


Knowledge for Climate

Midterm review Report

Hotspot

South-West Netherlands Delta

KfC 69/2012




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Contents

This report was written for the Midterm Assessment of the Dutch research programme Knowledge for Climate and as a report for the Steering Committee South West Netherlands Delta of the National Delta Programme South West Netherlands Delta.

1 Introduction

Knowledge for Climate (KfC) is the Dutch research programme in which knowledge and services are developed that are needed to assess the investments in geographical space and infrastructure anticipated over the next 20 years in terms of climate resistance, and if necessary to make adjustments. There are three tranches, eight scientific themes and eight regional hotspots. The South West Netherlands Delta is one of these hotspots.
In the course of 2012 the eight thematic research programmes reached the halfway mark in their second tranche research. Knowledge for Climate will therefore organise a Midterm Assessment on 4 October 2012 where the state of affairs of the research programme will be presented at thematic level. That day will give the hotspots a good opportunity to present the first outlines of their Options for Regional Adaptation Strategy (ORAS) and to illustrate how the (anticipated) results of the first, second and third tranche will be combined in the hotspot and will be used in practice.
The goal of the KfC Midterm Assessment 2012 is to draw up a midway review of the programme by informing, inspiring and learning from each other and, where necessary, make adjustments. The focus of this assessment is on the main lines of the research themes and the prospect regarding the ultimately integrated hotspot adaptation strategies. In an organizational sense the assessment strives for a stronger relation between the hotspots and the consortiums. After all, KfC's ambition is to give scientific excellence social relevance.
The target group of this midterm assessment is first and foremost the KfC community; the hotspots and researchers within the research programme (including our foreign partners). Representatives of the KfC committees (advisory councils, steering committees, etc.) and the Delta Programme will also be invited.

This Midterm Report Hotspot South West Netherlands Delta sets out the state of affairs in the hotspot with regard to the development of integrated adaptation strategies (ORAS), the scientific and societal results that contribute to those strategies and the co-creation process from the perspective of the hotspot itself.

2 Hotspot South West Netherlands Delta

The Hotspot South West Netherlands Delta is included in the Dutch Research Programme Knowledge for Climate with the following goal:

"To actively and integrally include the consequences of climate change in the long term, and the associated (social and scientific) uncertainties in the planning and implementation of spatial investments as referred to in the Delta Programme. Also to formulate adaptation strategies for water management and spatial planning in the South West Netherlands Delta that can be introduced efficiently and quickly in the current and future planning processes." (Version 1-5-2007 Substantive underpinning of decentralised programme lines for the Committee of Wise Men).
In 2007 five theme lines were designated:

- Communicate and efficiently embed climate resilience in the Planning and implementation in the South West Netherlands Delta by means of co-makership;
- The effects of the climate on strategies to restore the estuarine dynamics;
- New integral methods for coastal defence;
- The spatial organisation and the availability and quality of water under climate change;
- The climate as an opportunity for entrepreneurs (brackish water farming, aquaculture, recreation, fishery).

The above were the result of workshops organised by the Province of Zeeland in association with Wageningen University for stakeholders in the area. The knowledge questions formulated by the stakeholders were combined in the thematic lines.

The adaptation tasks and knowledge questions within the Hotspot South West Netherlands Delta are explained in this chapter by giving a brief outline of the region. The kind of questions addressed in the Delta Programme is also overlooked, as well as the kind of questions that were addressed within KfC. It will also be explained which thematic lines were given the most emphasis.

The South West Netherlands Delta borders on rivers, land and sea and has an altitude that is on average slightly below sea level. Many former islands are linked by dams, bridges and tunnels. Due to these regional characteristics, the area is affected by several effects of climate change like sea level rise, extreme high and low river discharges, extreme rainfall and drought. The land is also more susceptible to human intervention, as is the case with salinization of agricultural areas and land subsidence due to excavation and drainage.
There is a long tradition in the South West Netherlands Delta in dealing with changes due to the changed natural circumstances. In the past this region was a rather pristine natural dynamic estuarine area: channels, streams and rivers and the location of salt marshes and mud flats were constantly changing. The wide intertidal area was the habitat for a wide diversity of flora and fauna. After the 1953 flood it was decided to adopt a strategy that gave the highest priority to safety; this led to the realisation of the Delta Works. Estuaries were closed off by permanent, semi-open or closable dams. The region is

divided into connected islands and water compartments: estuaries, saline and freshwater lakes. The safety strategies pursued by the State, provincial authorities and district water boards are in fact adaptation strategies to counteract the effects of climate change. The height of dykes, dyke covering and pumping capacity are adjusted periodically. Knowledge questions in the field of water safety have been brought into the Delta Programme and are consequently given a lower priority in the KfC research.

The Delta Works have resulted in an unintentional reduction in nature values and no longer meet the European standards. Hence strategies are explored to restore the estuarine dynamics. The climate-proof aspect as a part of these strategies has been tested in the KfC research.

