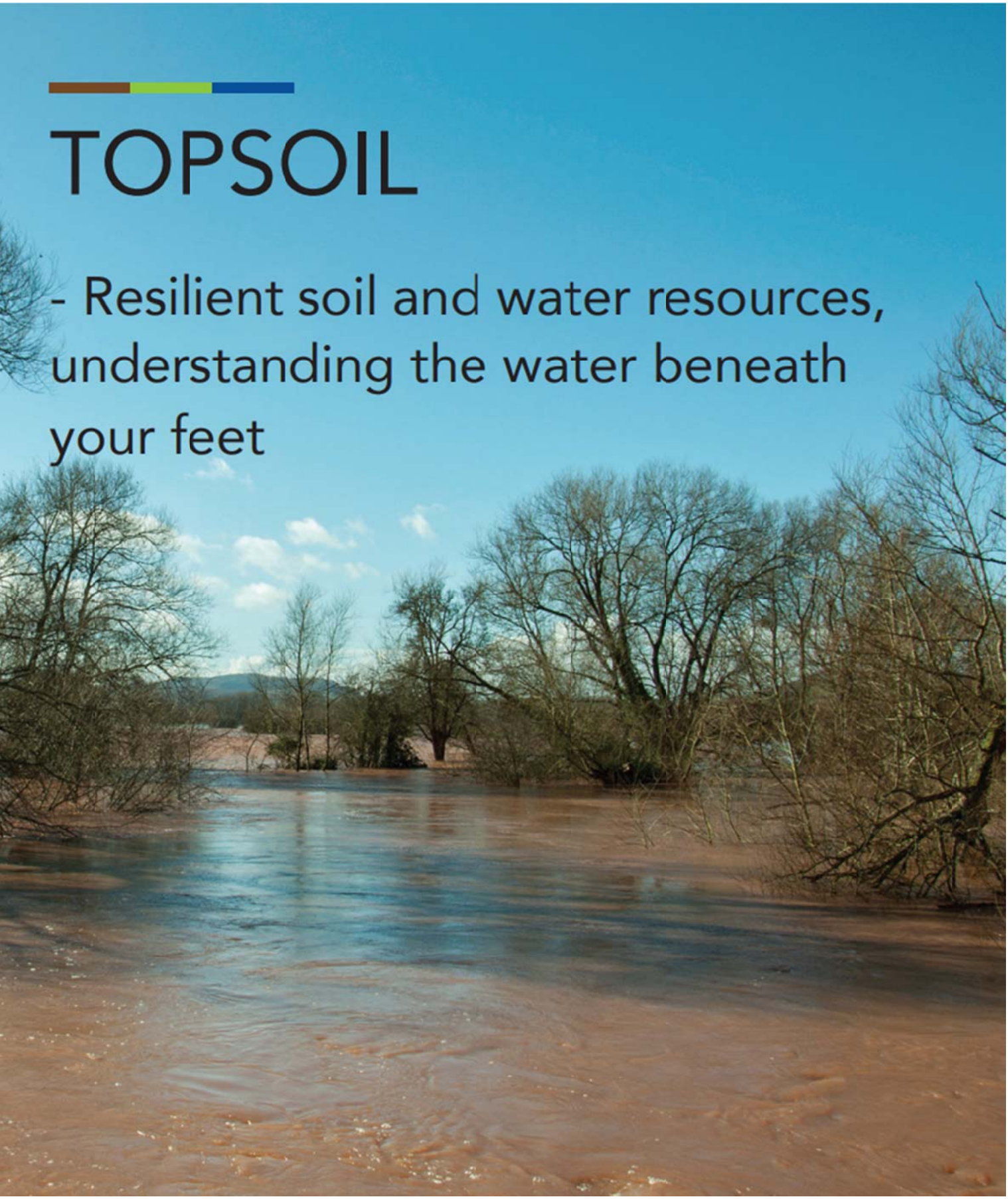
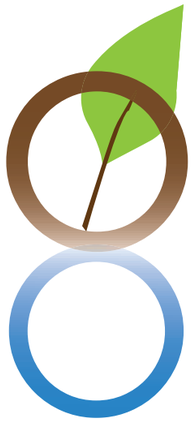

TOPSOIL
- Resilient soil and water resources, understanding the water beneath your feet



TOPSOIL

- Resilient soil and water resources,
understanding the water beneath your feet

Field trip, Zeegster Hoeve, Netherland, August 2016

"In our pilot there is not enough water due to climate change and farmers and nature demand!"

Rinke Van Veen, Project manager, Province of Drenthe

FOREWORD

Climate change affects the hydrological cycle and we now experience more heavy rains and increasing sea levels. The changes in climate also affect the groundwater aquifers – the water beneath our feet.

Across the North Sea in Northern Europe we share different challenges within ground water and climate change. In a 3½ year European project we have identified five shared challenges to be addressed via geological, geophysical and hydrological investigations, stakeholder involvement and changes in management.

The five challenges are addressed in 16 pilot areas, to develop and test solutions for managing uppermost 20-30 m of the subsurface. In this leaflet summaries of all pilots are included. Further an overview of the methods used in the pilots. The work in the different countries will lead to a strong improvement of climate resilience in and across pilot areas.

The Topsoil Project will explore the possibilities of using the topsoil layers to solve current and future water challenges concerning water quantity and quality. It looks beneath the surface of the ground, predicts and finds solutions for climate related threats like flooding during wet periods and droughts during summer seasons.

The overall objective of the Topsoil Project is the joint development of methods to describe and manage the uppermost 30 m of the subsurface, in order to improve the climate resilience and protect the environment of the North Sea Region.

We hope you enjoy the reading.

Sincerely

The TopSoil Partnership

Our five shared challenges are:

1. **Flooding** in towns and agricultural areas due to the rising groundwater table caused by changed precipitation patterns.

2. **Saltwater intrusion** into freshwater reserves due to rising sea levels and changed irrigation, drainage and drinking water demands.

3. The need for a **groundwater buffer** to store water in periods of excess rainfall. The buffer of fresh water can be used for irrigation purposes during dry periods.

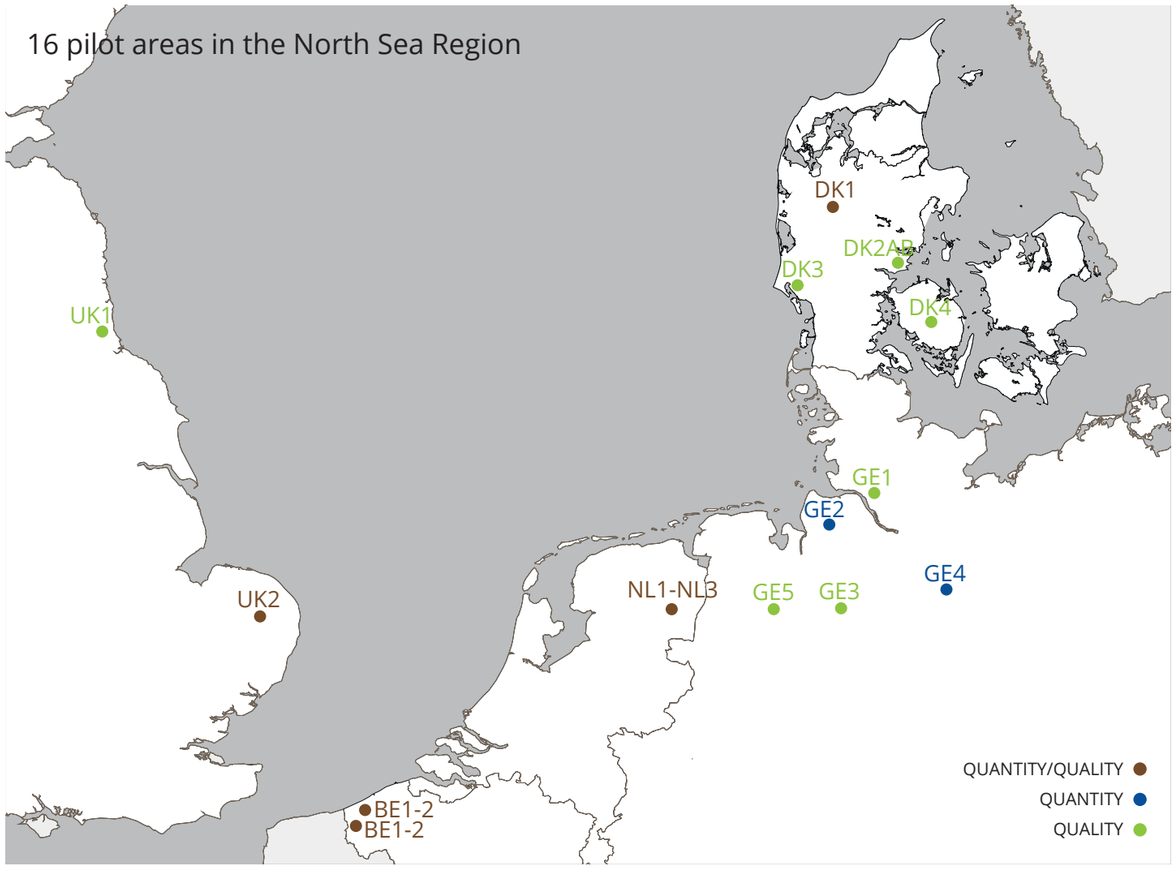
4. Better knowledge and management of **soil conditions**, which will provide better resilience to extreme rainfall events, improve water quality and improve crop yields.

