jan 2013	3	0	0	3	3	0	0	6	2	0	0	1	1	0	2	3	2	1
P41: 42. 30 jan 2013	6	0	0	0	4	2	0	0	0	0	0	0	2	3	4	3	2	1
P42: 43. 13 feb 2013	3	3	0	0	16	0	1	1	1	2	13	0	2	10	1	7	3	0
P43: 44. 11 mrt 2013	3	3	0	0	5	0	0	0	0	0	0	0	0	0	1	0	1	0
TOTALS:	114	57	32	21	260	36	68	108	147	53	132	40	71	314	94	61	49	26

Annex 3c

	3 use/pilots/aplications	3 users	4 complexity of model/instrument	4 diagnose/system analysis	4 ease of use	4 ecological knowledge rules	4 effects of measures	4 provide insights in costs	4 quality models	4 relations with other instruments	4 schematisation	4 scope and scale	4 transparency	4 uncertainty	4a advice groups	4a attitude parties involved	4a communication about WFDE/cr	4a cooperation between parties in
P 1: 1. 19 Jan 2009	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
P 2: 2. 11 Mrch 09	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
P 3: 3. 11 Mrch 09	6	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
P 4: 4. 26 feb 10	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
P 5: 5,6 19 okt 09	11	5	1	0	2	2	1	1	0	0	0	2	0	1	0	4	3	0
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	2	8	0	0	0	4	1	1	0	4	2	3	0	0	0	1	1	2
P 8: 8. 05 jan 10	0	5	0	0	1	3	2	1	0	4	1	6	1	0	0	5	0	0
P 9: 9. 05 mrt 10	2	13	0	0	1	0	1	1	6	0	0	1	0	2	0	6	1	0
P10: 10. 8 mrt 2010	0	6	1	7	0	9	8	0	1	0	0	1	0	6	0	8	1	0
P11: 11. 08 okt 10	1	7	0	1	0	3	0	0	3	1	1	1	3	3	0	3	2	0
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P14: 14. 01 Mrch 10	7	3	3	0	0	0	1	0	4	2	0	1	0	0	0	4	4	0
P15: 15,1 15 Mrch 10	2	4	4	0	0	3	3	2	3	0	0	2	1	1	0	4	7	0
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	0
P18: 18. 25 June 2010	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
P19: 19. 28 June 2010	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P27: 28. 20 May 2011	0	1	0	0	0	2	1	0	0	5	0	0	0	0	0	0	0	0
P28: 29. 1 11 2011	0	2	0	4	0	23	3	0	7	0	0	2	0	0	5	6	0	0
P29: 30. 16 Nov 2011	5	2	0	0	0	8	0	0	1	2	2	0	0	0	0	0	0	0
P30: 31. 03 Feb 2012	1	2	0	2	0	4	0	0	1	1	0	0	0	0	1	0	0	0
P31: 32. 27 17 feb 2012	0	0	0	1	0	0	4	0	1	0	0	0	0	0	0	1	1	0
P32: 33. 27 Mrch 2012	2	12	1	0	0	0	0	0	8	4	6	2	3	0	1	0	0	0
P33: 34. 6 June 2012	0	5	0	0	0	0	2	0	7	6	0	3	0	0	0	0	0	0
P34: 35,3, 26 June 2012	5	0	0	1	0	2	2	0	1	0	0	0	0	0	0	0	0	0
P35: 36,7 23 Oct 2012	0	1	0	0	0	5	0	0	1	1	0	0	0	0	1	0	0	1
P36: 37. 13 nov 2012	7	4	0	0	0	5	1	0	3	0	1	0	1	0	0	1	0	3
P37: 38. 21 jan 2013	0	3	0	1	0	4	2	0	4	0	0	2	12	2	1	0	0	2
P38: 39. 22 jan 2013	3	10	2	9	0	25	2	0	4	0	2	0	5	0	2	2	0	0
P39: 40. 25 jan 2013	0	0	1	0	0	6	1	0	2	0	0	0	0	0	1	1	0	0
P40: 41. 29 jan 2013	1	4	0	1	0	12	2	0	5	0	0	0	0	0	5	0	1	0
P41: 42. 30 jan 2013	1	2	0	9	0	6	2	1	0	0	0	1	0	0	2	5	0	0
P42: 43. 13 feb 2013	3	1	0	3	1	4	4	2	6	0	0	2	0	1	0	5	0	0
P43: 44. 11 mrt 2013	4	10	0	2	1	4	0	0	0	2	1	2	0	3	0	1	0	0
TOTALS:	67	114	13	41	8	138	45	10	69	32	16	32	27	20	19	59	22	8

Annex 3c

	4a data avalailability	4a programming	4a resources	4a timing	4b integration of instruments/mod	4b support WFD planning process	4b WFDE as instrument for commu	4b WFDE as knowledge instrument	5 comparison old-new WFDE	5 contacts	5 DSS?	5 expert judgement	5 expertise developers or their adv	5 expertise in instrument	5 expertise interviewees not develc	5 Model?	5 modulair	5 objectives parties involved
P 1: 1. 19 Jan 2009	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
P 2: 2. 11 Mrch 09	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0
P 3: 3. 11 Mrch 09	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
P 4: 4. 26 feb 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P 5: 5,6 19 okt 09	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	4	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
P 8: 8. 05 jan 10	1	0	3	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0
P 9: 9. 05 mrt 10	0	0	3	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0
P10: 10. 8 mrt 2010	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
P11: 11. 08 okt 10	3	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P14: 14. 01 Mrch 10	1	0	0	3	0	1	2	1	0	0	0	0	0	0	0	0	0	0
P15: 15,1 15 Mrch 10	2	0	3	2	0	2	0	4	0	0	0	0	0	0	0	0	0	0
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P18: 18. 25 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P19: 19. 28 June 2010	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P27: 28. 20 May 2011	0	15	0	0	0	0	0	1	1	2	1	0	4	6	0	0	4	0
P28: 29. 1 11 2011	1	0	2	0	0	0	0	0	2	7	1	9	17	1	0	1	0	0
P29: 30. 16 Nov 2011	2	0	2	0	0	0	0	0	4	5	1	0	7	6	0	2	8	0
P30: 31. 03 Feb 2012	0	3	6	1	0	1	0	0	0	1	1	0	6	1	0	1	0	6
P31: 32. 27 17 feb 2012	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	2	0	0
P32: 33. 27 Mrch 2012	2	6	6	0	3	0	0	0	1	1	1	0	14	2	0	1	0	1
P33: 34. 6 June 2012	0	0	5	0	4	1	0	0	1	3	1	0	7	0	0	1	0	2
P34: 35,3, 26 June 2012	0	0	0	1	0	4	1	0	0	2	2	0	0	5	2	0	0	6
P35: 36,7 23 Oct 2012	1	0	5	0	0	0	0	0	0	3	1	0	18	0	0	2	1	2
P36: 37. 13 nov 2012	1	0	2	0	0	1	0	0	0	1	1	1	6	1	0	2	0	18
P37: 38. 21 jan 2013	1	0	1	1	2	4	1	3	1	2	3	0	2	1	0	2	0	2
P38: 39. 22 jan 2013	1	0	4	0	0	1	0	0	0	0	1	1	0	0	0	3	0	0
P39: 40. 25 jan 2013	4	0	0	1	0	1	0	0	0	1	1	0	0	0	1	1	0	0
P40: 41. 29 jan 2013	1	0	0	2	0	0	1	0	0	0	2	0	2	0	1	3	0	0
P41: 42. 30 jan 2013	0	0	0	0	0	3	0	0	0	1	0	0	0	0	1	3	0	0
P42: 43. 13 feb 2013	1	0	5	1	2	2	0	5	0	3	0	5	0	0	1	5	0	1
P43: 44. 11 mrt 2013	2	7	3	0	0	2	0	1	1	1	1	1	2	0	0	1	2	5
TOTALS:	33	31	56	15	16	29	20	18	11	33	21	18	85	23	6	30	15	43