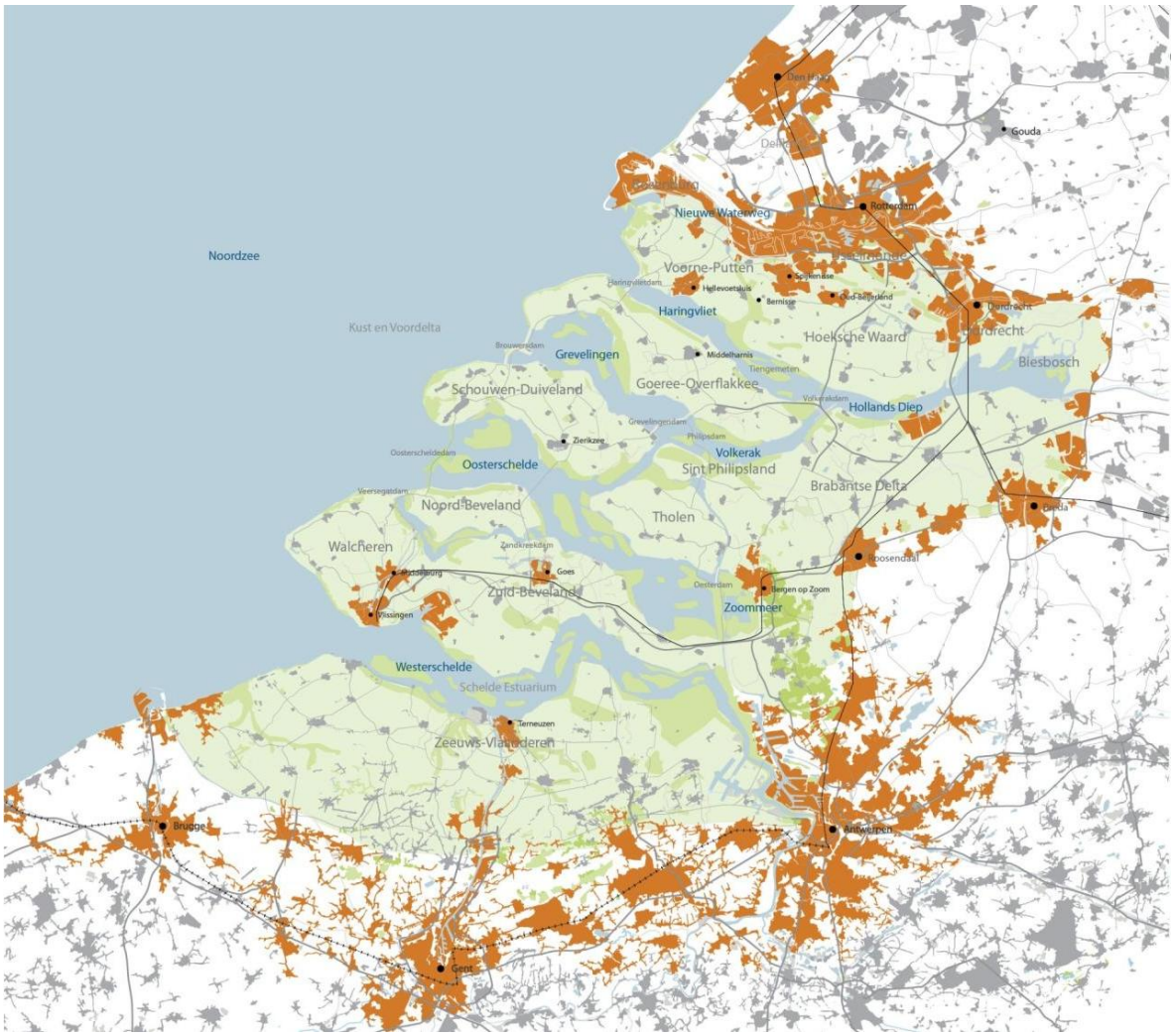
The most important economic functions of the entire South West Netherlands Delta region are port-linked industrial processes, especially in the chemical industry, located on the borders of the area (Rotterdam, Terneuzen, and Antwerp). Shipping is very important for the supply and transport of raw materials and products. The shellfish sections in the Delta waters are also of economic importance. These major economic interests already led to extra measures being taken in the past to guarantee water safety. Account has been taken with extra water safety tasks as a result of climate change in the current planning process (especially the MIRT (Multi-year programme for Infrastructure, Spatial Planning and Transport) Room for the River). Industrial areas were constructed high above NAP (Amsterdam Ordnance Datum ≈ mean sea level). The effects of adaptation measures on industry are studied in the Delta Programme (Sub-programme Rijnmond-Drechtsteden); an area under investigation in the South West Netherlands Delta Sub-programme. This theme is not part of the KfC research in the Hotspot South West Netherlands Delta.

Land bound agriculture and horticulture takes up the most space in the South West Netherlands Delta. In the South Western part of the Delta, agriculture and horticulture have no access to freshwater from the main water system (rivers and canal system predominantly/exclusively fed bij river discharge). The supply of water to the Northern part of the Delta is possible; this relates to the hydrological subsectors located around the Haringvliet and the Volkerak-Zoommeer. Agriculture in this part of the marine clay area mainly depend on rainwater, and fresh groundwater for irrigation at a few locations. An artificial water supply has been made possible on Zuid-Beveland to be used by the agricultural (fruit) sector there; this is a supply pipe that carries water from the Biesbosch. An improvement in how we deal with the available supply of fresh water (in the current situation and also in the future situation under the influence of climate change) is one of the main theme lines in both the Delta Programme and in the elaboration of the KfC research programme. The nature of the knowledge questions relates to both the fundamental level and the application of new methods and techniques, for example for buffering fresh water. The knowledge questions related to the tasks of government fit better in the Delta Programme; knowledge questions focusing more on creating opportunities for industry are more appropriate for KfC.

In terms of administration, the South West Netherlands Delta is a complex region due to the State's overriding responsibility for coastal protection and managing the large water basins, the provincial

authorities' responsibility for the regional nature, spatial and regional-economic development, and the water boards' responsibility for regional water management and the local councils' responsibility for integral local policy. The regional divisions of both the Delta Programme and KfC reflect the administrative interests.

The Hotspot South West Netherlands Delta borders on the Hotspot Rotterdam Region (related to the Delta sub-programme Rijnmond Drechtsteden) and the Hotspot Major Rivers (related to the Delta sub-programme Rivers). The interweave of these regions, the differences in levels of scale and the decision milestones hamper energetic action. This has led to progressively closer collaboration between the relevant sub-programmes in the Delta Programme. The Delta Commissioner is boosting this collaboration by having the sub-programmes jointly prepare a 'Rhine-Meuse-Delta Decision'. KfC, assisted by notification and support from the sub-programmes, actively participates in preparing the Rhine-Meuse-Delta Decision in which the philosophy of action-based-research is applied.



3 Vision on strategy development

In comparison with other hotspots within the Knowledge for Climate Programme it is striking to see that climate adaptation has been a part of strategy and policy development for a long time now in the Hotspot South West Netherlands Delta. Rijkswaterstaat, the provincial authorities, water boards and municipal authorities have for decades (if not centuries) been engaged in dealing with changing natural circumstances, especially in the field of water management. In successive future visions on the South West Netherlands Delta published over the past few years by the provincial authorities and national government (via Delta Council and later the South West Netherlands Delta Steering Committee) we see several developments:

- A more integral approach of the area visions[1];
- Drawing up an agenda for the long term tasks, including climate change[2].

The dilemma we are facing now (2012) is how to link the short term tasks (e.g. regional development) and long term tasks (deal with climate change) in the South West Netherlands Delta.

Delta Programme

In the National Delta Programme South West Delta (NDP ZWD) strategies were identified in 2011/2012 to tackle the long term tasks that arise from climate change (water safety, fresh water supply). Players from the Hotspot South West Netherlands Delta were closely involved in this.

The task of this sub-programme is: *"To secure long-term water safety/climate resilience and to create preconditions for a sustainable water supply in the South Western part of the country in such a way that it makes an integral contribution to the ecological and economic reinforcement of the Delta".*

The South West Delta sub-programme uses the term 'Adaptive Delta Management': *"an approach to taking uncertainties and dependencies in decision-making on delta management into consideration in a smart and transparent way; the objective being to reduce the chance of over and under investing, to make sound choices, and to capitalise the opportunities."* When applying adaptive delta management, potential strategies for the long term are linked to the plans, wishes and projects for the short term. In 2011/2012 the sub-programme worked out the term 'Adaptive Delta Management' in greater detail in the foresight studies for extra water storage (climate task) in the Volkerak-Zoommeer (current planning process), Grevelingen (exploratory) and Oosterschelde (allocated).

As an answer to climate change, adaptive Delta Management is still not generally accepted on the regional level and is therefore not articulated in policy documents. It is also evident that due to the

[1] De Delta in Zicht [Delta in Sight], an integral vision of the Delta Waters, Province of Zeeland 2003
[2] Veilig Veerkrachtig Vitaal [Safe, Resilient, Vital], Implementation Programme South-West Netherlands Delta 2010-2015+, Steering Committee South-West Netherlands Delta, 2011

national focus of the Delta Programme on water safety and the fresh water supply, the integral approach (Safe, Resilient, Vital) is curbed.