5. The **capacity to break down** nutrients and other environmentally hazardous pollutants in the uppermost layers is yet unexplored. By improving our understanding, better land management can be implemented.

Kick Off, Aarhus, Denmark, March 2016

"Knowledge transfer on groundwater modelling and climate change adaptation among the North Sea countries is a highly relevant task with mutual benefits for the stakeholders"

Torben Sonneborg, Ass. Professor, GEUS



GENERAL INFORMATION:

Duration:
1 December 2015 – 1 February 2020
Budget: 7.4 mio Euros

For work packages and list of all partners
see page 82-83

PILOT PROJECTS

“Testing new geophysical methods in the North Sea area and exchanging knowledge on technical aspects is of great inspiration to our scientific work. Working together with colleagues from different disciplines is challenging. In the end science helps to make better decisions.”

Dr. Helga Wiederhold, Leibniz-Institut für Angewandte Geophysik, (LIAG)

BE 1:

Identifying the salinization of groundwater in the (Western) Flemish coastal area by collecting airborne electromagnetic data

CHALLENGES

Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater

Surface water

- Real data
- Model calculations

Field scale

Catchment scale

Groundwater in the Belgian western coastal plain is saline by origin, making sure fresh, salt and brackish groundwater are found there. This fresh-salt distribution was mapped in the 60s and 70s and published in a so-called 'salinity map'. However, half a century later, there is a clear need for area-wide mapping of the salinization of the area. The freshwater lenses in the area are frequently used as freshwater supplies. By comparing the newly collected data with the existing salinity map, the autonomous evolution of the freshwater-saltwater distribution can provide a reference in considering the effects of climate change and a rising sea level.

The aim of this action is mapping the fresh-salt water distribution. The proposed project consists of groundwater monitoring, data processing and reporting. While originally, the formatting of the original salinity map involved labor-intensive measuring at ground-level, electromagnetic induction monitoring from out of the air can be used today. A probe attached to a small plane or a helicopter transects the area. The measuring probe transmits a magnetic field and induces an electrical current in the subsoil. This electrical current in turn generates a second electromagnetic field which is detected by the probe. The generated data is processed and checked with the results of already performed research, ultimately leading to an image of the salinization of the subsoil.

QUANTITY/QUALITY INDICATOR:

Can help to define baseline for project BE-2.

DELIVERABLES

Salinity map	This map shows the depth of the fresh-saltwater interface for the coastal area.
3D resistivity model	A detailed 3D image of subsoil resistivitytration/run off.

ACTIVITIES

Flight preparation	To be finished – 3 quarter 2017.
Data acquisition	To be finished – 3 quarter 2017.
Data processing	To be finished – 3 quarter 2017.
Validation	To be finished - 3 quarter 2018.
Conclusion and report	To be finished – 4 quarter 2018.

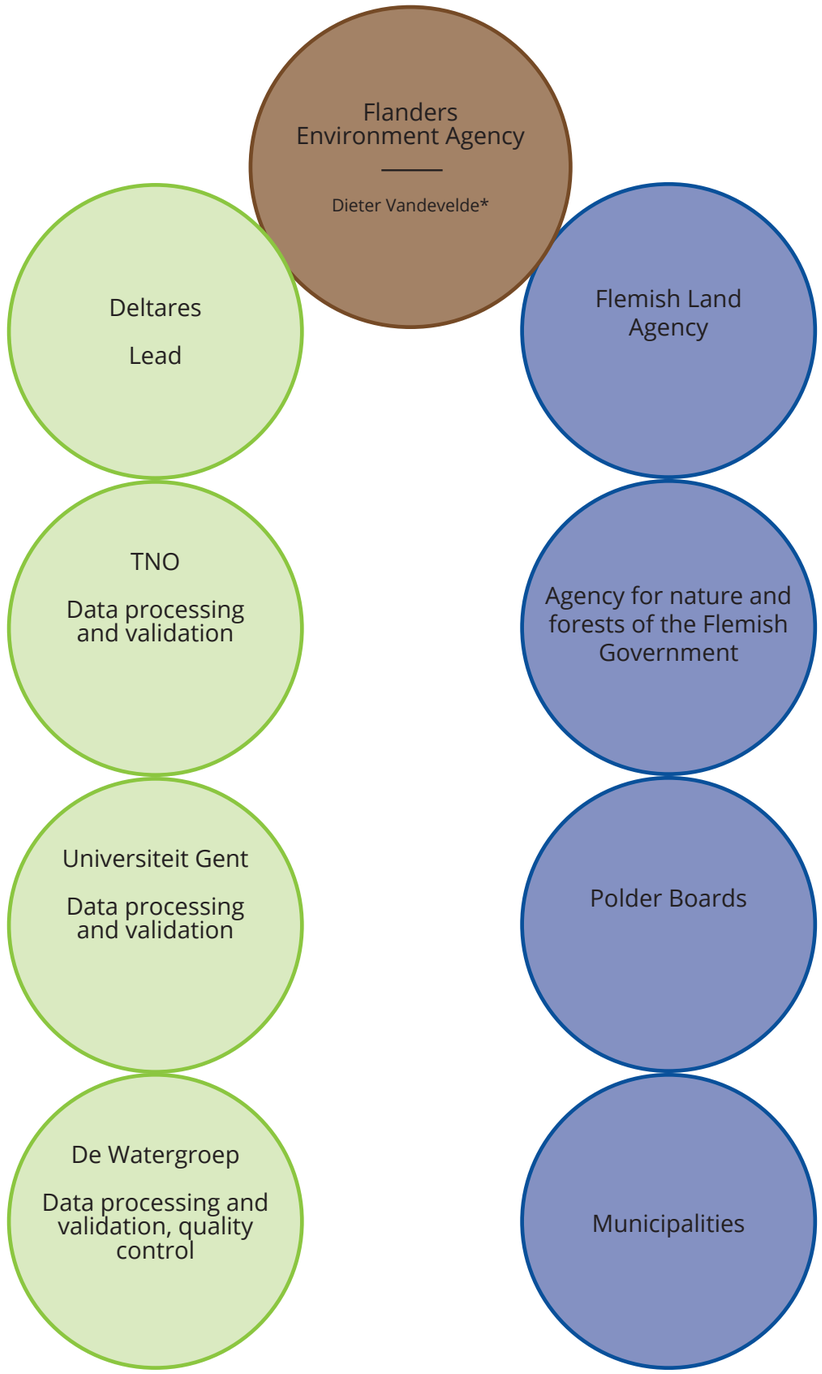
"Working in TOPSOIL gives OOWV the opportunity to get inspired on groundwater management"

Silke Buecker, Leader of innovation network,
Oldenburgisch-Ostfriesische Wasserverband (OOWV)

BE 1:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT BE 2

* di.vandevelde@vmm.be · 0032 (0)22142127

BE 2:

Increasing the availability of freshwater for agriculture by improving local hydro(geo)logical conditions

CHALLENGES

- Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater
  Surface water
- Real data
- Model calculations
- Field scale
- Catchment scale

Farmers in West-Flanders make significant use of groundwater from the Paleocene for their water supply. For years, the level of the Paleocene aquifer is decreasing, compromising the water supply through this layer. In addition, shallow water resources are scarce because of the brackish nature of the top aquifer near the coast, and the shallow occurrence of aquitards (clay layers) deeper inland.