Annex 3c

	5 operation and maintenance	5 personal success/objectives?	5 requierments for good model/DS	5 steering group	5 user-story/functional specificatio	5 VSS	5 WFDE Model or DSS?	5 WFDE success?	aquarein	role of expertise for policy	TOTALS:
P 1: 1. 19 Jan 2009	0	0	0	0	0	0	0	0	0	0	12
P 2: 2. 11 Mrch 09	0	0	0	0	0	0	0	0	2	0	37
P 3: 3. 11 Mrch 09	0	0	0	0	0	0	0	0	0	0	30
P 4: 4. 26 feb 10	0	0	0	0	0	0	0	0	0	0	9
P 5: 5,6 19 okt 09	0	0	0	0	0	0	0	0	1	0	64
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	4	0	24
P 7: 7. 26 okt 09	0	0	0	0	0	0	0	0	2	0	50
P 8: 8. 05 jan 10	0	0	0	0	0	0	0	0	4	0	79
P 9: 9. 05 mrt 10	0	0	0	0	0	0	0	0	0	0	78
P10: 10. 8 mrt 2010	0	0	0	0	0	0	0	0	1	0	93
P11: 11. 08 okt 10	0	0	0	0	0	0	0	0	1	0	81
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	4	0	73
P13: 13,3 26 Jan 10	0	0	0	0	0	0	0	0	1	0	52
P14: 14. 01 Mrch 10	0	0	0	0	0	0	0	0	0	0	67
P15: 15,1 15 Mrch 10	0	0	0	0	0	0	0	0	0	0	113
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	108
P17: 17. 23 June 2010	0	0	0	0	0	0	0	0	0	0	118
P18: 18. 25 June 2010	0	0	0	0	0	0	0	0	8	0	95
P19: 19. 28 June 2010	0	0	0	0	0	0	0	0	1	0	72
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	102
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	48
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	42
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	43
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	2	0	86
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	2	0	36
P26: 27. 28 feb 2011	0	0	0	0	0	0	0	0	4	0	76
P27: 28. 20 May 2011	0	3	0	0	4	0	0	1	0	0	58
P28: 29. 1 11 2011	0	3	0	5	0	7	1	3	0	0	128
P29: 30. 16 Nov 2011	0	2	2	1	0	0	2	2	0	2	71
P30: 31. 03 Feb 2012	1	2	1	7	0	11	1	1	0	1	80
P31: 32. 27 17 feb 2012	0	1	0	0	0	1	1	1	4	0	74
P32: 33. 27 Mrch 2012	0	1	1	1	11	0	1	1	1	1	119
P33: 34. 6 June 2012	0	1	0	0	3	0	1	2	1	0	80
P34: 35,3, 26 June 2012	0	0	0	0	0	1	1	5	1	0	46
P35: 36,7 23 Oct 2012	0	2	3	0	0	0	1	1	1	3	62
P36: 37. 13 nov 2012	1	1	1	0	3	1	1	1	0	1	87
P37: 38. 21 jan 2013	1	1	2	4	0	0	0	2	3	2	123
P38: 39. 22 jan 2013	0	0	0	0	0	7	0	3	1	0	113
P39: 40. 25 jan 2013	0	1	0	0	0	4	1	1	1	0	62
P40: 41. 29 jan 2013	0	0	0	0	0	4	1	3	0	0	78
P41: 42. 30 jan 2013	0	0	0	0	0	4	0	0	0	0	68
P42: 43. 13 feb 2013	1	1	0	0	0	1	0	1	16	0	146
P43: 44. 11 mrt 2013	0	2	2	0	8	0	1	2	0	2	89
TOTALS:	4	21	12	18	29	41	13	30	66	12	3172

Annex 3d

Word count per code
HU 'Interviews'

Code-Filter: All [64]
PD-Filter: All [43]
Quotation-Filter: All [2314]

	0 role interviewee	1 harmonisation, uniformity	1 parties actively involved	1 role consultancies	1 role of knowledge/ expertise	2 attitude towards WFD	2 international context	2 methods	2 objectives and measures WFD	2 political context	2 relations with other policy areas	2 resources for WFD
P 1: 1 19 Jan 2009	0	0	0	0	17	0	0	0	0	0	0	0
P 2: 2 11 Mrch 09	21	40	27	0	36	189	34	138	224	0	57	0
P 3: 3 11 Mrch 09	38	0	0	39	22	0	0	36	20	0	86	0
P 4: 4 26 feb 10	0	0	0	0	209	0	0	0	0	0	0	0
P 5: 5,6 19 okt 09	49	0	0	45	232	0	83	146	0	0	0	0
P 6: 6. 20 okt 09	34	0	0	0	113	68	0	0	56	0	445	0
P 7: 7. 26 okt 09	79	0	0	0	223	0	0	0	0	0	0	0
P 8: 8. 05 jan 10	87	108	120	0	1048	0	0	301	127	0	317	0
P 9: 9. 05 mrt 10	226	0	160	0	294	45	0	0	0	0	0	0
P10: 10. 8 mrt 2010	160	0	0	0	2603	0	0	711	107	0	0	0
P11: 11. 08 okt 10	228	53	412	154	1001	7	0	80	80	0	0	0
P12: 12. 12 Jan 10	160	67	290	0	76	259	0	126	297	0	288	120
P13: 13,3 26 Jan 10	0	90	197	0	336	64	0	879	764	0	142	236
P14: 14. 01 Mrch 10	159	0	197	166	569	0	0	149	0	0	0	0
P15: 15,1 15 Mrch 10	122	603	241	171	1340	0	0	123	0	0	0	0
P16: 16 24 June 2010	60	331	0	0	1153	516	1222	573	312	404	655	0
P17: 17. 23 June 2010	243	0	139	0	321	144	444	111	1538	463	1538	211
P18: 18. 25 June 2010	176	551	31	0	733	0	201	367	1195	190	283	0
P19: 19. 28 June 2010	105	169	63	0	510	126	611	174	661	338	299	523
P20: 20. 28 June 2010	241	159	0	0	799	0	1621	804	1803	168	815	0
P21: 21. 29 June 2010	349	0	0	0	419	68	524	126	227	547	769	25
P22: 22. 28 June 2010	254	0	0	0	399	127	171	0	250	0	757	145
P23: 24. 09 feb 2011	242	0	0	0	433	134	0	212	717	49	155	73
P24: 25. 11 feb 2011	340	1654	143	0	836	340	238	2477	688	226	1131	1143
P25: 26. 11 feb 2011	649	0	0	0	551	0	0	547	1830	335	123	487
P26: 27. 28 feb 2011	64	147	0	0	467	0	22	185	730	450	866	276
P27: 28. 20 May 2011	100	0	0	0	0	0	0	0	0	0	0	0
P28: 29. 1 11 2011	312	0	0	0	254	0	0	0	187	0	0	0
P29: 30. 16 Nov 2011	155	0	0	0	0	0	0	0	0	0	0	0
P30: 31. 03 Feb 2012	204	0	0	90	93	0	0	0	252	0	338	112
P31: 32. 27 17 feb 2012	46	0	0	0	550	103	207	93	327	721	567	203
P32: 33. 27 Mrch 2012	481	0	0	92	0	0	0	0	0	0	0	0
P33: 34. 6 June 2012	558	165	73	0	475	62	0	0	0	0	64	0
P34: 35. 3 26 June 2012	0	0	0	0	156	0	0	0	0	0	0	0
P35: 36,7 23 Oct 2012	209	0	0	0	74	0	0	0	0	0	0	0
P36: 37. 13 nov 2012	303	146	0	0	0	0	0	0	0	0	0	0
P37: 38. 21 jan 2013	254	484	0	0	1355	92	0	0	124	246	353	0
P38: 39. 22 jan 2013	125	0	0	170	343	0	0	202	192	0	0	38
P39: 40. 25 jan 2013	193	142	0	0	570	0	0	635	207	0	0	0
P40: 41. 29 jan 2013	226	0	0	272	246	0	0	402	156	0	0	45
P41: 42. 30 jan 2013	358	0	0	0	266	275	0	0	0	0	0	0
P42: 43. 13 feb 2013	224	230	0	0	1585	0	73	86	153	111	1059	0
P43: 44. 11 mrt 2013	244	218	0	0	301	0	0	0	0	0	0	0
TOTALS:	8078	5357	2093	1199	21008	2619	5451	9683	13224	4248	11107	3637