Knowledge for Climate contribution

The objective of Knowledge for Climate is to make a contribution towards regional adaptation strategies, and therefore also in the South West Netherlands Delta. During the KfC Programme and the development of the NDP ZWD a more intense look is taken at the complementarity of the two programmes. Collaboration and the integration of results is pursued in several, different ways. Agreements have been reached in this respect between the Delta Commissioner and the Board of KfC.

Knowledge for Climate does not strive to develop a separate regional adaptation strategy, but to contribute to the development of strategy in the South West Netherlands Delta Programme and strategy development among stakeholders. This is done by

a. bringing researchers into action with regard to the work carried out by the NDP ZWD;
b. updating knowledge on the availability of fresh water in the South West Netherlands Delta and making that knowledge accessible;
c. fundamental and practical scientific research into the effects of internal salinisation and measures to increase self-sufficiency in water availability;
d. supporting entrepreneurs by providing them with scientific knowledge about climate change to assist them in adapting their business plans;
e. valorisation of knowledge on fresh water management by product development for self-sufficiency.

KfC supports the NDP ZWD and even gives concrete support to trade and industry in developing climate adaptive business plans (such as the Water Optimisation Plans) and products.

Transdisciplinary approach

In the research programme Knowledge for Climate the connection between science and policy is a specific subject of attention and development. Bridging the existing gap between science and policy with dilemmas regarding the independency of scientific research and the procedural integrity of the policy cycle. In the initial stage of the hotspot, the approach according to 'mode 2' [3] was discussed. Mode 2 research involves multidisciplinary teams brought together for short periods of time to work on specific problems in the real world; mode 1 is academic, investigator-initiated and discipline-based knowledge production[4]. In the hotspot participation of the private sector in research projects is seen as a result of this discussion. The label 'mode 1' is not frequently used today. Allied approaches are indicated as being 'multidisciplinary', 'transdisciplinary' and especially 'action research'. The terms are less important than the reasoning: scientific production is not only an activity performed by observers who are remote from the practical situation. Scientific knowledge also arises in multidisciplinary teams in which people

[3] Gibbons, Michael; Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, & Martin Trow (1994). The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage
[4] http://en.wikipedia.org/wiki/Mode_2

involved in either policy or practice also participate, and scientific knowledge evolves where the practice is intervened.
Collaboration between KfC and the Delta Programme is interesting to reveal in which situations effective development of new policy is combined with the yield of new scientific knowledge.
The studies conducted within KfC will be finished in 2014. What effects the transdisciplinary practice-based approach of scientific research has had on policy (the administrative line) and the business community (private players) will then be known.
The transdisciplinary approach taken by the ZWD Hotspot (self evaluation) can be summarized in a SWOT matrix.

Strength	**Weakness**
- KfC and NDP ZWD use roughly the same definition for the term 'knowledge'. - KfC is represented in NDP ZWD by means of theme 7 (action-based research) HSZD01 (Fresh water supply / Dealing with uncertainties) and Workshop (hot spot coordinator) - Entrepreneurs and climate scientists work on adaptive business plans (Water Optimisation Plans WOP and HSZD03)	- It takes much time to create a basis for a transdisciplinary approach among the participants - A learning path (time) is needed, and the policy process (Delta Programme) progresses fast - The themes in the 2nd tranche are structured to gain more in-depth knowledge about the themes and disciplines; transdisciplinarity must therefore be organized informally between the themes. Success depends on individuals with good intentions wanting to look further than their own theme.
Opportunities	**Threats**
- The knowledge institutes in 'the line' (DLO, Deltares) work together in KfC; KfC is the platform that breaks through the sectoral research programming. - In 2010/2011 knowledge was developed in KfC which will be needed in 2012/2013 in the Delta Programme (e.g. assessment systematics). - Involvement of Hogeschool Zeeland in fresh water research and in the project 'Climate as an opportunity for entrepreneurs'. - Collaboration between themes 2 and 7 can be strengthened - Policy development and knowledge development can be better integrated.	1. The science policy interface within ministries (EL&I, I&M) is sectorally organized and important for these sectors. Transdisciplinary knowledge can be regarded as a threat. 2. Transdisciplinarity is difficult to explain in administrative and publicity terms.

The Final Report of KfC, Hotspot South West Netherlands Delta, will be published in 2014 by the governments that coordinate the research programme and are involved with the NDP ZWD. In order to develop a regional scientific and practice-based research agenda the results of the studies and input from trade and industry concerning their needs will be used. This will be the guiding principle for further research and regional co-financing. This final report will be presented to the scientific institutes and universities of professional education that have the South West Netherlands Delta as a field of research.

4 Research carried out by the Hotspot South West Netherlands Delta

Organisation and coordination

As a staff member of the Province of Zeeland, the hotspot coordinator will coordinate this research. During stakeholder meetings[5], held in the initial stage, the choice was made not to set up a separate organisational structure for the hotspot and to take a transdisciplinary, practice-based approach of scientific research. Use was made of existing structures, such as the Knowledge Network Delta Water and the National Delta Programme South West Netherlands Delta to generate and select research questions. In a few cases, employees of the organisations involved attended meetings as a hotspot team. One example in this respect was a workshop on regional adaptation strategies in preparation of tranche 3.

The hotspot guides and implements research questions through the steering committees of KfC research themes. At the request of the hotspot coordinator, employees of provincial authorities or water boards in the South West Netherlands Delta were members of the steering committees of Theme 1 Climate Proof Flood Risk Management, Theme 2 Climate Proof Fresh Water Supply and Theme 7 Governance of Adaptation; these persons were also involved in the Delta Programme South West Netherlands Delta. The research questions were validated by comparison with current policy, by means of scientific verification within the framework of KfC, and by procuring co-financing from regional stakeholders. The results of hotspot guidance are laid down in annexes to the subsidy agreements in which the research questions, cases, direction, collaboration and communication in the region are described.

Contact between KfC researchers from the Hotspot South West Netherlands Delta and NDP ZWD occurs via the Implementation Programme, in the South West Netherlands Delta Workshop and through contact with the Long term team of the NDP ZWD. Researchers explained their research at the South West Netherlands Delta Workshop and the feedback and contacts were used to accentuate their research questions and establish contact with the stakeholders.

Researchers regularly elucidate their (interim) results at meetings and take part in meetings to discuss the progress of the Delta Programme South West Netherlands Delta.

Members of the hotspot team have occasionally mediated in obtaining access to organisations in the hotspot and advised on the organisations to be involved.

Occasionally, members of the hotspot team attend stakeholder meetings or researcher workshops.

The hotspot coordinator can also be involved in approaching reviewers for research reports and advising on actions to be taken in response to reviews. In general, the role of the hotspot could be typified as that of a knowledge broker.