The pilot project aims to look into a number of measures that increase the availability of freshwater for agriculture in the polder area of West-Flanders. The expected impact of this pilot project is highly anticipated in the river basin management plans for Flanders. The pilot project will evaluate the possibilities for freshwater storage and aims to specify what measures can be taken to achieve this. Together with the water users and water managers, it wants to prepare a plan for the realisation of one or more pilot projects that can improve the availability of freshwater.

QUANTITY/QUALITY INDICATOR: Improving availability of freshwater.

DELIVERABLES

Map with potentials	This map shows the potential to increase the freshwater availability.
Overview of measures	Overview of measures to increase the availability of freshwater for agriculture.
Plan for the realisation of pilot(s)	The project aims to prepare a plan for the realization of one or more pilot projects that can improve the availability of freshwater.

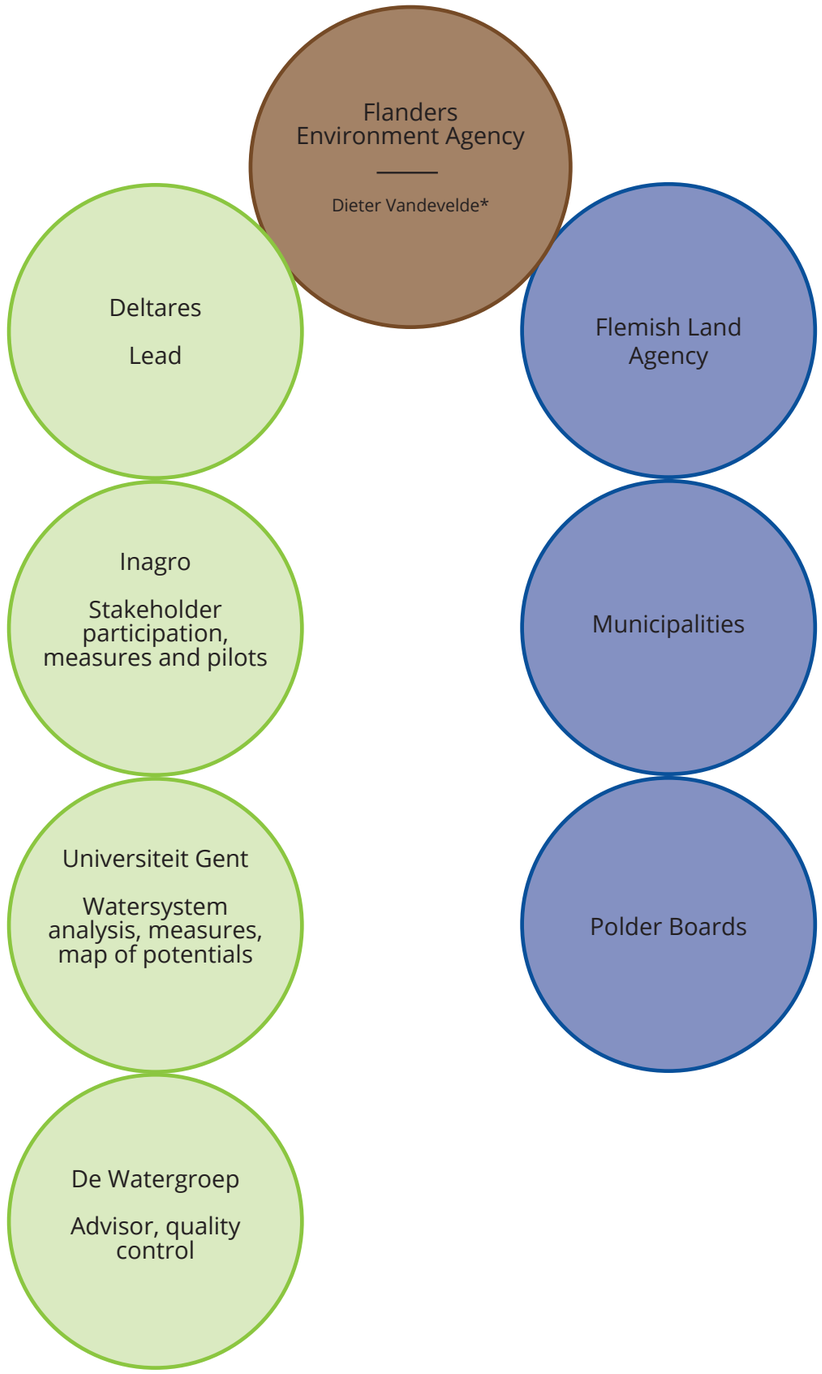
ACTIVITIES

Watersystem analysis	To be finished – 3 quarter 2018.
Stakeholder participation	To be finished – 4 quarter 2018.
Measures and pilots	To be finished – 1 quarter 2019.
Conclusion and report	To be finished – 2 quarter 2019.

BE 2:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



* di.vandevelde@vmm.be · 0032 (0)22142127

NEXT DK 1

DK 1:

High groundwater table in a Danish town - Challenges and opportunities in a climate adaptation perspective

CHALLENGES

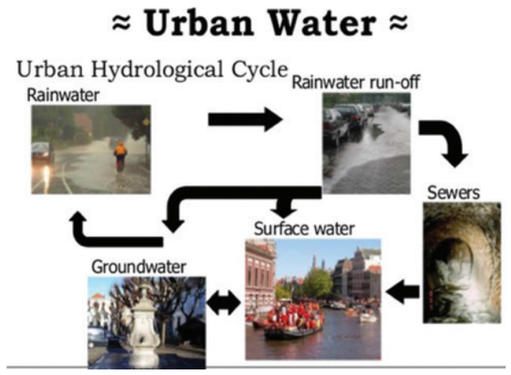
- Flooding
  Saltwater intrusion
- Groundwater buffer
- Soil conditions
- Break down capacity