Annex 3d

	2 WFD as a policy/legal instrument	2 WFD planning process	3 development process	3 objectives WFDE	3 obstacles	3 stimulants/advantages	3 use/pilots/apllications	3 users	4 complexity of model/instrument	4 diagnose/system analysis	4 ease of use
P 1: 1 19 Jan 2009	0	0	54	43	81	10	0	28	0	0	0
P 2: 2 11 Mrch 09	0	265	0	0	69	106	41	0	0	0	0
P 3: 3 11 Mrch 09	0	65	33	0	98	105	262	28	0	0	78
P 4: 4 26 feb 10	0	0	0	0	0	34	0	0	0	0	0
P 5: 5,6 19 okt 09	0	423	0	263	455	156	788	415	14	0	103
P 6: 6. 20 okt 09	0	656	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	0	0	214	303	117	52	106	547	0	0	0
P 8: 8. 05 jan 10	0	22	195	168	122	0	0	267	0	0	46
P 9: 9. 05 mrt 10	0	0	1082	276	64	0	161	1029	0	0	49
P10: 10. 8 mrt 2010	0	0	410	47	82	82	0	361	56	577	0
P11: 11. 08 okt 10	0	11	960	0	0	0	30	428	0	61	0
P12: 12. 12 Jan 10	0	2406	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	1592	0	0	0	0	0	0	0	0	0
P14: 14. 01 Mrch 10	0	45	534	56	171	69	546	307	168	0	0
P15: 15,1 15 Mrch 10	0	33	921	403	480	203	163	249	312	0	0
P16: 16 24 June 2010	864	2661	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	864	2598	0	63	10	0	238	0	0	0	0
P18: 18. 25 June 2010	524	1870	0	0	0	0	0	0	0	0	0
P19: 19. 28 June 2010	334	737	0	51	0	0	0	0	0	0	0
P20: 20. 28 June 2010	882	773	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	582	384	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	254	947	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	68	1424	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	226	3321	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	297	2279	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	351	1902	0	0	0	51	57	77	0	0	0
P27: 28. 20 May 2011	0	0	48	61	0	0	0	139	0	0	0
P28: 29. 1 11 2011	0	0	208	200	0	0	0	137	0	554	0
P29: 30. 16 Nov 2011	0	0	104	0	0	0	425	104	0	0	0
P30: 31. 03 Feb 2012	0	0	196	0	138	0	92	214	0	132	0
P31: 32. 27 17 feb 2012	0	1333	165	196	0	0	0	0	0	38	0
P32: 33. 27 Mrch 2012	0	0	459	173	204	234	153	595	52	0	0
P33: 34. 6 June 2012	0	0	145	120	0	0	0	302	0	0	0
P34: 35. 3 26 June 2012	0	0	0	109	0	0	576	0	0	99	0
P35: 36,7 23 Oct 2012	0	0	129	0	0	0	0	115	0	0	0
P36: 37. 13 nov 2012	0	0	583	0	0	0	468	218	0	0	0
P37: 38. 21 jan 2013	0	117	120	524	0	0	0	313	0	67	0
P38: 39. 22 jan 2013	0	87	0	271	161	82	160	711	111	687	0
P39: 40. 25 jan 2013	0	243	0	306	55	118	0	0	55	0	0
P40: 41. 29 jan 2013	88	0	164	121	201	27	61	160	0	93	0
P41: 42. 30 jan 2013	258	196	304	253	86	25	26	77	0	731	0
P42: 43. 13 feb 2013	209	958	184	420	188	0	348	75	0	170	114
P43: 44. 11 mrt 2013	0	0	75	0	32	0	343	636	0	142	66
TOTALS:	5801	27348	7287	4427	2814	1354	5044	7532	768	3351	456

Annex 3d

	4 ecological knowledge rules	4 effects of measures	4 provide insights in costs	4 quality models	4 relations with other instruments	4 schematisation	4 scope and scale	4 transparency	4 uncertainty	4a advice groups	4a attitude parties involved
P 1: 1 19 Jan 2009	0	0	0	0	0	0	29	0	0	0	0
P 2: 2 11 Mrch 09	0	0	0	0	0	0	0	0	20	0	0
P 3: 3 11 Mrch 09	20	0	0	0	0	0	0	0	0	0	0
P 4: 4 26 feb 10	32	0	0	0	0	0	0	34	0	0	0
P 5: 5,6 19 okt 09	104	44	44	0	0	0	88	0	59	0	265
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	240	33	44	0	384	186	267	0	0	0	39
P 8: 8. 05 jan 10	170	46	5	0	179	21	407	108	0	0	385
P 9: 9. 05 mrt 10	0	71	61	435	0	0	49	0	146	0	485
P10: 10. 8 mrt 2010	1124	671	0	157	0	0	157	0	570	0	999
P11: 11. 08 okt 10	262	0	0	224	128	78	60	144	161	0	201
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	0	0	0	0	0	0	0	0	0	0
P14: 14. 01 Mrch 10	0	26	0	344	212	0	40	0	0	0	381
P15: 15,1 15 Mrch 10	207	218	154	101	0	0	61	31	99	0	326
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	0	124	112	0	0	0	0	0	0	0	0
P18: 18. 25 June 2010	63	0	0	0	0	0	0	0	0	0	145
P19: 19. 28 June 2010	96	0	0	96	0	0	0	0	0	0	0
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P27: 28. 20 May 2011	141	20	0	0	281	0	0	0	0	0	0
P28: 29. 1 11 2011	1910	367	0	466	0	0	141	0	0	422	624
P29: 30. 16 Nov 2011	477	0	0	117	105	198	0	0	0	0	0
P30: 31. 03 Feb 2012	297	0	0	72	54	0	0	0	0	180	0
P31: 32. 27 17 feb 2012	0	185	0	38	0	0	0	0	0	0	93
P32: 33. 27 Mrch 2012	0	0	0	460	240	467	242	105	0	35	0
P33: 34. 6 June 2012	0	132	0	587	372	0	334	0	0	0	0
P34: 35. 3 26 June 2012	279	169	0	99	0	0	0	0	0	0	0
P35: 36,7 23 Oct 2012	454	0	0	96	84	0	0	0	0	19	0
P36: 37. 13 nov 2012	298	109	0	148	0	57	0	108	0	0	109
P37: 38. 21 jan 2013	346	154	0	180	0	0	97	922	189	28	0
P38: 39. 22 jan 2013	1834	74	0	240	0	128	0	358	0	173	187
P39: 40. 25 jan 2013	475	118	0	134	0	0	0	0	0	44	118
P40: 41. 29 jan 2013	962	71	0	230	0	0	0	0	0	377	0
P41: 42. 30 jan 2013	417	105	48	0	0	0	30	0	0	137	348
P42: 43. 13 feb 2013	347	191	53	502	0	0	196	0	59	0	392
P43: 44. 11 mrt 2013	280	0	0	0	127	66	184	0	144	0	64
TOTALS:	10835	2928	521	4726	2166	1201	2382	1810	1447	1415	5161

Annex 3d

	4a communication about WFDE/cre	4a cooperation between parties inv	4a data avalailability	4a programming	4a resources	4a timing	4b integration of instruments/mode	4b support WFD planning process	4b WFDE as instrument for commu	4b WFDE as knowledge instrument	5 comparison old-new WFDE
P 1: 1 19 Jan 2009	0	0	0	0	35	0	0	43	43	0	0
P 2: 2 11 Mrch 09	0	0	0	0	0	6	0	0	42	0	0
P 3: 3 11 Mrch 09	0	0	19	0	0	0	0	0	33	0	0
P 4: 4 26 feb 10	0	0	0	0	0	0	0	0	0	0	0
P 5: 5,6 19 okt 09	212	0	0	0	83	0	29	0	190	0	0
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	37	223	384	0	0	0	125	0	141	0	0
P 8: 8. 05 jan 10	0	0	38	0	211	0	212	0	52	48	0
P 9: 9. 05 mrt 10	24	0	0	0	183	0	0	385	283	0	0
P10: 10. 8 mrt 2010	82	0	195	0	0	0	0	0	56	0	0
P11: 11. 08 okt 10	94	0	267	0	113	161	0	0	93	0	0
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	0	0	0	36	0	0	0	0	0	0
P14: 14. 01 Mrch 10	341	0	90	0	0	255	0	74	96	86	0
P15: 15,1 15 Mrch 10	434	0	119	0	167	160	0	207	0	189	0
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	10	0	0	0	0	0	0	0	0	0	0
P18: 18. 25 June 2010	0	0	0	0	0	0	0	0	0	0	0
P19: 19. 28 June 2010	0	0	96	0	0	0	0	0	0	51	0
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P27: 28. 20 May 2011	0	0	0	1170	0	0	0	0	0	41	49
P28: 29. 1 11 2011	0	0	41	0	128	0	0	0	0	0	84
P29: 30. 16 Nov 2011	0	0	142	0	121	0	0	0	0	0	329
P30: 31. 03 Feb 2012	0	0	0	232	442	35	0	30	0	0	0
P31: 32. 27 17 feb 2012	36	0	0	0	0	0	0	0	0	0	0
P32: 33. 27 Mrch 2012	0	0	93	488	345	0	279	0	0	0	90
P33: 34. 6 June 2012	0	0	0	0	412	0	334	55	0	0	143
P34: 35. 3 26 June 2012	0	0	0	0	0	58	0	359	51	0	0
P35: 36,7 23 Oct 2012	0	79	66	0	346	0	0	0	0	0	0
P36: 37. 13 nov 2012	0	225	39	0	121	0	0	52	0	0	0
P37: 38. 21 jan 2013	0	165	176	0	72	117	68	332	81	145	40
P38: 39. 22 jan 2013	0	0	93	0	207	0	0	142	0	0	0
P39: 40. 25 jan 2013	0	0	315	0	0	55	0	118	0	0	0
P40: 41. 29 jan 2013	88	0	50	0	0	170	0	0	55	0	0
P41: 42. 30 jan 2013	0	0	0	0	0	0	0	277	0	0	0
P42: 43. 13 feb 2013	0	0	82	0	369	72	147	51	0	376	0
P43: 44. 11 mrt 2013	0	0	193	514	152	0	0	152	0	66	32
TOTALS:	1358	692	2498	2404	3543	1089	1194	2277	1216	1002	767