[5] Province of Zeeland, Rijkswaterstaat, Water Board Zeeuwse Eilanden, Water Board Zeeuwsch Vlaanderen, Delta multi-utility company, Grontmij consultancy, Zuidelijke Land- en Tuinbouworganisatie, Recron, Zeeuws Landschap, Zeeuwse Milieufederatie, Wageningen University and Research Centre (Alterra, IMARES, PRI), NIOO/CEME, Hogeschool Zeeland, Deltares, Utrecht University, Knowledge Netwerk Delta Water.

Research projects

Developing scientific and applied knowledge within Knowledge for Climate is done in three tranches. The first tranche is reserved for addressing the first urgent knowledge questions and foresight studies from the hotspots. The second tranche concerns giving more depth to long term studies on a number of themes that are important for climate adaptation. The third tranche focuses on regional adaptation strategies.

The following foresight studies were assigned within Hotspot South West Netherlands Delta:

- MSZD01: A foresight study into the fresh water supply in the South West Netherlands Delta (Acacia Water BV)
- HSZD01: Negotiating uncertainties: defining climate-proofing and assessing associated uncertainties in the South West Delta region of the Netherlands (WUR/Alterra)
- HSZD02: Climate change effects on restoration of estuarine dynamics within the Delta region (IMARES)
- HSZD03: Climate change as an opportunity for entrepreneurs (HZ University of Applied Sciences)

The most important research areas that resulted from these foresight studies are:

1. Availability of Fresh Water Supply (theme 2)
2. Governance (theme 7)
3. Opportunities for entrepreneurs
4. Estuarine dynamics

These subjects are central in the second tranche. An overview of the relevant work packages and associated cases within the various themes is presented in Appendix 2. In the third tranche, the choice was to focus on the further detailing of opportunities for the regional economy by handling the availability of fresh water in a different way.

In the following sections the main knowledge questions and research projects are defined per field of research. Chapter 4 sets out the (interim) results. Appendix 5 gives detailed descriptions of all projects and case studies from the three tranches.

4.1 Availability of Fresh Water

The first question related to the state of affairs of research into the supply of and demand for fresh water in the South West Netherlands Delta. This question was relevant to the National Delta Programme South West Netherlands Delta (NDP ZWD). The hotspot convened a meeting for the policy advisors of NDP ZWD, the collaborating governments and the researchers of all relevant knowledge institutes, after which the knowledge institutes joined forces to carry out a study (1st tranche MSZD01).

A great deal of research had already been conducted into internal salinization by Deltares; among other things at the assignment of the Province of Zeeland. In the 2nd tranche this research was continued and supplemented in KfC theme 2 Fresh Water Supply. The Province of Zeeland and the other parties in the

Delta Programme South West Netherlands Delta felt it important to further refine the development of models on the interaction between fresh water and saline water in different bed layers. Subsequently the accent in the Delta Programme would be placed on measures. To find out which measures are either more or less effective, research into this effectiveness commenced. This was particularly so in the following Work Packages and Cases:
WP 2.1 Modelling salinization research;
WP 2.2 Measures to deal with salinization;
WP 4.1 Fresh water storage in creek ridge basin;
WP 4.2 Optimisation of self-sufficiency in the utilisation of water in pomology at parcel level and company level (Water Optimisation Plans, WOPs);
WP 6.3 (case) Operational water system management in Tholen and West-Brabant after the reintroduction of saline water into the Volkerak Zoommeer.

For these research questions the hotspot focused on the link between the knowledge questions of the Delta Programme South West Netherlands Delta, involving trade and industry in the region, the HZ University of Applied Sciences is preparing practical experiments and disseminating knowledge through publications, workshops with policy advisors, guest lectures, etc.

In the 3rd tranche the emphasis is on the further detailing of practical examples and valorising the fresh water measures (still being) studied in the 2nd tranche; the scientific content is focused on this. No research was carried out in the 3rd tranche for other themes, and the focus is now entirely on fresh water availability.

The goal of project HSZD3.2 “Towards implementation of promising measures for local fresh water supply and salinity control in the South Western Delta” is to study the extent to which local measures are able to increase the availability of fresh water for agricultural use in the South West Netherlands Delta. This project focuses on two hydrological showcases/measures in areas that will probably be more quickly subjected to pressure by climate change: 1. increase the fresh water stock in creek ridges and 2. robust rain water lenses in saline seepage areas. The project also looks into the possibility of up-scaling the solutions; in addition to hydrological feasibility, studies are also carried out into the economic feasibility. Stakeholders are also closely involved with the project in order to be able to test the innovation immediately in and with the practical situation. Innovative solutions are presented for the current and future shortage of fresh water by means of this research; it also contributes to the economic progress in agricultural areas and anticipating local and regional policy questions. Deltares (leader), Alterra, KWR, Acacia and Hogeschool Zeeland collaborate in this project.

4.2 Governance

With regard to decisions taken by governments, the administrators must deal with numerous actors with contradicting interests, with factors of which the effects are uncertain, and with a broad package of potential adaptation measures of which the effects are often still unclear. Through research and expert

advice an attempt is made to reveal the actual relation between interventions and their effects. Major or minor uncertainties always play a role in this respect. The uncertainties are often shown to be more significant by stakeholders than they actually are. How administrators deal with these uncertainties has an influence on creating support and on the ultimate decisions. Dealing with uncertainties was looked into in the 1st tranche project "Negotiating uncertainties: defining climate-proofing and assessing associated uncertainties in the South West Delta region of the Netherlands " (HSZD01).

The process that yields measures that will adapt an area to climate change is no simple matter. In addition to technical considerations the wishes of residents and users also play a major role. Governments are responsible for taking all considerations into account and making decisions that to a large extent will determine the future. The Hotspot South West Netherlands Delta attaches great value to this process, to understand it and to develop effective forms of collaboration and decision strategies. In this respect the emphasis is on those issues that play a role in the Delta Programme South West Netherlands Delta and the connection with the theme of fresh water availability in the programme.

In the 2nd tranche this research is included in the following Work Packages of KfC theme 7 (Governance):
WP 2.4 Multilevel governance;
WP 3.1 Dividing the responsibilities between government parties and market parties and citizens when implementing climate adaptation measures, including water storage as studied in theme 2;
WP 3.2 Regulating and pricing water services such as storage.

When developing these research questions the hotspots focused on the link between the knowledge questions of the Delta Programme South West Netherlands Delta and the water boards, involving trade and industry in the region, preparing practical experiments and disseminating knowledge through publications, workshops with policy advisors, guest lectures, etc.

4.3 Opportunities for entrepreneurs

A study is included in the 1st tranche in which the HZ University of Applied Sciences is the lead partner (HSZD03). The research question is: "How do farmers and entrepreneurs in the tourist and recreation industries in rural areas experience climate change, and how can regional and rural knowledge be used to give shape and form to action perspectives on different time scales, and to regional and industrial sector-linked adaptation strategies.

When developing this research question the hotspot aimed at the lead partnership of HZ University of Applied Sciences. The task of the universities of applied sciences in the Netherlands – in association with universities and knowledge institutes – is to form a bridge between scientific research and application in small and medium-sized enterprises. This is the only research in Knowledge for Climate for which a university of applied sciences is the lead partner.