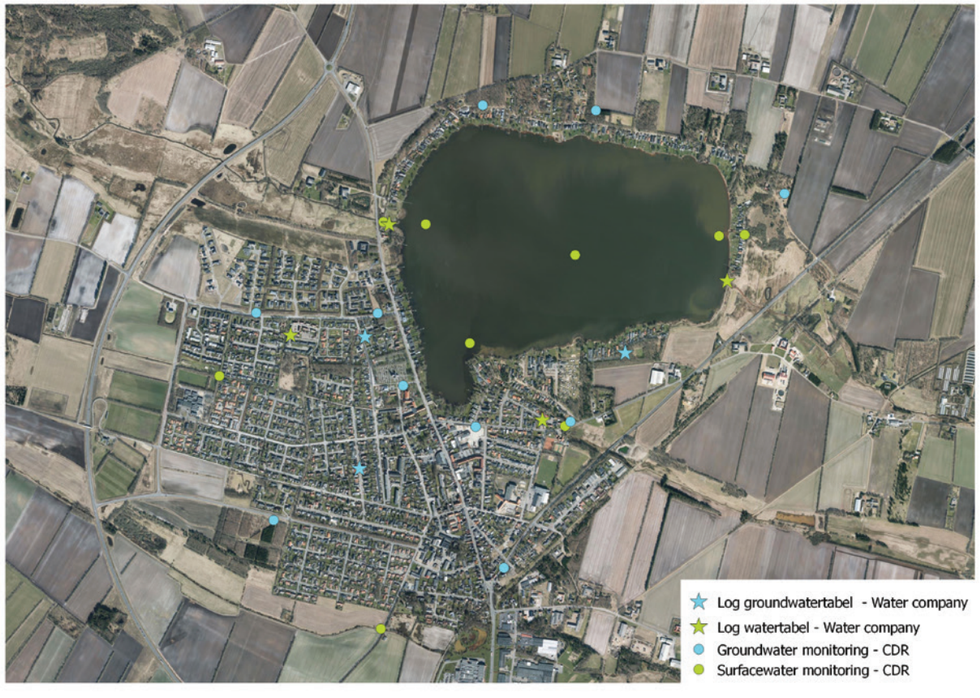
- Groundwater
  Surface water

- Real data
- Model calculations

  Field scale
- Catchment scale

The aim of this pilot is to better understand the challenges connected to a strong control of the groundwater table. The town of Sunds is placed in a flat sandy agricultural area. The groundwater table in the town and the surrounding agricultural area is very close to the surface and reacts very fast to increasing rainfall. Due to renovation of sewage pipes and extra precipitation in future climate the area is likely to be flooded by upcoming groundwater. The quality of the excess water differs. In some areas, the quality is of high standards while in others the quality of the water is poor due to pollutants. Handling the climate adaptation due to groundwater flooding will be investigated by new methods and by introducing knowledge from other partner countries with expertise within this field. If possible pilot interventions will be established, tested and introduced to the relevant stakeholders.





QUANTITY/QUALITY INDICATOR: Not described yet.

DELIVERABLES

Recommendation	Recommendation to choice of solution.
Recommendation	Assessment and recommendation to the use of tTEM as input to groundwatermodelling.

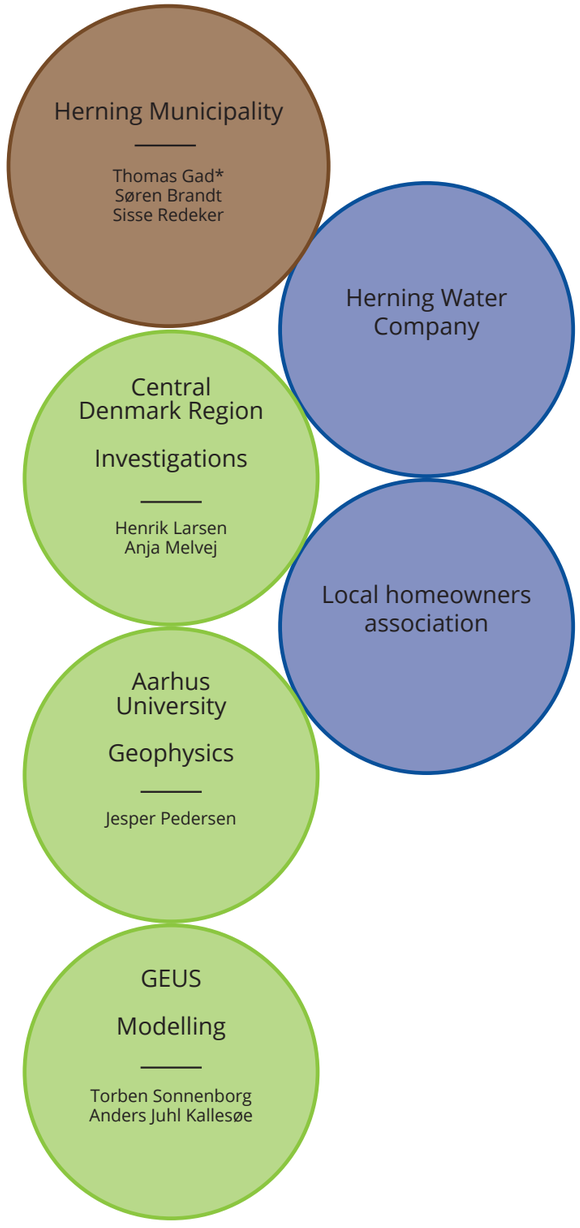
ACTIVITIES

Traditional investigation proposal	To be finished - 2. quarter 2016.
Investigations	To be finished - 4. quarter 2017.
tTEM	Final development spring 2017 - measurements mid 2017.
Groundwater modeling	To be finished - 4. quarter 2017.
Description of excess water	To be finished - 2. quarter 2018.
Solutions and effects	To be finished - 4. quarter 2018.

DK 1:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT DK 2A

*bjgtg@herning · 0045 30667890

DK 2A:

Targeted regulation of fertilizers to obtain sustainable intensification. Investigating the potential for natural break-down of pollutants in the subsurface groundwater

CHALLENGES

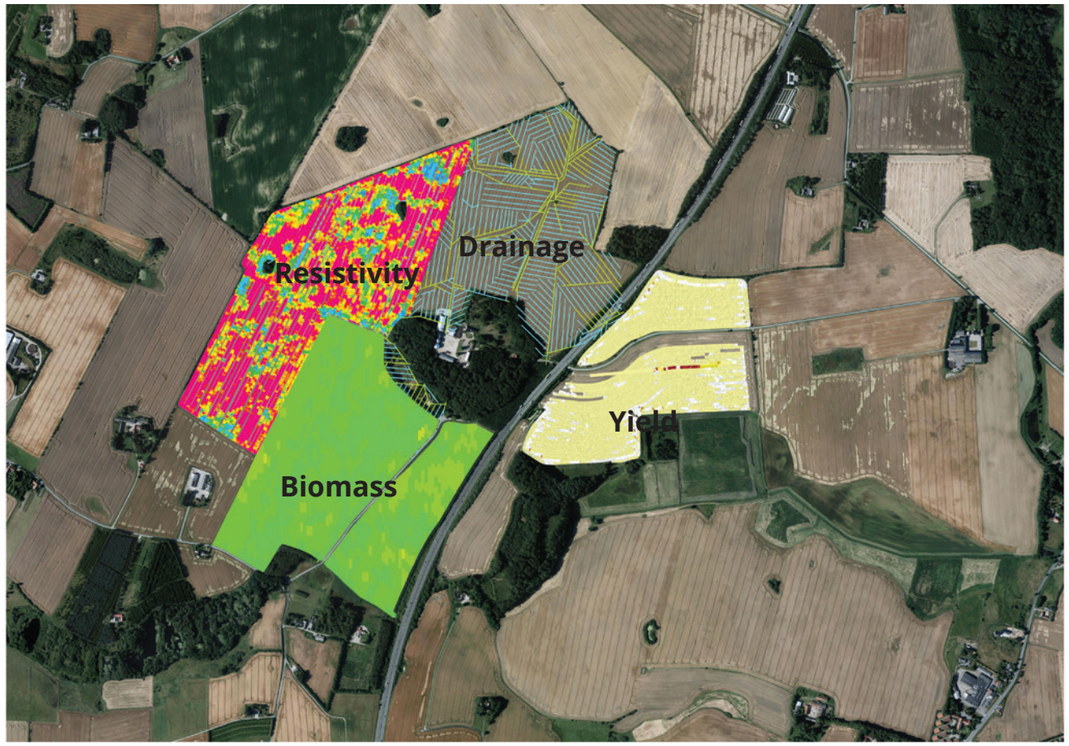
- Flooding
  Saltwater intrusion
  Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater
- Surface water

- Real data
- Model calculations

- Field scale
  Catchment scale

The aim is to reduce leaching of nitrates by optimized fertilizer allocation and/or optimized break-down conditions. Data from geophysical and geological mapping of the surface and uppermost 30 m subsurface will be compared to the farmer's knowhow and data. Hereby detecting vulnerable as well as resilient field areas. A geological model and a groundwater model will be made. Different allocation scenarios as well as climate scenarios will be tested. The output aim is a management system for change in cultivation practice/regulation.



QUALITY INDICATOR:

20 % nitrate reduction in flux of water in drains and recharge by innovative management.

DELIVERABLES

Recommendation	Recommended management system for change in cultivation practice/regulation.