Annex 3d

	5 contacts	5 DSS?	5 expert judgement	5 expertise developers or their advi	5 expertise in instrument	5 expertise interviewees not develo	5 Model?	5 modulair	5 objectives parties involved	5 operation and maintenance	5 personal success/objectives?
P 1: 1 19 Jan 2009	0	0	0	0	0	0	0	0	0	0	0
P 2: 2 11 Mrch 09	0	0	0	0	0	0	0	0	0	0	0
P 3: 3 11 Mrch 09	0	0	0	0	0	0	0	0	0	0	0
P 4: 4 26 feb 10	0	0	0	0	0	0	0	0	0	0	0
P 5: 5,6 19 okt 09	0	0	0	0	0	0	0	0	0	0	0
P 6: 6. 20 okt 09	0	0	0	0	0	0	0	0	0	0	0
P 7: 7. 26 okt 09	0	0	0	0	0	0	0	0	0	0	0
P 8: 8. 05 jan 10	0	0	0	0	0	0	0	0	0	0	0
P 9: 9. 05 mrt 10	0	0	0	0	0	0	0	0	0	0	0
P10: 10. 8 mrt 2010	0	0	0	0	0	0	0	0	0	0	0
P11: 11. 08 okt 10	0	0	0	0	0	0	0	0	0	0	0
P12: 12. 12 Jan 10	0	0	0	0	0	0	0	0	0	0	0
P13: 13,3 26 Jan 10	0	0	0	0	0	0	0	0	0	0	0
P14: 14. 01 Mrch 10	0	0	0	0	0	0	0	0	0	0	0
P15: 15,1 15 Mrch 10	0	0	0	0	0	0	0	0	0	0	0
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	0	0	0
P17: 17. 23 June 2010	0	0	0	0	0	0	0	0	0	0	0
P18: 18. 25 June 2010	0	0	0	0	0	0	0	0	0	0	0
P19: 19. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	0	0	0
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	0	0	0
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P24: 25. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P25: 26. 11 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P26: 27. 28 feb 2011	0	0	0	0	0	0	0	0	0	0	0
P27: 28. 20 May 2011	164	61	0	243	338	0	0	345	0	0	180
P28: 29. 1 11 2011	302	23	877	904	52	0	30	0	0	0	194
P29: 30. 16 Nov 2011	140	82	0	666	347	0	100	550	0	0	200
P30: 31. 03 Feb 2012	83	95	0	464	35	0	31	0	392	30	261
P31: 32. 27 17 feb 2012	0	227	93	0	0	0	121	0	0	0	49
P32: 33. 27 Mrch 2012	36	42	0	478	140	0	69	0	29	0	70
P33: 34. 6 June 2012	157	170	0	441	0	0	60	0	164	0	117
P34: 35. 3 26 June 2012	150	104	0	0	286	36	0	0	452	0	0
P35: 36,7 23 Oct 2012	163	120	0	569	0	0	75	84	151	0	81
P36: 37. 13 nov 2012	99	28	87	187	51	0	188	0	1076	79	37
P37: 38. 21 jan 2013	97	223	0	60	96	0	42	0	174	27	83
P38: 39. 22 jan 2013	0	83	31	0	0	0	274	0	0	0	0
P39: 40. 25 jan 2013	25	71	0	0	0	32	26	0	0	0	34
P40: 41. 29 jan 2013	0	128	0	97	0	103	139	0	0	0	0
P41: 42. 30 jan 2013	24	0	0	0	0	74	202	0	0	0	0
P42: 43. 13 feb 2013	216	0	451	0	0	120	379	0	103	43	71
P43: 44. 11 mrt 2013	162	121	64	201	0	0	137	83	362	0	197
TOTALS:	1818	1578	1603	4310	1345	365	1873	1062	2903	179	1574

Annex 3d

	5 requierments for good model/DS	5 steering group	5 user-story/functional specificatio	5 VSS	5 WFDE Model or DSS?	5 WFDE success?	aquarein	role of expertise for policy	TOTALS:
P 1: 1 19 Jan 2009	0	0	0	0	0	0	0	0	383
P 2: 2 11 Mrch 09	0	0	0	0	0	0	73	0	1388
P 3: 3 11 Mrch 09	0	0	0	0	0	0	0	0	982
P 4: 4 26 feb 10	0	0	0	0	0	0	0	0	309
P 5: 5,6 19 okt 09	0	0	0	0	0	0	60	0	4350
P 6: 6. 20 okt 09	0	0	0	0	0	0	307	0	1679
P 7: 7. 26 okt 09	0	0	0	0	0	0	261	0	4005
P 8: 8. 05 jan 10	0	0	0	0	0	0	358	0	5168
P 9: 9. 05 mrt 10	0	0	0	0	0	0	0	0	5508
P10: 10. 8 mrt 2010	0	0	0	0	0	0	136	0	9343
P11: 11. 08 okt 10	0	0	0	0	0	0	128	0	5619
P12: 12. 12 Jan 10	0	0	0	0	0	0	357	0	4446
P13: 13,3 26 Jan 10	0	0	0	0	0	0	132	0	4468
P14: 14. 01 Mrch 10	0	0	0	0	0	0	0	0	5081
P15: 15,1 15 Mrch 10	0	0	0	0	0	0	0	0	7837
P16: 16 24 June 2010	0	0	0	0	0	0	0	0	8751
P17: 17. 23 June 2010	0	0	0	0	0	0	0	0	9171
P18: 18. 25 June 2010	0	0	0	0	0	0	601	0	6930
P19: 19. 28 June 2010	0	0	0	0	0	0	91	0	5131
P20: 20. 28 June 2010	0	0	0	0	0	0	0	0	8065
P21: 21. 29 June 2010	0	0	0	0	0	0	0	0	4020
P22: 22. 28 June 2010	0	0	0	0	0	0	0	0	3304
P23: 24. 09 feb 2011	0	0	0	0	0	0	0	0	3507
P24: 25. 11 feb 2011	0	0	0	0	0	0	117	0	12880
P25: 26. 11 feb 2011	0	0	0	0	0	0	166	0	7264
P26: 27. 28 feb 2011	0	0	0	0	0	0	343	0	5988
P27: 28. 20 May 2011	0	0	415	0	0	44	0	0	3840
P28: 29. 1 11 2011	0	345	0	391	20	186	0	0	9359
P29: 30. 16 Nov 2011	139	102	0	0	120	95	0	139	4957
P30: 31. 03 Feb 2012	34	671	0	748	95	37	0	34	6213
P31: 32. 27 17 feb 2012	0	0	0	76	103	47	398	0	6015
P32: 33. 27 Mrch 2012	38	45	860	0	63	70	66	38	7331
P33: 34. 6 June 2012	0	0	190	0	49	110	21	0	5812
P34: 35. 3 26 June 2012	0	0	0	27	37	251	67	0	3365
P35: 36,7 23 Oct 2012	108	0	0	0	35	51	23	108	3239
P36: 37. 13 nov 2012	86	0	323	59	36	126	0	86	5532
P37: 38. 21 jan 2013	139	261	0	0	0	167	288	139	8957
P38: 39. 22 jan 2013	0	0	0	492	0	136	100	0	7892
P39: 40. 25 jan 2013	0	0	0	290	37	39	165	0	4620
P40: 41. 29 jan 2013	0	0	0	391	103	155	0	0	5381
P41: 42. 30 jan 2013	0	0	0	261	0	0	0	0	4778
P42: 43. 13 feb 2013	0	0	0	107	0	59	1272	0	11845
P43: 44. 11 mrt 2013	193	0	544	0	11	61	0	193	6360
TOTALS:	737	1424	2332	2842	709	1634	5530	737	241073

Annex 4a

Primary Documents Hermeneutic Unit 'Key Documents'

P 1: 1 2004 projectplan.pdf {80}
Families:
internal documents
Comment:
Doc one is the oldest document I have, the project plan late 2004. It describes the planned research and development to arrive at a policy tool for WFD implementation .