The importance of opportunities for entrepreneurs was also the determining factor of the research in theme 2 Fresh Water Supply for directing in the hotspot. This resulted in entrepreneurs in the agricultural sector, their organised interest group and suppliers being closely involved in the organisation and implementation of the research.

4.4 Estuarine dynamics

In the first tranche the knowledge question was into the effects of intervening in the main water system on the habitats for any current and new species, especially for invasive species that could pose a threat to the biodiversity in the Delta waters.
The "Climate change effects on restoration of estuarine dynamics within the Delta region" project (HSZD02) was carried out in order to contribute towards the development of research methods for this question. This project looked into whether inputting climate change data into a flow model (Deltares) and a habitat model (IMARES) will lead to the possibility of making reliable forecasts on these effects.

In the second tranche a small case within theme 1 Water Safety was used to participate in the study into the effects of supplementary sand. An 'erosion bank' (a small version of a 'sand motor') was built in front of the coast of West Zeeland Flanders in 2009. The effects of sand build-up on the beach, dunes and fore shore were examined, as well as the effect of dune plants on sand entrapment and the perception of the population.
The research is included in the 2nd tranche in the following Work Packages in theme 1 Water Safety:
WP 2.1 Dune model for suppletion strategies.
WP 2.2 Dune development. Measurement of sand height as an effect of erosion bank (sand suppletion).

When developing this research question the hotspot steered in the direction of the desirability to gather impact information on the Water Board's innovative intervention to dump part of the sand concentrated in front of the coast in the Weak Links project. Monitoring was out of the question in this project. The erosion bank was part of the provincial policy as a pilot project and a display window for innovative delta technology.

A meeting of experts was organised (HSZD3.1) on sedimentation in the third tranche. This joint 'knowledge day' of KfC and the Delta Programmes Wadden Sea, Coast and South West Netherlands Delta, was organised on 6 June 2012 to give the initial impetus to formulating new research themes on morphological processes in the Netherlands Delta.

Research bureau staff, university and Delta Programme staff and several government and non-governmental organisations involved in this subject attended this meeting to share the available knowledge with each other, develop it further and make it available for policy. The main aspect was the principle that a safe, climate-proof and ecologically healthy Rhine-Schelde-Meuse Delta and Wadden

area is only achievable if the existing problems of the shortage and inappropriately allocation of the sediment have been resolved. The key questions set out below were formulated for the meeting:

- do we know what the guiding physical, chemical and biotic processes and preconditions are?
- how can we influence those processes and preconditions? for instance by stimulating: a) natural sedimentation, b) semi-natural sedimentation (suppletion for instance) and/or c) artificial sedimentation (raising the level).

These questions were approached in three different ways:

1. time and space scale; from large scale (Coast – Wadden – SW Delta; years – decades) to small scale (channels, shallows, mud flats; months – years);
2. type of sediment; from course (sand) to fine (mud);
3. type of measure; from completely natural (feed duct, transport and settlement by means of natural processes) through semi-natural (fed by means of suppletion, transport and settlement by means of natural processes) to completely artificial (raising the sediment level).

This meeting resulted in a knowledge agenda containing sub-questions that need to be looked into in order to be able to answer the key questions. Answers and solutions to a number of the sub-questions were already formulated by the experts present. For instance, the chance of creating favourable conditions to form a natural salt marsh (raising the ground level by accretion and vegetation growth) in the existing Oosterschelde or in a future Grevelingenmeer (with reduced tidal flow) is thought to be low. A sufficient supply of mud and adequate tidal movements are essential conditions to do this and neither can be guaranteed.

5 Results

The results of the various studies carried out within the Hotspot South West Netherlands Delta and the case studies that were set up and are now being implemented are described per theme in the following paragraphs.
The connection between the knowledge questions listed in the Delta Programme and the research carried out within Knowledge for Climate is dealt with in a separate section.

5.1 Fresh Water Availability

MSZD01: (1st tranche) *Foresight study into the fresh water supply in South West Netherlands Delta*
An overview of the joint knowledge concerning the supply of and demand for fresh water in the South West Netherlands Delta was made. There is a strikingly wide diversity between the various islands. The characteristics of the current situation (including problems), the impacts of climate change and potential solutions have been described. There is a great deal of inefficiency in flushing out watercourses with fresh water in order to control internal salinisation in specific cases: because the inlet of fresh water is also carried out to let out brackish water, the water let in soon becomes brackish after the inlet point. Only a small percentage of the fresh water that has been let in is used for sprinkling purposes.

Theme 2 WP 2.1 *Adaptation to drought and salinization in a combined ground and surface water system*
This project focuses on analysing the integrated ground and surface water system at both a regional level and the scale level of the capillary fringe. The goal here is to look into whether this system will be adequately climate proof in the future. Also investigated is how the regional water system can be made more efficient and sustainable so that sufficient water of a good quality continues to be available under future preconditions. Monitoring campaigns are being carried out in two cases in a low-lying area of the Netherlands (Haarlemmermeerpolder and Schermer) and analysis frameworks are being built up to analyse the effects of control measure strategies on the availability of fresh water.

Theme 2 WP 2.2 *Research into rainwater lenses in coastal areas on various levels of scale*
One promising measure to make thin rain water lenses thicker (and consequently control salinisation) is level-controlled drainage that makes a dynamic drainage base possible and thereby store water longer in the soil. Conversely, storing superfluous rain water in rainwater lenses in creek ridges during the winter months is a potential measure, because in many cases the unsaturated zone below creek ridges is large, so that an increase in the level of groundwater is not associated with water damage. This will be tested in a showcase in project HSZD3.2 (KfC Tranche 3). The intention of this pilot project is to prevent drain stoppage by using horizontal inlet drains positioned close to the groundwater level. If this measure is successful, it is quite conceivable that old regulations – based on extraction without infiltration – must be amended.

For updates of projects 2.1 and 2.1:
http://publicwiki.deltares.nl/display/kvk2/KvK+Thema+2+-+Climate-proof+Fresh+Water+Supply

Theme 2 WP 4.1 *Fresh water storage in creek ridge: The Freshmaker*
After it appeared in 2010 that the large creek ridge basin (Evides initiative) was not feasible, this work package moved in the direction of a smaller scale pilot on storing fresh water underground. The KWR Water Research Cycle Institute's SBIR initiative 'Freshmaker[6], in which the Southern Agriculture and Horticulture Organisation (ZLTO) and contractor Meeuwse Goes BV collaborated was already under way. The following was achieved by continuing this work within KfC:

- Working out the configuration, preconditions and potential performance of the Freshmaker by using the groundwater, flow and transport model (SEAWAT);
- Realising the opportunity maps for the South Beveland region on the basis of preconditions and regional information on the geology, groundwater and surface water quality and data on the water demand from the Water Optimisation Plans;
- Selecting and further investigating parcels of land for testing, followed by further local geological and water quality investigations by means of geophysics, drilling and water level columns on one of the parcels that will be made available for this purpose by the owner (Rijk-Boonma, Ovezande).