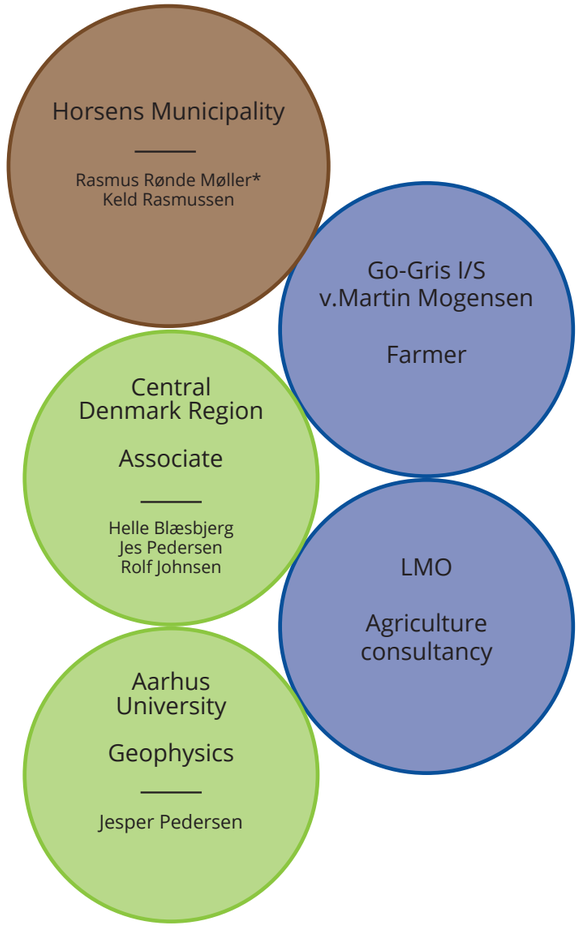
ACTIVITIES

GCM	Finished in 2. Quarter 2016.
T-TEM	Final development spring 2017 - measurements mid 2017.
Magnetometer	Measurements mid 2017.
N-min sampling	Sampling in 1. Quarter 2017.
Drillings	2017.
Drain water sampels	Continuous.
Farm data	Continuous.
Geological model	2017.
Groundwater model	2018.

DK 2A:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT DK 2B

* rrm@horsens.dk · 0045 23963376

DK 2B:

Improvement of traditional investigations by prior geophysical investigations

CHALLENGES

Flooding
Saltwater intrusion
Groundwater buffer
Soil conditions
- Break down capacity

- Groundwater
- Surface water

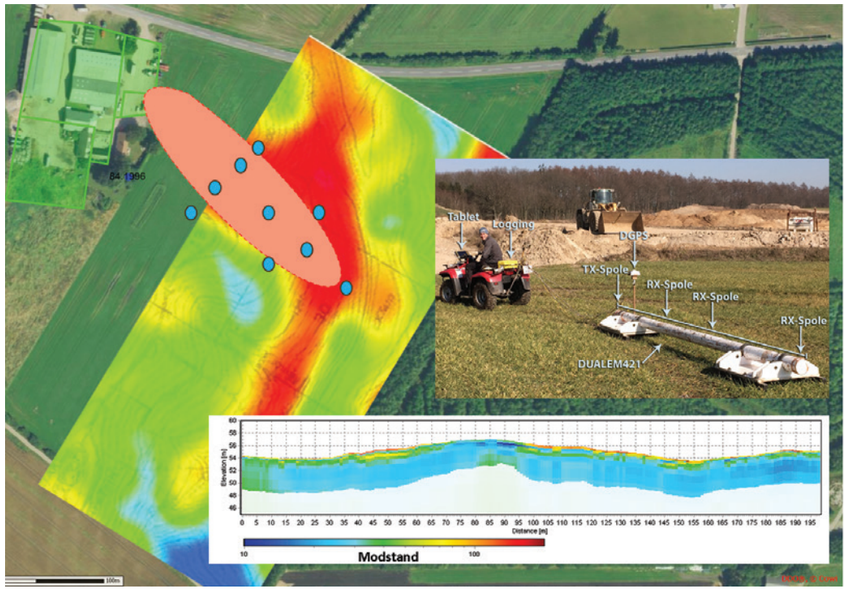
- Real data

Model calculations

- Field scale

Catchment scale

The traditional investigation concept with series of sampling points build upon each other contains a substantial uncertainty especially in a heterogeneous geological setting, thus a solid risk assessment implies a large number of bore-holes. The objective of this pilot is to clarify if expenses and/or time can be re-duced by adding geophysical measurements prior to the point approach. The trial is carried out on a former landfill and an agricultural contractor, where pollutions with leachate and pesticides have been proved. The final output should be recommendations and guidelines for a better integrated practice.



QUALITY INDICATOR: 20% cost reduction on traditional investigations of point source contamination.

DELIVERABLES

Recommendation	Recommendation and guidelines for at better integrated practice.

ACTIVITIES

Traditional investigation proposal	To be finished 1. Quarter 2017.
GCM	To be finished January 2017.
tTEM	Final development spring 2017 - measurements mid 2017.
Investigation proposal based on geophysics	2017.
Field investigations	2018.
Analysis and recommendations	2018.

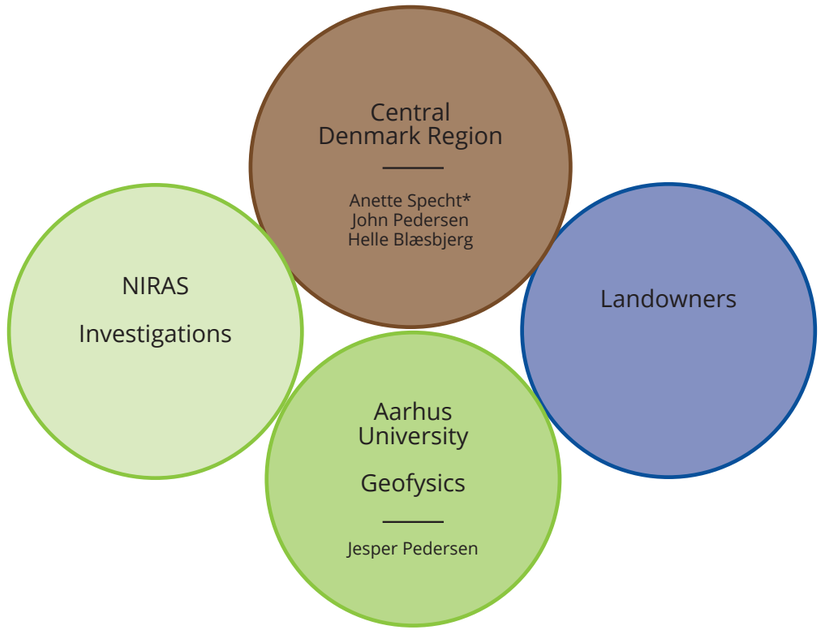
"Topsoil is improving our understanding of surface and ground water connectivity in a water permeable landscape where the Magnesian Limestone meets the North Sea. This coastal landscape, under pressure from urban and agricultural pollution and from mining and quarrying legacy issues, includes Sites of Special Scientific Interest, Special Protection Areas, Special Conservation Areas and a National Nature Reserve. "

Niall Benson, Durham Heritage Coast Officer, Chair, Coastal Streams Partnership.