P 2: 2 sept 2005 hoofdrapport.pdf {93}
Families:
external documents
Comment:
Doc 2 is a report on phase 1 of the research and development of the prototype instrument. Its use is to inform the funders of the results of the project. The Board that oversees the development has seen a draft report and this incorporates their comments.

P 3: 3 Jan 2006 Projectplan KRW-VK fase2 vs3.doc {46}
Families:
internal documents
Comment:
Doc 3 is a project plan for phase 2 of the development of the WFDE. The intention is to develop the prototype into a basic but complete version that can be applied in the river basins (I assume they mean river basin (sub)districts) in the Netherlands.

P 4: 4 Sep 2006 handleiding H 1 en 3.pdf {48}
Families:
external documents
Comment:
Doc 4 is the users' guide that was written for the basic version of WFDE in sept 2006. 132 pages. I have only coded 1 and 3, that deal with the general set-up and the role of the instrument. The other chapters deal with the purely technical aspects. All possible measures and how to deal with them in WFDE, and what the limits of the knowledge is, are discussed

P 5: 5 jan 2007 jan Projectplan KRW Verkenner.doc {34}
Families:
internal documents
Comment:
Doc 5 is an RIZA internal document. It is a proposal to continue the development of the WFDE after the funding from Leven met Water ceases. It explains why RIZA should continue to support this development and elaborates on a prospected new project period. It focusses on internal project organisation in order to ensure effective development and later operation and maintenance.

P 6: 6 feb 2009 Reeze en de Vlieger Rapportage KRW Verkenner ecologie definitief.pdf {66}
Families:
external documents
Comment:
Doc 6 is the external evaluation of the WFDE, performed by a consultancy. The objective of the report is to assess how the regional water managers perceive the instrument and what wishes and suggestions are for continued development of the instrument. The consultancy interviewed representatives of nearly all water boards. Furthermore, they explored all instruments used and they made an inventory of knowledge available at the regional water boards concerning relations between measures and effects. I can't see who commissioned the report.

P 7: 7 Apr 14 2009 Verslag_14 april 2009 Bijeenkomst_Doorontwikkeling_KRW-verkenner.doc {20}
Families:
external documents
Comment:
Doc7 is the report of the public meeting discussing the future development of WFDE. Prospective users as well as developers and funders participated. I was there to observe as well. Actually it is interesting to see that the objective of the meeting and the targeted group all point to use of the instruments by waterboards.

P 8: 8 juli 2009 SG toekomstvisieconceptVisie_def.doc {95

Families:

internal documents

Comment:

Doc 8 is the report written by the developers for discussion in the Steering Board elaborating the future development and use of WFDE. It is based the evaluation (doc 6) as well as on workshops and discussions with funders, users and involved research institutes.

P 9: 9 oct 2009 def PVA.doc {67}

Families:

internal documents

Comment:

Doc 9 is the project plan for the redesign of the WFDE, approved by the Steering Board. It describes why and how the instrument will be redesigned. It start with stating the requirements set by the Steering Board as a response to the vision of the future (doc 8).

P10: 10 2011 05 pvA -Landelijke pilot KRW-Verkenner_def.pdf {24}

Families:

internal documents

Comment:

Doc 10 is the project plan for the national pilot application of the WFDE. It describes the objectives of the pilot and how they are to be realised. This version is the final version of May 2011, but although this was then thought to be final, several revisions followed. The national application was delivered in December 2012.

P11: 11 2011 juni Communicatieplan KRW-Verkenner_concept_1juni2011.doc {17}

Families:

internal documents

Comment:

Doc 11 is the communication plan written by the developers (project leader mainly) for discussion in the Steering Board. The SB accepted it as is. It describes what will be communicated to whom, when and how.

P12: 12 dec 2011 Drie notities doel KRW-verkenner.doc {35}

Families:

internal documents

Comment:

Doc 12 (new) consists of three memo's concerning the future of WFDE. The memos were written by the three of the main funders of the developed of WFDE. At first I didn't want to include this doc, because the fourth funder did not write a memo, so I felt it was incomplete. Be that as it may, later I realised that the fact that the memo was not written is significant in itself. This fourth funder is taking a step away from this project. The memos were discussed in a meeting "by the fireside", attended by all. An informal discussion of views on the WFDE now and in the future. The report of this meeting stresses the similarities in these views and concludes that although views may not always be exactly the same they are compatible.

P13: 13 2012 11 Gebruikershandleiding.pdf {27}

Families:

external documents

Comment:

Doc 13 is the users' manual of the latest release (Jan 2013) of the WFDE. The introduction to the WFDE is copied from the manual for the first WFDE (p4). The rest is purely descriptive of the functionalities and what steps to take to apply them.

P14: 14 2012 12 Landelijke pilot KRW-Verkenner def.pdf {27}

Families:

external documents

Comment:

Doc 14 is the report on the national pilot application (see doc 10 for project plan) by the PT. It describes how the application was set up, how it performed, what the results were and it provides a list of suggested improvements.

P15: 15 2013 jan probleemstoffen 1205956-000-ZWS-0009-r-Belasting per KRW waterlichaam voor probleemstoffen in Nederland.pdf {9}

Families:

external documents

Comment:

Doc 15 is a report of the first actual use of the instrument for policy making. WFDE, applying a modified part of the national application, was used to predict the concentration of specific pollutants in the main waters. The purpose is to have water boards use this as background information for developing the new programmes of measures for the second round of WFDE planning. This study was not done by the PT, but by other Deltares staff.

P16: 16 2013 jan innovatief scenario 1206111-004-BGS-0003-r-Innovatief Scenario Kennis Moet Stromen.pdf {8}

Families:

external documents

Comment:

Doc 16 is a study using WFDE to calculate the effect of certain 'innovative' agricultural measures. This was not a study performed by the PT. It was commissioned to Deltares by DGW.

P17: 13 2013 feb Handleiding KRW Verkenner feb 2013.doc {12}

Families:

external documents

Comment:

This is a later version of the manual, as found on the WFDE website, Aug 19. 2013, dated feb 2013 see doc 13. The introduction is drastically shortened. The rest is the same as doc 13. I will discard doc 13.

Annex 4b

Code Book ‘Key Documents’

---

1 targeted users
Quotations: 43
Comment:
Who are said to be the (future) users?

---

1 WFDE objectives
Quotations: 109
Comment:
The answer to the question: what do you want to achieve by building this instrument? This includes what the developers want to achieve with the instrument, but also to what potential users are said to want achieve.

2a analyse/diagnose
Families (1): objectives
Quotations: 13
Comment:
Analyse water system, diagnose issues that need to be addressed to improve water system, assess waterquality or ecology in the system. Note: ambiguous terms. Parties do not agree on what is to be called diagnosis or analysis. That is why they are not separated.

2a bridge the gap between science and policy
Families (1): objectives
Quotations: 8
Comment:
references to using WFDE to bridge gap between science and policy

---

2a compare objectives and (sets of) measures
Families (1): objectives
Quotations: 12
Comment:
reference to using WFDE to compare WFD objectives with measures

---

2a Coordination, communication between actors
Families (1): objectives
Quotations: 21
Comment:
References to using WFDE to support cooperation, coordination, deliberations, including to supporting discussion and communication

---

2a costs of measures
Families (1): objectives
Quotations: 18
Comment:
References to using WFDE to calculate costs of measures

2a develop programmes of measures
Families (1): objectives
Quotations: 27
Comment:
references to using WFDE to develop programme of measures, including evaluating the 'value' of sets of measures, judging which would be best (beoordeling, afwegen)

2a easy to use and quick results
Families (1): objectives
Quotations: 10
Comment:
Ease of use and good performance, including speed of calculations

---

2a effects of measures
Families (1): objectives
Quotations: 45
Comment:
Effects of measures, including effectivity of measures.