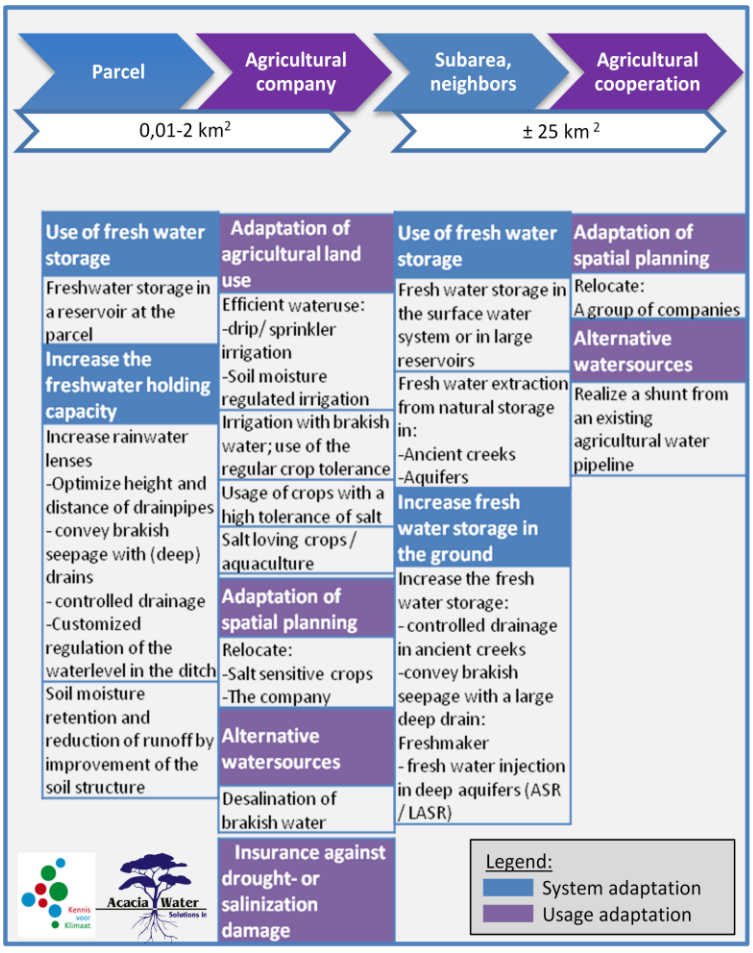
A testing station will need to be installed in the autumn of 2012, after which injection can take place in the winter months. That water will then be extracted in the summer of 2013. The entire testing procedure will be monitored and interpreted/optimised (also part of the third tranche KfC research) in this work package (WP 4.1 – Koen Zuurbier).

Theme 2 WP 4.2 *Optimising self-sufficiency in water use in the fruit growing sector at parcel level and operational level (Water Optimisation Plan (WOP*)).
A Water Optimisation Plan (WOP) was developed in the project for a sustainable water supply for fruit growers. The WOP was implemented on 37 fruit growing farms by advisors of the Southern Agriculture and Horticulture Organisation (ZLTO) in which the current water supply was brought into view, and one or several alternative options regarding the technical and financial possibilities were assessed. The measures investigated in the WOP are the efficient utilisation of water and minerals, optimisation of drainage, collection and storage, and the utilisation of drinking water or agricultural water pipes.

[6] Freshmaker background: An experiment carried out in the 1970s with vertical infiltration drains resulted in drain stoppages and there was no recovery benefit (that part of the fresh water that can be recovered). In the current pilot project the hope is to prevent this from happening by making use of horizontal drains: A shallow drain (approx. 7 m below ground level) will inject/extract fresh water, while the deeper drains (20 m below ground level) only catch brackish water. By means of infiltration the fresh water lenses become thicker giving rise to the opportunity to extract (more) irrigation water during dry periods. It is quite conceivable that old regulations – based on extraction without infiltration – must be amended.

Theme 2 WP 6.3 (case) *Operational water system management in Tholen and West-Brabant after allowing the Volkerak Zoommeer to become saline again*.
The South West Netherlands Delta is the area with the highest salt concentrations in Dutch ditches. Nevertheless, agriculture is still practised on a large scale here. This is possible because of what are called 'fresh water islands in saline waters'. Part of the area has access to an external supply of fresh water, while another part depends totally on the naturally present internal fresh water in the form of fresh water lenses found on top of the deeper saline waterbodies in the ground.

Small scale adaptation at an operational level is focused on in the approach taken in the case South West Netherlands Delta to cope with the changes in the supply of and demand for fresh water. This case is used to find out which measures can be taken to promote self-sufficiency. The western islands serve as an example for circumstances in which an external supply is not necessary and use is made of the present fresh water lenses. Optimising the drainage in these regions could prevent the disappearance of fresh water lenses and can bring down the amount needed for sprinkling in other areas. Highly profitable crops need a good quality water supply that can be optimised by means of extra storage, the utilisation of underground storage and/or a more efficient use of water (see the foregoing section Theme 2 WP 4.2 on the Water Optimisation Plans). This case shows how the interaction between the system, the user and the administrator is the determinative factor for the set of measures chosen.



5.2 Governance

Theme 7 WP 2.4 *Multilevel governance of climate adaptation*

Two lines of research have been launched. The first line is a study into multi-level governance in the South West Netherlands Delta Programme and the projects in the South West Netherlands Delta (including Volkerak-Zoommeer). This study is looking into how programme management can be shaped in such a way that it contributes to the programme's goals and the objectives of the governments and NGOs concerned. The results of this study will be directly incorporated in the South West Netherlands Delta Programme through the active participation of the researcher in the South West Netherlands Delta programme office. The second line is a participative action study that was started in August 2011 concerning the Delta Decision Rhine-Meuse Delta. This study is examining how the sub-programmes South West Netherlands Delta, Rivers, Rijnmond-Drechtsteden and the National Delta Programme are working together on the delta decision, and how this complex multi-level collaboration can be best shaped. This will be given shape in action research, in which the researcher actively helps to think about shaping the collaboration concerning the Delta Decision Rhine-Meuse Delta.

Theme 7 WP 3.1 *Governance arrangements for responsibilities public/private*

During 2011 it became clear that the case study on salinization of the Volkerak Zoommeer and the issue of alternative fresh water supply for agricultural use are no longer relevant to this hotspot. This is because the decision about salinization of the Volkerak Zoommeer was (temporary) postponed by the current government. In October, an interview with Koos Beurskens took place regarding a brainstorm about two possible alternative case studies. The first is on the regional water system "Beek & Kreekherstel" (restoration of river and creek) in North West Brabant (a regional project), in which improvement of fresh water supply is the central theme, and multi-functionality plays an important role. The second case idea is about a problem analysis for responsibilities in the water distribution issue in the South West Delta. Considerable differences appear to be present in the service levels on fresh water supply of the various water boards, and there is no legal framework (yet). This case idea is consistent with the sub-program Freshwater of the Delta Programme. It has been agreed that Heleen Mees (PhD student Theme 7) will explore these alternatives, and will come back to that in the autumn of 2012. It was also agreed that the research for this hotspot will be carried out in 2013 in stead of 2012.