DK 2B:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT DK 3

* anespe@rm.dk · 0045 51166723

DK 3:

Development and testing of high-resolution near-surface methods for improved groundwater vulnerability assessment

CHALLENGES

Flooding

Saltwater intrusion

- Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater

Surface water

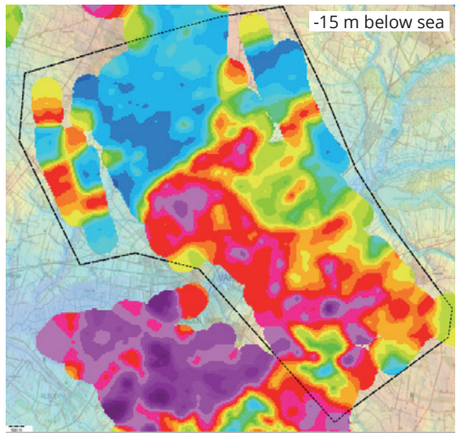
Real data

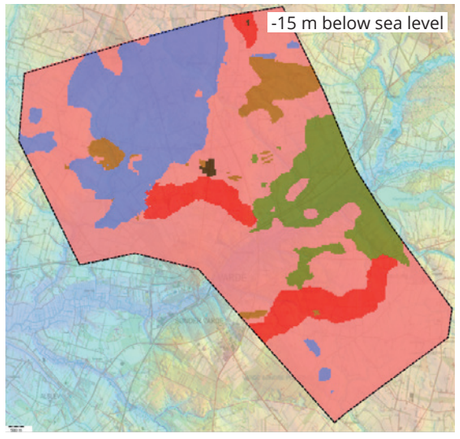
- Model calculations

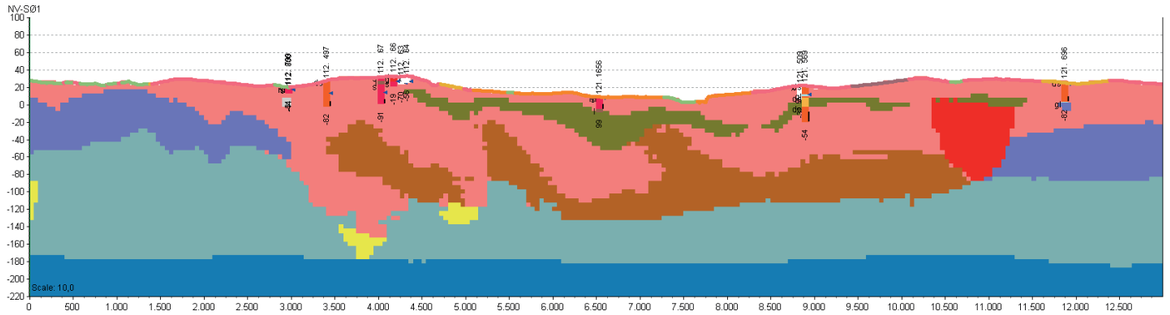
- Field scale

Catchment scale

Glacial deformation is generally widespread in the formerly glaciated areas of Northern Europe including the North Sea region. The existing methods used for groundwater mapping has a limited resolution capability and the resulting models does not describe the subsurface in scales less than bout 50-100 m. The town of Varde is located in the southwestern part of Jutland. The area suffers from lack of clean ground water. Very often nitrate and pesticides pollute the known aquifers and it has for many years been difficult to find new clean aquifers. Recent investigations show that the area is heavily glacially deformed with thrusting and folding of the subsurface. This means that gateways for pollution along these structures to the aquifers frequently exist in the area. Due to the presence of the complex geology a new high-resolution mapping method is needed. New ways of data interpretation and modelling of such dense data also has to be developed.







QUALITY INDICATOR: Not described yet.

DELIVERABLES

Detailed 3D models	A 3D geological model and groundwater flow model (including climate scenarios) from surface down to 200 m. The model will be very detailed in the uppermost 30-50 m allowing precise delineation of vulnerable areas and areas potentially flooded by groundwater due to climate changes.
Recommendation	Options for regulation towards optimized groundwater protection and development of climate change adaption plans.

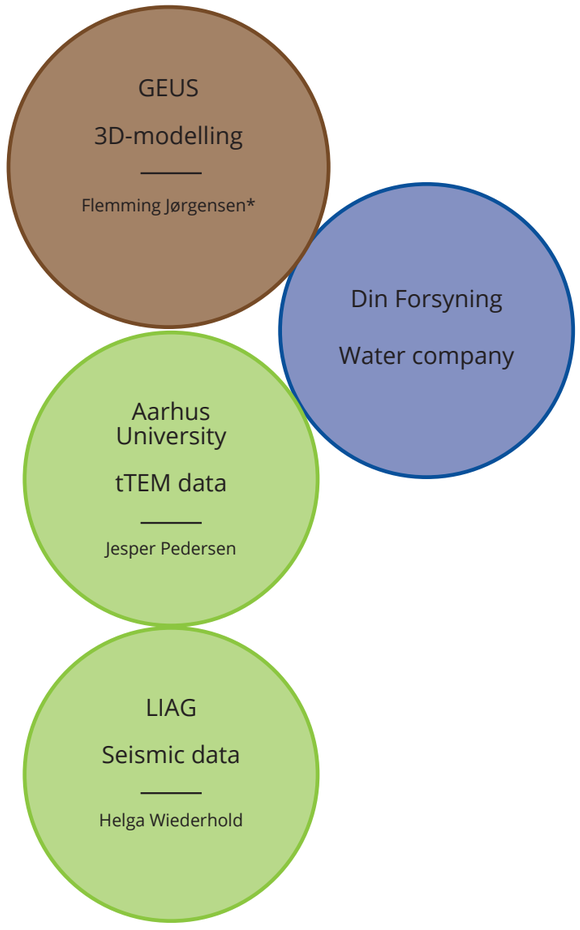
ACTIVITIES

t-TEM survey	Will be conducted late 2017.
Modelling activities	Existing models will be updated during 2017 and early 2018.
Vulnerability maps	2018 - 2019.
Climate change adaption plans	2018 - 2019.

DK 3:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT DK 4

* flj@geus.dk · 0045 22946626

DK 4:

Integrated water management in Odense City for improved risk assessment

CHALLENGES

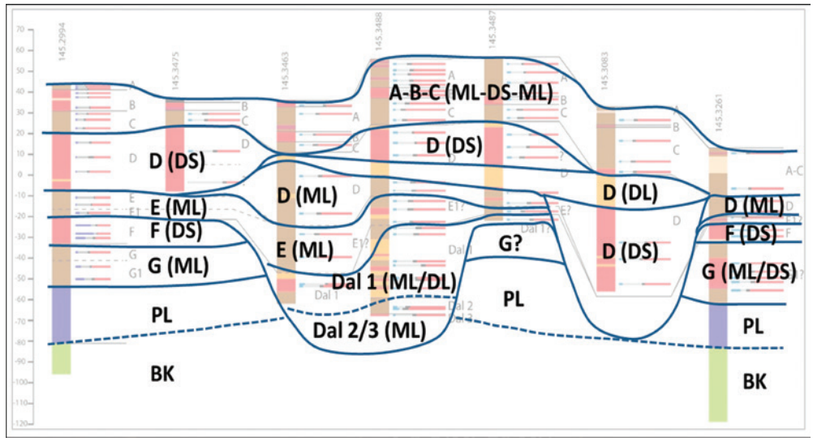
- Flooding
- Saltwater intrusion
- Groundwater buffer
  Soil conditions
- Break down capacity

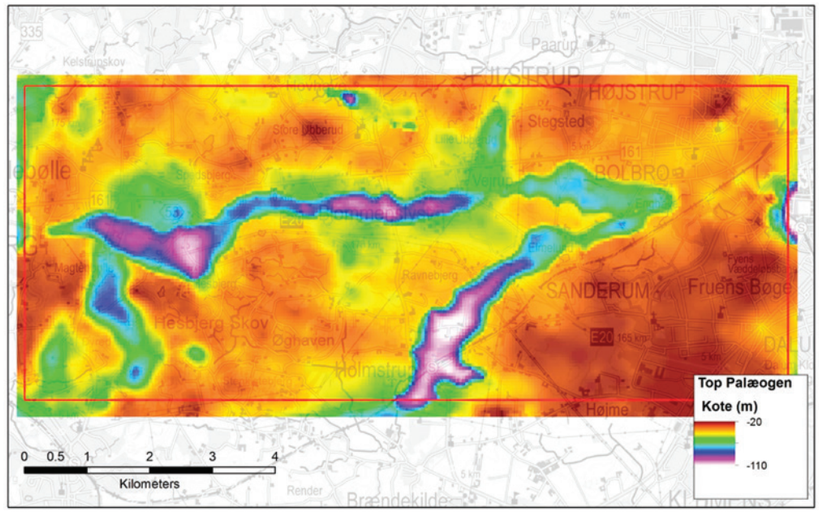
- Groundwater
  Surface water

- Real data
- Model calculations

- Field scale
  Catchment scale

Odense City is threatened by inundation from increasing groundwater levels and flooding events from both the river, the fjord and flash floods caused by extreme precipitation. An optimal management of the urban water cycle in a future more extreme climate requires an integrated approach that combines the individual components: geology, hydrology, urban and climate data. The goal of the project is to create a tool which can be used for management of water flow in urban areas in climate change conditions and allow to access the risk from the contamination. The model can quantify how changes in one compartment (e.g. increasing infiltration of surface waters) affect the state of another compartment (e.g., groundwater). It is believed that an integrated hydrological modelling approach is the most efficient way to quantify the impacts of both climatic changes, adaptation measures and changes in urbanization. All those factors affects the urban hydrological cycle, including groundwater levels, groundwater and surface water flow paths and resulting in migration of pollutant from the historical point contamination sources.