2a flexibility
Quotations: 14
Comment:
Referring to ease of making changes, adaptability to specific local circumstances, providing opportunities to change parameters or rules etc.

2a harmonisation
Families (1): objectives
Quotations: 12
Comment:
references to harmonisation, including uniformity

2a integrated approach
Families (1): objectives
Quotations: 8
Comment:
references to using WFDE as a tool for integrated approaches including: ruimtelijke samenhang tussen waterlichamen; integrale benadering;-afwenteling; samenhang rijkswateren <-> regionale wateren

---

2a monitor and evaluate effects of current measures
Families (1): objectives
Quotations: 5
Comment:
references to using WFDE to monitor and evaluate measures taken

---

2a present current situation
Families (1): objectives
Quotations: 4
Comment:
references to using WFDE to present the current situation

2a provide knowledge
Families (1): objectives
Quotations: 23
Comment:
references to using WFDE to provide knowledge, collect knowledge, joint knowledge base *** Merged Comment from: 2a provide knowledge (2013-08-06T13:08:15) ***
een gezamelijke kennisbasis, gezamelijk referentiekader etc

2a regional-national coordination
Families (1): objectives
Quotations: 8
Comment:
reference to using WFDE to support coordination between regional and national water managers

---

2a set ecological targets
Families (1): objectives
Quotations: 5
Comment: reference to using WFDE to set ecological targets/determine MEP/Prague method

---

2a support for measures
Families (1): objectives
Quotations: 2
Comment:
References to using WFDE to gather support for the measures to be taken

---

2a support policy process
Families (1): objectives
Quotations: 20
Comment:
References to using WFDE to support the policy planning process

---

2b consultancies
Families (1): Users
Quotations: 11
Comment:
References to the use of WFDE by consultancies

2b DG water
Families (1): Users
Quotations: 2
Comment:
References to the use of WFDE by DG water

2b other authorities
Families (1): Users
Quotations: 5
Comment:
References to the use of WFDE by other governmental authorities

---

2b others
Families (1): Users
Quotations: 7
Comment:
References to the use of WFDE by other parties than specified in the other codes, or to unspecified users

---

2b Policy makers
Families (1): Users
Quotations: 3
Comment:
References to the use of WFDE by policy makers

2b regional project teams
Families (1): Users
Quotations: 9
Comment:
References to the use of WFDE by regional water managers/waterboards

---

2b regional water managers/waterboards
Families (1): Users
Quotations: 32
Comment:
Includes these terms: -waterbeheerders; waterschappen, regionale waterbeheerders (the term is commonly used for waterboards, but can include regional divisions of rijkswaterstaat. In some docs it is very hard to determine which is referred to.)

2b research institutes
Families (1): Users
Quotations: 7
Comment:
references to the use of WFDE by research institutes

2b Rijkswaterstaat
Families (1): Users
Quotations: 5
Comment:
References to the use of WFDE by Rijkswaterstaat (national water management organisation, in charge of the management of the larger water bodies, sea, Lake IJssel, main rivers).

2b technical experts
Families (1): Users
Quotations: 2
Comment:
References to the use of WFDE by technical experts

---

applications/pilots
Families (1): process
Quotations: 18
Comment:
Any reference to actual use of the instrument, in the form of a pilot or a study by any user.

---

connection with other instruments
Families (1): process
Quotations: 53
Comment:
References to connections with other instruments, Both instruments that provide input and similar instruments to the WFDE that may be merged.

---

functionalities/deliverables
Families (1): instrument
Quotations: 24
Comment:
The how question? How will the tool reach the objectives?

---

knowledge/expertise
Families (1): process
Quotations: 52
Comment:
Knowledge present and required. Expertise involved or to be involved. State of knowledge. Knowledge development. Users and their role in knowledge management

---

parties actively involved
Families (1): process
Quotations: 25
Comment:
Funders, developers, associated partners in the development process.

Planning
Families (1): process
Quotations: 6
Comment:
timing of tasks, development milestones

Policy needs
Families (1): process
Quotations: 17
Comment:
The policy context that is referred to as rationale behind developing WFDE.

---

process
Families (1): process
Quotations: 32
Comment:
process of developing WFDE.

---

resources
Families (1): process
Quotations: 12
Comment:
funding, man power, etc

Scope and scale instrument
Families (1): instrument
Quotations: 77
Comment:
*** Merged Comment from: Scope instrument (2013-08-12T10:42:40) ***
ecology as the scope of the instrument. Knowledge selection, development etc is in knowledge/expertise
*** Merged Comment from: Scope instrument (2013-08-12T14:15:54) ***
A what scale will, or does, the instrument operate: waterbody, group of waterbodies, river basin, national.

SOBEK
Quotations: 23
Comment:
References to the instrument SOBEK

Technology
Families (1): instrument
Quotations: 10
Comment:
referenced to examples of technology, predecessors, as well as state of the art insights in technology development

---

Annex 4c

Codes Frequency

HU 'Key Documents'

Code-Filter: All [42]

PD-Filter: All [17]

Quotation-Filter: All [708]

	1 targeted users	1 WFDE objectives	2a analyse/diagnose	2a bridge the gap between science and policy	2a compare objectives and (sets of) measures	2a Coordination, communication between actors	2a costs of measures	2a develop programmes of measures	2a easy to use and quick results	2a effects of measures	2a flexibility	2a harmonisation	2a integrated approach	2a monitor and evaluate effects of current measures	2a present current situation	2a provide knowledge	2a regional-national coordination	2a set ecological targets	2a support for measures	2a support policy process	2b consultancies	2b DG water	2b other authorities	2b others	2b Policy makers	2b regional project teams	2b regional water managers/waterboards	2b research institutes	2b Rijkswaterstaat	2b technical experts	applications/pilots	connection with other instruments	functionalities/deliverables	knowledge/expertise	parties actively involved	planning	Policy needs	process	resources	Scope and scale instrument	SOBEK	technology	TOTALS:
P 1:	9	12	1	3	1	4	1	7	0	1	0	3	2	0	1	7	1	2	2	2	1	0	1	1	0	2	5	1	0	0	0	0	1	0	1	0	6	4	1	5	0	6	94
P 2:	6	18	1	3	3	1	4	3	3	4	3	1	1	0	1	6	0	0	0	1	1	0	2	1	0	2	6	0	0	0	0	0	1	8	2	0	3	9	0	11	0	1	106
P 3:	3	5	0	2	1	0	2	2	0	3	0	1	0	0	0	2	1	0	0	2	1	0	0	0	0	0	3	0	0	0	1	0	3	4	2	1	1	3	0	1	0	1	45
P 4:	4	8	0	0	1	4	0	1	2	1	0	2	0	0	1	2	0	1	0	1	1	0	1	2	0	1	2	0	0	0	1	0	0	9	1	0	1	0	0	8	0	0	55
P 5:	3	4	0	0	0	1	0	1	0	0	0	1	0	0	0	1	1	1	0	2	2	1	0	0	0	0	3	0	1	0	0	0	0	4	2	0	0	4	1	2	0	0	35
P 6:	3	7	1	0	0	1	0	1	1	5	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3	24	0	13	1	0	0	2	0	3	23	0	93
P 7:	1	3	0	0	0	1	0	0	0	1	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	2	1	0	1	0	0	4	0	0	22
P 8:	4	14	4	0	0	2	5	4	1	5	0	0	3	3	1	0	1	0	0	3	0	1	0	0	1	0	4	0	2	0	3	11	6	7	9	2	3	8	7	11	0	2	127
P 9:	2	7	0	0	1	2	1	3	2	6	7	0	0	2	0	0	0	0	0	1	2	0	0	0	0	2	0	2	0	0	2	7	10	3	2	1	0	0	1	8	0	0	74
P10:	1	2	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	1	2	0	0	1	0	0	1	1	2	0	0	20
P11:	2	1	1	0	1	0	1	1	0	2	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	15
P12:	2	7	0	0	0	0	2	1	0	7	1	3	0	0	0	0	1	0	0	3	0	0	0	0	0	0	2	2	1	1	1	1	1	1	0	1	1	1	0	8	0	0	48
P14:	1	5	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	2	6	1	0	1	1	0	0	1	5	0	0	30
P15:	0	4	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	2	0	0	13
P16:	0	2	1	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	9
P17:	1	3	0	0	0	2	1	1	0	1	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	17
TOTALS:	43	109	13	8	12	21	18	27	10	45	14	12	8	5	4	23	8	5	2	20	11	2	5	7	3	9	32	7	5	2	18	53	24	52	25	6	17	32	12	77	23	10	839