Theme 7 WP *Water storage as a 'climate service' provided to society by the (agricultural) entrepreneur and the regulation and pricing of the distribution of water during times of water shortage.*

The focus in this sub-project is on the implementation and performance of specific instruments to realise climate services such as water storage and nature conservancy. Two mechanisms this project will chiefly focus on are auctions and smart subsidies. The performance of auction is being investigated with the aid of an economic experiment, Learning in Repeated, Multi-unit, Procurement Auctions versus the Endowment Effect: an Experimental Study (Dijk et al., 2012a). In another article entitled 'Can informational rents ever be avoided? Optimal conservation programmes when farmers' preferences are heterogeneous' (Dijk et al., 2012b) the efficiency of self-selecting subsidies; an options menu of smart subsidies' constructed in such a way that government is able to realise as many possible climate services

on a limited budget. Both methods are explained and the potential improvements in efficiency in the Netherlands are discussed in the ESB article “De economische efficiëntie van natuurbeheer” [The economic efficiency of nature conservation] (Van Soest and Dijk, 2011).
Furthermore, why land procurement is constantly becoming more expensive over the years will also be looked into in this sub-project. This study was inspired by the problems surrounding the project ‘Eco-friendly river banks’ (NVO) in the South West Netherlands Delta (but is also of direct relevance for instance for the problems surrounding the Ecological Main Structure; see also Van Soest 2011). The yet to be published article ‘Policy instruments for promoting adaptation to climate change: A framework for assessing public, private and interactive instruments and mixes’ (Mees et al., 2012 contains an NVO case in which various instruments are assessed on the basis of their score in terms of economic, legal and policy scientific criteria. Justin Dijk is also involved with the case ‘Retain water at source’ in North Brabant. Together with the stakeholders, the blueprint for a hypothetical and/or non-hypothetical auction experiment is being elaborated in association with members of the Southern Agriculture and Horticulture Organisation (ZLTO). Contact has also been established with Koen Zuurbier (KfC Theme 2 Fresh Water Availability, WP 4.1.) The consortium (KWR, Deltares and Acacia) plans to take up a number of pilot projects in tranche 3 of KfC in which the emphasis will be on storing extra water in the soil. Whether WP3.2 can give support with regard to specific questions concerning the financial aspects and other economic issues will be looked into.

HSZD03 (1st tranche) *Climate change as an opportunity for entrepreneurs*
The transdisciplinary approach to science production within Hotspot South West Netherlands Delta led to research being set up in the 1st tranche with entrepreneurs in the recreation and agricultural sectors on the positive contribution to their operational opportunities thanks to adaptation to climate change. It is also quite unique that this research was set up by HZ University of Applied Sciences (HZ). Thanks to the teamwork with LEI and PRI (research institutes of Wageningen University & Research Centre) complications in the field of methodology were overcome in the research set-up.
From interviews with entrepreneurs in the agricultural, tourism and recreation sectors it is evident that they have experienced changes in the weather over the past few years. They say that the number of dry periods are definitely increasing and moreover are lasting longer. Rainfall is becoming more intense and more frequent. And recent years have shown a clear alternation of dry and wet periods. All entrepreneurs are experiencing that ‘extreme weather conditions’ are having an impact on their operations, but the extent of that impact differs from one entrepreneur to the next. Generally speaking, cattle farmers are not experiencing difficulties from the extreme weather conditions. For both crop farmers and entrepreneurs in the recreation sector it is important what time of year the extremes occur. Especially the weather in the early season has a considerable effect on the harvest and the number of reservations made for the high season.
Perceptions regarding changing weather conditions and the degree to which entrepreneurs experience extremes as a burden differs per industry. Entrepreneurs in the recreational sector recognise big differences in the weather but still say that the weather conditions in Zeeland Flanders are often better than in the rest of the country. This is especially the case in a wide strip along the coast.
From the interviews we see that entrepreneurs in the region are already constantly adapting their business operations to the weather. They mainly follow their own concrete observations of the weather

conditions and are very critical about the abstract information concerning the anticipated climate change ensuing from scientific research.
Regional characteristics, such as clay soil and the relatively favourable climate in the coastal zone imply for this region that climate change will not only bring about problems but opportunities as well. The entrepreneurs indicated that collaboration with other actors is essential in the case of major adaptations. On the basis of the inventory of measures, HZ and Wageningen University and Research Centre are to look further into whether and how other professional actors can offer support to entrepreneurs in the agricultural and recreation & tourism sectors. And also which of the measures could be the most successful in relation to preventing loss of income and making use of business opportunities for the companies.

5.3 Estuarine dynamics

Theme 1 WP 2.1 *Aeolian transport and coastal dune formation under climate change; a model study*
The variability in coastal dune development and the connection with beach width was looked into in the main study. Specific attention was given to the effect of the creation of an artificial dune near the coast at Nieuwvliet-Groede. Subsequently, work was undertaken in WP 2.1 on an integrated dune vegetation model for the medium short term forecasts. Furthermore, knowledge of and models for dune development at Deltares and Wageningen University and Research Centre were mapped out in more depth and will be integrated in a long-range dune model. Both models could be used to plan coastal management, especially for the development of suppletion strategies and also as a tool during coast workshops to provide the stakeholders concerned with an understanding of the potential effects of different scenarios (climate and management) on coastal safety and nature.

Theme 1 WP 2.2 *Management strategies for preservation and improvement of the climate buffer potential of dunes* – Territorial development Nieuwvliet Groede.
Within the context of this study, one Master's student looked at the development of the erosion bank (punt zandsuppletie) and the effect on the adjoining, new dune areas near Nieuwvliet-Groede. In addition to the effect on dune volume, vegetation development was also examined, and a survey (52 respondents) looked at whether the residents of Nieuwvliet and Groede had changed their perception with regard to the aspects of safety and spatial quality after the coastal reinforcement had been completed.

5.4 Knowledge questions Delta Programme South West Netherlands Delta

The Delta Programme South West Netherlands Delta drew up its own knowledge agenda. Some of the questions are in keeping with studies conducted within the framework of Knowledge for Climate. Deltares is often the organisation that carries out this research, sometimes Imares, Alterra or another Wageningen University and Research Centre DLO institute. KfC provides answers to knowledge questions from the Delta Programme by means of producing research reports or through the participation of their researchers in workshops and giving advice. Within the Delta Programme it is often not known that KfC has contributed to providing answers to questions. This is not a problem with regard

to the quality of the answers but does have the consequence that KfC does not always get credit where it is due.
The Delta Programme organises many meetings on its knowledge questions or policy questions. Researchers who have obtained relevant insight within the framework of KfC attend these meetings and thus their knowledge is brought into the Delta Programme. If reference is made to how the knowledge has been acquired, then it is often the names of the institutes that employ the researchers.