QUALITY INDICATOR:

Preventing groundwater resources from contamination from the historical point sources as climate changes. The improved risk assessment tool will help to set the priority of the avoid groundwater contamination.

DELIVERABLES

3D model	A detailed hydrogeological model of the uppermost 30-50 m of the subsurface and a groundwater flow model with the interaction of climate change processes, drainage, groundwater buffering.
Adaption strategies	Implementation of modeling as a tool for optimization of groundwater management and the risk assessment.

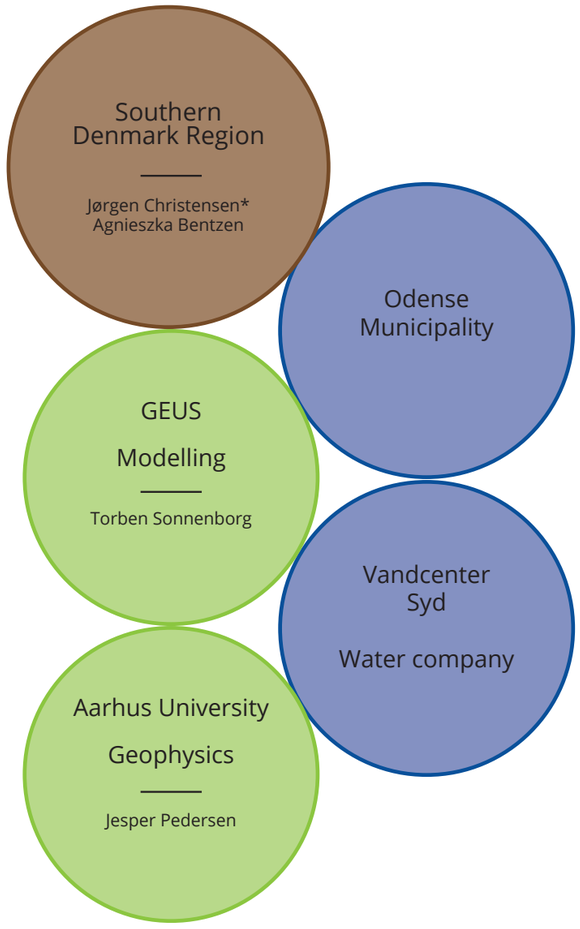
ACTIVITIES

The field investigation	To be finished in November 2016.
The geological model	To be finished January 2017.
The hydrological model	To be finished in July 2017.
The climate model	To be finished in 4. Quarter 2017.
Modeling of migration of the contaminants	To be finished in 2. Quarter 2018.
Adjustments, solutions and adaptation	To be finished in 1. Quarter 2019.

DK 4:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT GE 1

* joergen.f.christensen@rsyd.dk · 0045 29201928

GE 1:

Investigation of the geophysical, hydrochemical and hydraulic chracteristics of the subsurface in a moraine area and adjacent marshlands as a basis for geological and hydrological modeling

CHALLENGES

- Flooding
- Saltwater intrusion
- Groundwater buffer

Soil conditions

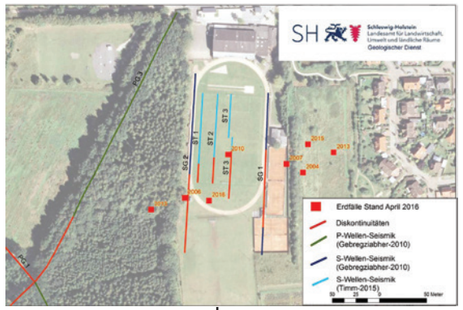
Break down capacity

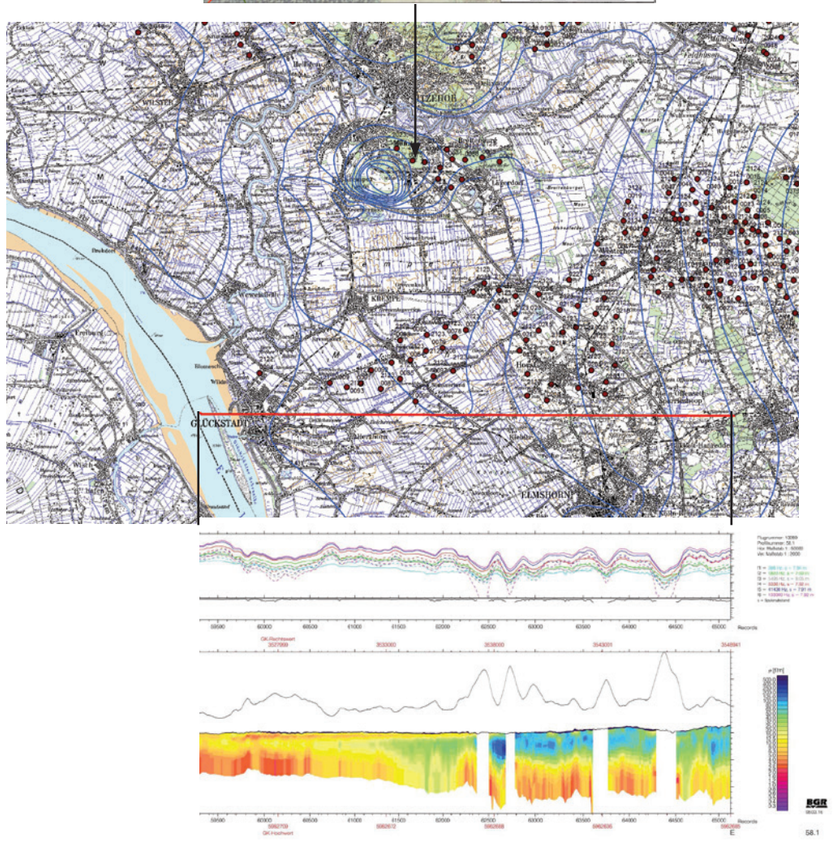
- Groundwater

Surface water

- Real data
- Model calculations
- Field scale
- Catchment scale

The pilot area is characterized by the transition from a moraine area with sandy soils to the marshlands of the rivers Stör and Elbe. Groundwater recharge takes place in the moraine area, while in the drained marsh areas saline groundwater with shallow freshwater lenses occurs. Groundwater modelling based on a geological model will allow a better prediction of future changes of groundwater tables, freshwater-saltwater distribution and the demand for drainage under the impact of climate change and sea-level rise. Additionally, the sinkhole area in the village of Münsterdorf is investigated with geophysical methods to understand solution processes of the near surface limestones to enable a better delineation of the sinkhole risk area.





QUALITY INDICATOR:

reduce the impact of the climate change to the freshwater-saltwater distribution.

DELIVERABLES

Recommendation	Recommended changes in practice for groundwater and drainage water management.

ACTIVITIES

Reflection seismic survey	Completed in the moraine area, in preparation, to be completed in fall 2017 in the marsh area.
Resistivity measurements	In progress, to be completed 2018.
Fixed vertical electrode measurements	In preparation, to be completed 2018.
Groundwater modeling	Geological model.
Groundwater model	In preparation, to be completed 2019.