Annex 4d

Word count
HU 'Key documents'

Code-Filter: All [42]
PD-Filter: All [17]
Quotation-Filter: All [708]

	1 targeted users	1 WFDE objectives	2a analyse/diagnose	2a bridge the gap between science and policy	2a compare objectives and (sets of) measures	2a Coordination, communication between actors	2a costs of measures	2a develop programmes of measures	2a easy to use and quick results	2a effects of measures	2a flexibility	2a harmonisation	2a integrated approach	2a monitor and evaluate effects of current measu	2a present current situation	2a provide knowledge	2a regional-national coordination	2a set ecological targets	2a support for measures	2a support policy process	2b consultancies	2b DG water
P 1:	544	1125	39	170	11	160	19	279	0	21	0	125	53	0	51	199	41	28	47	131	13	0
P 2:	334	1523	51	111	176	37	135	130	113	140	50	59	29	0	38	278	0	0	0	11	13	0
P 3:	51	558	0	133	18	0	30	29	0	55	0	16	0	0	0	42	33	0	0	26	22	0
P 4:	307	783	0	0	49	94	0	17	47	43	0	51	0	0	48	146	0	48	0	22	12	0
P 5:	91	315	0	0	0	8	0	17	0	0	0	22	0	0	0	60	25	48	0	99	98	61
P 6:	132	536	10	0	0	48	0	10	23	333	86	0	0	0	0	5	0	0	0	0	0	0
P 7:	17	230	0	0	0	14	0	0	0	13	0	0	30	0	0	0	89	0	0	0	0	0
P 8:	143	1010	189	0	0	173	387	136	40	306	0	0	162	53	66	0	45	0	0	112	0	45
P 9:	90	1046	0	0	46	44	12	119	72	255	505	0	0	38	0	0	0	0	0	32	25	0
P10:	52	301	22	0	55	0	0	0	0	36	47	0	0	0	0	0	0	0	0	32	3	0
P11:	11	154	12	0	3	0	3	4	0	19	0	0	17	0	0	0	0	0	0	24	0	0
P12:	68	438	0	0	0	0	27	65	0	260	50	143	0	0	0	0	59	0	0	86	0	0
P14:	73	1218	0	0	32	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0
P15:	0	217	179	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0
P16:	0	352	3	0	17	0	0	0	0	241	0	0	0	0	0	0	0	0	0	0	0	0
P17:	107	397	0	0	0	38	24	14	0	24	0	0	0	0	0	72	0	0	0	33	0	0
TOTALS:	2349	11059	505	414	407	668	663	851	316	1865	738	438	291	91	203	850	316	167	47	608	220	106

	P 1:	P 2:	P 3:	P 4:	P 5:	P 6:	P 7:	P 8:	P 9:	P10:	P11:	P12:	P14:	P15:	P16:	P17:	TOTALS:
TOTALS:	5796	6770	4335	3490	2081	9052	1243	11519	6010	1479	342	2555	2734	829	952	1144	62719
technology	678	103	359	0	0	0	0	272	0	0	0	0	0	0	0	0	1412
SOBEK	0	0	0	0	0	2287	0	0	0	0	0	0	0	0	0	0	2287
Scope and scale instrument	339	383	15	741	48	192	191	1445	337	41	23	673	193	152	90	402	5563
resources	91	0	0	0	107	0	0	1412	219	143	0	0	51	0	0	0	2023
process	392	1292	935	0	303	110	0	861	0	142	0	132	0	0	0	0	4167
Policy needs	601	243	33	107	0	0	76	167	0	0	0	104	0	139	0	0	1470
planning	0	0	8	0	0	0	0	437	198	0	0	10	79	0	0	0	732
parties actively involved	91	114	222	25	321	25	150	973	711	100	72	0	215	47	0	0	3066
knowledge/expertise	0	677	399	685	317	2313	138	446	336	0	0	25	0	0	0	0	5428
functionalities/deliverables	279	286	752	0	0	0	0	344	1188	0	0	123	25	0	0	0	3247
connection with other instruments	0	0	0	0	0	2531	150	1890	493	152	0	33	676	0	0	0	5925
applications/pilots	0	0	548	12	0	309	106	205	207	339	0	55	38	57	249	0	2125
2b technical experts	0	0	0	0	0	51	0	0	0	0	0	51	0	0	0	0	102
2b Rijkswaterstaat	0	0	0	0	50	0	0	52	0	0	0	17	34	0	0	0	153
2b research institutes	26	0	0	0	0	0	0	0	24	3	0	68	34	0	0	0	155
2b regional water managers/waterboards	188	171	51	45	91	0	39	143	0	0	0	68	34	0	0	33	919
2b regional project teams	9	144	0	9	0	0	0	0	13	11	0	0	0	0	0	0	216
2b Policy makers	0	0	0	0	0	51	0	5	0	0	0	0	0	0	0	0	82
2b others	20	58	0	170	0	0	0	0	0	0	0	0	0	0	0	0	319
2b other authorities	26	71	0	29	0	0	0	0	0	0	0	0	0	0	0	0	156

Annex 5a

Primary Documents Hermeneutic Unit 'Field Notes'

P 1: 2011 06 28 PT field notes.doc {128}

P 2: 2009 04 20 Field visit .doc {12}

P 3: 2011 10 20 sprint.doc {16}

P 4: 2009 04 20 notes.doc {6}

P 5: 2011 04 19 PT.doc {92}

P 6: 2011 05 31 PT.doc {113}

P 7: 2009 06 16 STOWA modellendag.doc {17}

P 8: 2011 03 01 Field notes sprint ed.doc {33}

P 9: 2011 03 22 sprint.doc {46}

P10: 2011 03 15 Users meeting.doc {11}

P11: 2011 03 29 users meeting.doc {7} [

P12: 2011 09 15 PT.doc {26}

P13: 2011 10 11 Informal talk.doc {5} [

P14: 2011 10 13 PT.doc {57}

P15: 2011 11 09 PT.doc {61}

P16: 2011 11 16 Field notes pilot.doc {137}

P17: 2011 12 01 PT Field notes.doc {39}

P18: 2011 12 06 notes open haard sessie.doc {6}

P19: 2012 01 11 PT.doc {93}

P20: 2012 02 01 PT.doc {120}

P21: 2012 03 08 PT.doc {143}

P22: 2012 03 28 PT.doc {140}

P23: 2012 04 19 PT.doc {69}

P24: 2012 05 22 PT.doc {114}

P25: 2012 06 13 PT.doc {97}

P26: 2012 10 9 PT.doc {47}

P27: 2012 11 20 PT.doc {99}

P28: 2012 11 30, informal talk.doc {7}

P29: 2012 12 11 PT.doc {105}

P30: 2012 12 13 watermozaiek.doc {7}

Annex 5b

Code Book 'Field Notes'

HU: field notes
File: [H:\My Documents\Scientific Software\ATLASti\TextBank\field notes.hpr6]

Attendees
Families (1): topic
Quotations: 21
Comment:
Persons present at meeting

---

attitude ecologists
Families (1): topic
Quotations: 4
Comment:
what is said about the attitude of ecologists

---

building team
Families (1): topic
Quotations: 11
Comment:
references to the programming team that builds WFDE

---

communication
Quotations: 10
Comment:
What is said about communication

---

costs module
Quotations: 3
Comment:
What is said about the cost module and the data needed for the cost module

---

data availability
Quotations: 13
Comment:
remarks about data availability (note: a lot of overlap with schematisation)

---

details of (one of) the model(s)
Quotations: 11
Comment:
detailed issues regarding any of the models in WFDE

---

details of the instrument
Quotations: 6
Comment:
details regarding the overall functionalities of the WFDE.

---

development proces
Quotations: 13
Comment:
Remarks regarding the process of developing WFDE, but not resources.