The table below shows how the knowledge agenda of the Delta Programme South West Netherlands Delta has developed to date in terms of interaction with knowledge institutes. Where appropriate, the knowledge institutes engage KfC researchers.

	ZWD Knowledge Agenda structure	Interaction with knowledge institutes / the line	Interaction with Knowledge for Climate
Plan of Action (South West Netherlands Delta Programme Office, 2010)	**Themes in combination with MIRT systematics** Safety, Freshwater supply, Ecology, Economy and society. Knowledge questions for these four themes are clustered for: a) scenarios and autonomous development, b) Alternatives (design questions) and c) assessment of alternatives.	Long Range ZWD Team consults Alterra, Deltares and Imares in two meetings. Long-range ZWD Team draws up its own knowledge agenda. The Knowledge Agenda does not really play a role in the research programming of I&M and EL&I (the research programming was fixed earlier).	In 2009 there was a 'Knowledge Agenda' team in which the hotspot coordinator participated. The hotspot's knowledge agenda was attuned to the sub-programme's knowledge agenda.
Problem analysis Problem analysis (Programme office for South West Netherlands Delta & Long-range Forecast Study Team 2011)	**Themes** Ecology Economics Freshwater supply Safety	Alterra and Deltares are represented in the Long-range Team; their task is to keep the knowledge agenda up to date. Knowledge agenda of the sub-programme is used by ELI/DKI (DLO) and I&M/Water services (Deltares) for research programming but it has not yet been standardised.	Project staff member HSZD01 of Alterra was part of the team DP ZWD, the task of which was to keep the knowledge agenda up to date. The knowledge agenda team has not been convened again. KfC Research of Ecology and Fresh water Supply successfully entered on the agenda. For ecology implicitly; for fresh water supply explicitly.
Draw up a statement of affairs on potential strategies	**Tables** Northern part of the SW Delta Southern part of SW Delta Freshwater supply Regional Development	Alterra and Deltares are represented in the Long-range Team; their task is to keep the knowledge agenda up to date. Knowledge agenda of the sub-programme is used by ELI/DKI (DLO) and I&M/Water services (Deltares) for research programming but guiding DLO/Deltares is done separately.	The same as for problem analysis. Governance theme contributes to writing the main text DP2013 (philosophy action-based research). Contribution KfC implicit.

6 End Product Hotspot South West Netherlands Delta

The state of affairs mid-2012 is set out in this Midterm Report. The coming period – up to the end of 2014 – will be used to complete the current research projects. It is in line with the aforementioned transdisciplinary approach to now take a critical look at implementation. The Midterm Assessment should be able to lead to adjustments and, where necessary, to new initiatives. This chapter describes the adjustment initiatives and several initiatives are named that are already in the make.

1. In many of the current studies it appears possible to make a better connection to the Knowledge Agenda of the National Delta Programme South West Netherlands Delta (NDP ZWD). The NDP ZWD will enter into an important phase in 2013: the development of 'potential strategies' via 'promising strategies' to the selection of 'preferred strategies'. It is crucial that knowledge about the possible effects of the selections is used.
   On the other hand it still remains important to stress the angle of approach taken by KvC: it is not only a question of facilitating government policy, but also of valorising knowledge for adaptation practice in companies and societal organisations.

2. In the 2nd tranche – which had a clear thematic approach – it was in several instances difficult to link the scientific research question to a case in the South West Netherlands Delta. The relation between the hotspot coordinator, the hotspot steering committees' representatives and stakeholders in the South West Netherlands Delta must be strengthened in order to find suitable cases. This is an agenda item for the Steering Committee South West Netherlands Delta.

3. The intended relation between Theme 2 Fresh Water Supply and Theme 7 Governance with a view to the South West Netherlands Delta has still not been realised adequately. A good start has been made through the contact established between Koen Zuurbier (T2 WP 4.1) and Justin Dijk (T7 WP 3.2). Reinforcing the contact between these two themes can be realised through planned activities and activities that still have to be identified. Planned activities are:
   - A Knowledge Day organised for businesses by the Knowledge Network Delta Water where an attempt will be made to bring into view new innovations in the economic practices of suppliers to the agricultural sector using the knowledge of Theme 2 Fresh Water Supply.
   - A conference of Theme 7 Governance in preparation of the Midterm Assessment, focusing on preparing adjustments in programme execution.

   An additional example of the importance of the science policy study and a potential subject for further study is supplied by some people who are dealing with Fresh Water Supply policy. They argue that various advisory reports about water demand and availability, as well as the related economic effects of water supply, are based on incorrect basic data and biased assumptions. It appears that restricted funding of these studies, results in rather poor quality reports. The results of such basic advisory reports are nevertheless frequently cited in new advisory reports,

smoothed by the fact that too little money was available to check the quality of the data and the methods used (We used the “best available data…”). So, the poor quality of the basic advisory reports affects the chain of reports on that specific theme and errors can even multiply during this course. As a consequence opinions (or beliefs) of policy makers are distorted, potentially leading to unfounded policy measures. This is of course an undesirable development and might be an interesting subject for a governance study “how to safeguard the quality of advisory reports for policy makers?

4. The Fresh Water Supply pilot projects carried out in the 3rd tranche result in the building of test plots and measuring facilities. It deserves to be recommended that these investments continue to be used after the Knowledge for Climate research programme has been completed. One option to shape this follow-up is to set up a foundation focusing on promoting fresh water research and valorisation in the sea clay area by researchers, trade and industry and water board officers. Appropriate discussions with the stakeholders can achieve that this foundation will increase the cohesion between a large number of studies and pilot projects. Among other things there is a quite clear relation with the Top Sector Delta Technology’s programme ‘Living with salt’. The Board of KfC has commissioned a feasibility study.

5. The South West Netherlands Delta and the surrounding area of Rhine, Meuse and Schelde is characterised by a strong economic dynamism in the field of industry, transport and port activities. At the same time this is a unique and valuable natural area with a high natural dynamism. The natural dynamism has a value in itself but is also of immense importance for fishery, recreation and for the quality of the area in terms of living and working in it. Choices must frequently be made where the natural dynamism and the societal dynamism converge. A sound scientific insight into the processes that determine this dynamism and their interaction is of immense importance for making well-informed choices as to the use of space and making investments in the delta.
   In a sense, the situation in this area is comparable with the situation in the Wadden area. The Wadden Academy fulfils a highly-valued role there in terms of augmenting scientific insight. The Board of KfC has commissioned a feasibility study into setting up a similar institute in the South West Netherlands Delta.

Annex 1 Representatives Hotspot South West Netherland Delta

Coordinator Hotspot South West Netherlands Delta: Nico Landsman, Province of Zeeland

Steering committee Theme 1 - Water safety: Lein Kaland, Province of Zeeland

Steering committee Theme 2 - Freshwater supply: Jan Smits, water board Hollandse Delta

Steering committee Theme 7 - Governance: Koos Beurskens, Province of Noord-Brabant

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Annex 3 Summary of projects and case studies

This Annex is only available in the Dutch version of this Midterm Report (see separate document).