---

dynamic steady-state
Quotations: 14
Comment:
Remarks regarding the debate of steady state versus dynamic modelling

---

ecological knowledge rules
Quotations: 36
Comment:
remarks regarding the ecological models being developed for the WFDE

---

ecology in general
Quotations: 2
Comment:
other ecological issues discussed

---

expert judgement
Quotations: 12
Comment:
remarks about expert judgement

---

measures in WFDE
Quotations: 10
Comment:
Remarks concerning the way in which the measures can be included in WFDE

---

objectives WFDE
Quotations: 9
Comment:
Renarks concerning the objectives of the WFDE

---

operation and maintenance
Quotations: 8
Comment:
remarks concerning the operation and maintenance of WFDE

---

other policy than WFD
Quotations: 2
Comment:
Remarks to other policy areas than WFD

---

parties involved
Quotations: 10
Comment:
parties involved in developing WFDE, in Steering board or project team

---

person 1
Quotations: 315
Comment:
remarks by or about person 1

---

person 2
Quotations: 82
Comment:
Remarks by or about person 2

person 3
Quotations: 340
Comment:
Remarks about or by person 3

person 4
Quotations: 65
Comment:
remarks by or about person 4

person 5
Quotations: 328
Comment:
Remarks by or about person 5

person 6
Quotations: 255
Comment:
Remarks by or about person 6

person 7
Quotations: 249
Comment:
Remarks by or about person 7

pilot/application
Quotations: 36
Comment:
remarks on the pilot application or any other application of the WFDE

Planning and progress
Quotations: 26
Comment:
Remarks concerning the planning and resolution of tasks

regional vs national
Quotations: 12
Comment:
Remarks regarding the debate whether WFDE should have a national or regional focus and nation versus regional applications

relations with other instruments
Quotations: 194
Comment:
remarks regarding the realtions with other instruments such as NHI, SOBEK and STONE

resources
Quotations: 33
Comment:
References to budget and manpower

retention
Quotations: 9
Comment:
References to retention as wel as nutrient supply from underwater soil

role of knowledge/expertise
Quotations: 8
Comment:
remarks regaring the role of knowledge/expertise

---

schematisation
Quotations: 33
Comment:
remarks about the schematisation of the water system in WFDE

---

steering board
Quotations: 49
Comment:
Remarks concerning what was said in the steering board and what will be reported to the SB

---

technical performance
Quotations: 10
Comment:
Remarks regarding technical performance of WFDE in terms of speed, bugs, disturbances, reliability

---

thoughts while observing
Quotations: 8
Comment:
my thoughts noted down during or directly after the meetings

---

user friendliness WFDE
Quotations: 1
Comment:
remarks regarding the ease of use of WFDE

---

users
Quotations: 19
Comment:
remarks regarding users, whether specific user groups or users in general and user comments on the WFDE

---

validation
Quotations: 5
Comment:
Remarks regarding validation, including the validation by Alterra

---

WFD policy
Quotations: 7
Comment:
Remarks regarding the WFD

Annex 6

List of meetings attended regarding the development of WFDE-2

User meetings (open):

14 04 2009	Discussion on redesign
21 01 2010	Presentation redesign plan
29 04 2010	First demo and try-out
09 09 2010	Second demo and try-out
15 03 2011	Third demo and try out
29 03 2011	Third demo and try out
27 06 2012	Fourth demo and try out
07 03 2013	Release WFDE-2

Public presentations

STOWA Themadag ecologische instrumenten en modellen, 16 06 2009
STOWA Watermozaiek 13 dec 2012

Sprintdemo's (internal):

01 03 2011
22 03 2011
20 10 2011

Project Team meetings (internal):

1	19 04 2011
2	31 05 2011
3	28 06 2011
4	15 09 2011
5	13 10 2011
6	08 11 2011
7	16 11 2011 (Pilot plan)
8	01 12 2011
9	11 01 2012
10	01 02 2012
11	08 03 2012
12	28 03 2012
13	19 04 2012
14	22 05 2012
15	13 06 2012
16	09 10 2012
17	20 11 2012
18	11 12 2012

Publications Sandra Junier

Scientific papers

Silveira, A., S.J. Junier, Q.F. Fan, F. Huesker and A. Rondorf (2016) "Organising cross-sectoral collaboration river basin management: case studies from the River Rhine and the Zhujiang (Pearl River)" Journal of River Basin Management

Cortes Arevalo V. J., S. Sterlacchini, T. Bogaard, S.J. Junier, N. van de Giesen (2016) "Decision support method to systematically evaluate first level inspections of the functional status of check dams" Structure and Infrastructure Engineering

Junier, S.J. and E. Mostert (2014) "Decision support systems in environmental policy: process, validity and useful information" Environmental Science and Policy

Junier, S.J. and E. Mostert (2012). "The implementation of the Water Framework Directive in The Netherlands: Does it promote integrated management?" Physics and Chemistry of the Earth, Parts A/B/C 47–48(0): 2-10.

Mostert, E. and S.J. Junier (2009). "The European flood risk directive: challenges for research" Hydrology and Earth System Sciences Discussions, 6(4), 4961-4988.

Edited volume

Junier, S., et al., Eds. (2011). Dialogues on Mediterranean water challenges: Rational water use, water value versus price and lessons learned from the European Water Framework Directive. Options Méditerranéennes, Series A: Mediterranean seminars.

Book chapter

Junier, S., I. Borowski, G. Bouleau, E. Interwies, E. Mostert (2011). Implementing the Water Framework Directive: lessons for the second planning cycle. The Water Framework Directive: Action Programmes and Adaptation To Climate Change. P. Quevauviller, U. Borchers, K. C. Thompson and T. Simonart. Cambridge, RSC Publishing**:** 80-96.

Conference papers

Charrière, M., T. Bogaard, S.J. Junier, E. Mostert (2016) Exploring risk communication – results of a research project focussed on effectiveness evaluation. EGU Vienna

Cortes Arevalo, V.J., S. Sterlacchini, T. Bogaard, S. Frigerio, S.J. Junier, L. Schenato, N. van de Giesen (2016) Use of volunteers' information to support proactive inspection of hydraulic structures. EGU, Vienna

Ertsen, M.W. and S.J. Junier An ant's nest could bring down a hill" The Material in Actor Network Theory. (2015) Workshop "Bruno Latour and Environmental Governance". Windsor, UK

M Charrière, T Bogaard, S Junier, JP Malet, E Mostert (2015) Conducting research in risk communication that is both beneficial for stakeholders and scientists. EGU General Assembly Conference Abstracts 17, 9744

Charriere, M., S. Junier, et al. (2014). One exhibition, many goals. A case study on how to combine scientific questions with stakeholder views on effective communication of risks. AGU Fall Meeting Abstracts.

M.K.M. Charrière, S.J. Junier, E. Mostert & T.A. Bogaard (2012) Flood risk communication - Visualization tools and evaluations of effectiveness. Flood risk conference 2012 Science, policy and practice: closing the gap, Rotterdam, the Netherlands

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Curriculum Vitae

Sandra Junier was born in The Hague in 1968 and moved to Rotterdam at the age of seven. After graduating from secondary school, RSG Schravenlant in Schiedam, she went to Wageningen to study water management for tropical areas. A gap year allowed her to travel six months in Peru with her future husband. Her internship took her to Ecuador, where she spent six months working for a farmers' organisation in a small village. She combined her studies with her work at the toy library where for some years she was in charge of buying the toys, which she enjoyed greatly.

She graduated in 1993, specialised in irrigation, technology & society, education and ecological farming. After the birth of their two children, the family moved to Delft. Her first paid position was at Delft University of Technology, at the faculty of Technology, Policy and Management where she was a secretary for nearly two years. This strengthened her skills in organising, communication and planning, as well as her computer skills.

Then she moved on to the waterboard Delfland in one of the most beautiful buildings in Delft. First she worked as an assistant to the elected board, which provided insights in policy development and decision making. After two years she became assistant crisis manager. In that capacity she drafted, or helped in the drafting, of crisis preparedness plans for the area of Delfland. In addition she provided staff training on various matters relevant for crisis preparedness. Together with partners such as the fire brigades, municipalities, the province, drinking water companies and so on, she worked on a broad scope of issues concerning water related crisis management.

After 10 years at Delfland it was time for a change. She arranged to be seconded to Delft University of Technology for a year to work on an educational website for secondary school students regarding flood risk management. When she was offered the opportunity to work on a project regarding the implementation of the WFD in the Netherlands, she gladly took it. The project evolved into a PhD track of which this book is the final result.

Beside the PhD work, she worked on a number of projects such as the Melia which resulted in a volume of papers that she edited. Another project concerned climate adaptation in Rotterdam. She was a member of Ribago, an exchange network for Chinese and European scientists and practitioners regarding the WFD and similar water quality policy initiatives. She really enjoyed the opportunities to teach, whether doing role plays, teaching about qualitative data analysis or giving guest lectures. Most rewarding was the joint supervision of two wonderful PhD students.