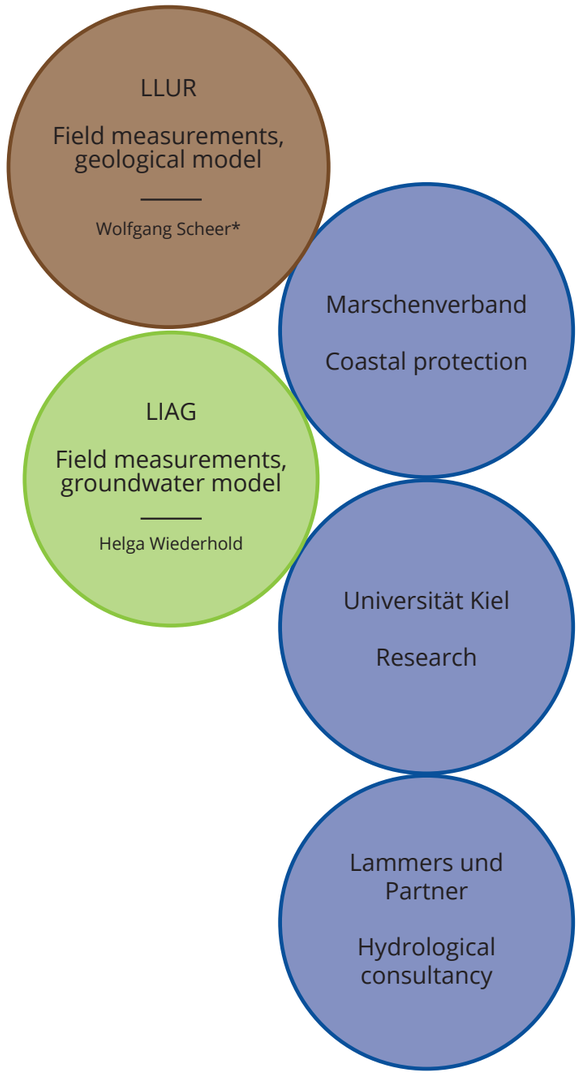
"The Topsoil project is a fantastic opportunity to share knowledge and ideas with partners from across the NSR, to learn about the different approaches to managing resilience challenges related to soil and water and to use these experiences to help shape our own approach in the UK"

Barry Bendall, Director Water & Land, The Rivers Trust.

GE 1:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



* wolfgang.scheer@llur.landsh.de · 0049 4347 704 525

NEXT GE 2

GE 2:

Development of climate change effected saltwater intrusion in the Elbe-Weser-region

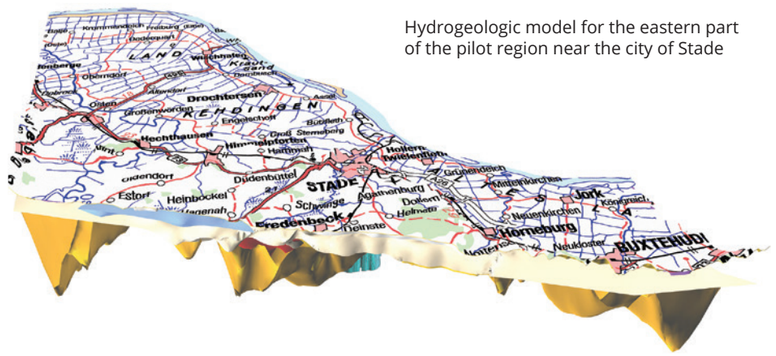
CHALLENGES

Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions

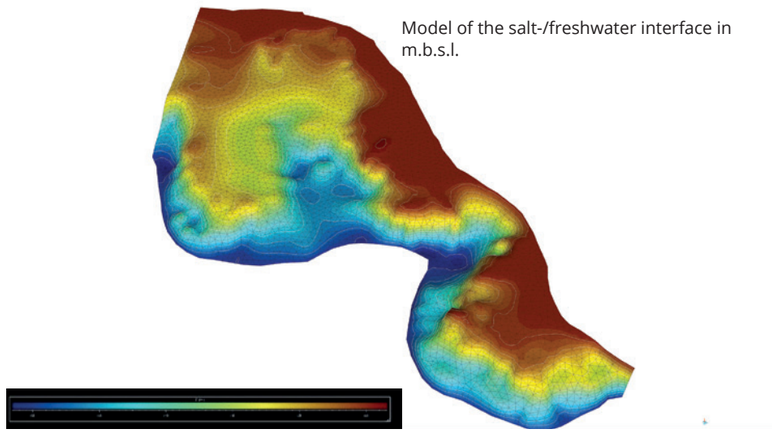
Break down capacity
- Groundwater
  Surface water
- Real data
- Model calculations

Field scale
- Catchment scale

The climate change will have effects on the coastal aquifers in the north sea region. Especially the distribution of the salt-/freshwater interface in the aquifers will change. The effects of drainage, irrigation and groundwater storage on the salt-/freshwater interface should be quantified to get a sustainable exposure to the groundwater system. Therefor a detailed hydrogeological model and a model of the salt-/freshwater interface will be set up for the uppermost 50m of the subsurface. Based on this model, a groundwater flow model will be developed to quantify the evolution of the salt-/freshwater interface due to climate change conditions.



Hydrogeologic model for the eastern part of the pilot region near the city of Stade



Model of the salt-/freshwater interface in m.b.s.l.

QUANTITY INDICATOR:

reduce 20% of the saltwater effected area in the coastal aquifers or reduce the worsening of the situation due to climate change.

DELIVERABLES

Detailed 3D models	A detailed hydrogeological model of the uppermost 50 m of the subsurface and a groundwater flow model with the interaction of climate change processes, drainage, groundwater buffering and saltwater intrusion.
Adaption strategies	Adaption strategies for farmers, water supplier and maintenance organizations to get a sustainable and resource conservative use of the groundwater in times of increasing demands and decreasing water availability.

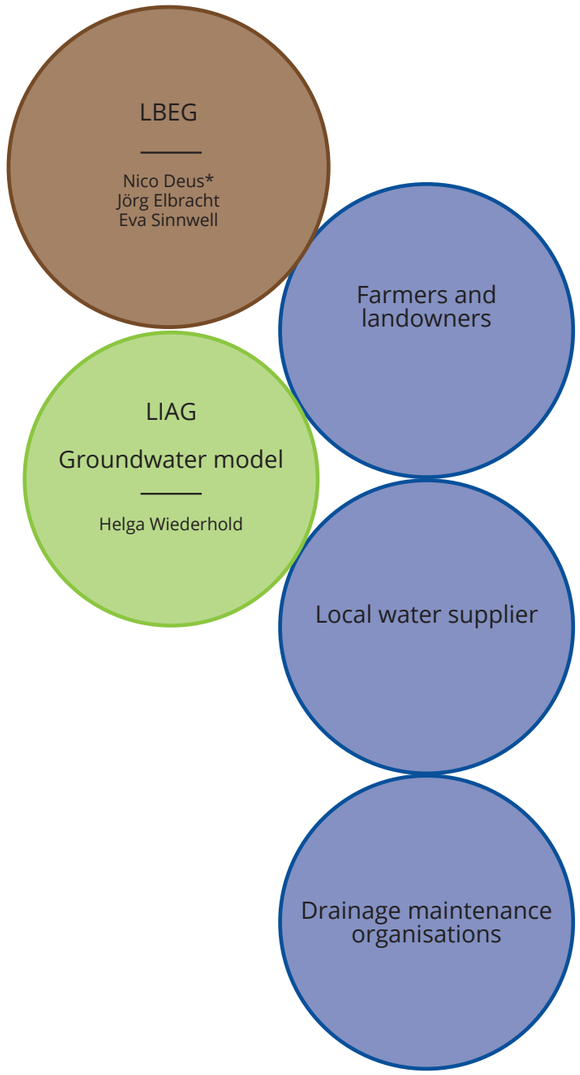
ACTIVITIES

Direct-Push sampling	Finished 4. quarter 2016.
Groundwater sampling	Continuous.
Sediment sampling	Continuous.
Hydrogeological 3D-model	To be finished 2. quarter 2018.
Groundwater model	To be finished 2. quarter 2019.
Solutions and adaption strategies	2019.

GE 2:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT GE 3

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GE 3: Bremen Dam: Effects of a dam on the surrounding groundwater

CHALLENGES

- Flooding
- Saltwater intrusion

Groundwater buffer
Soil conditions
Break down capacity

- Groundwater

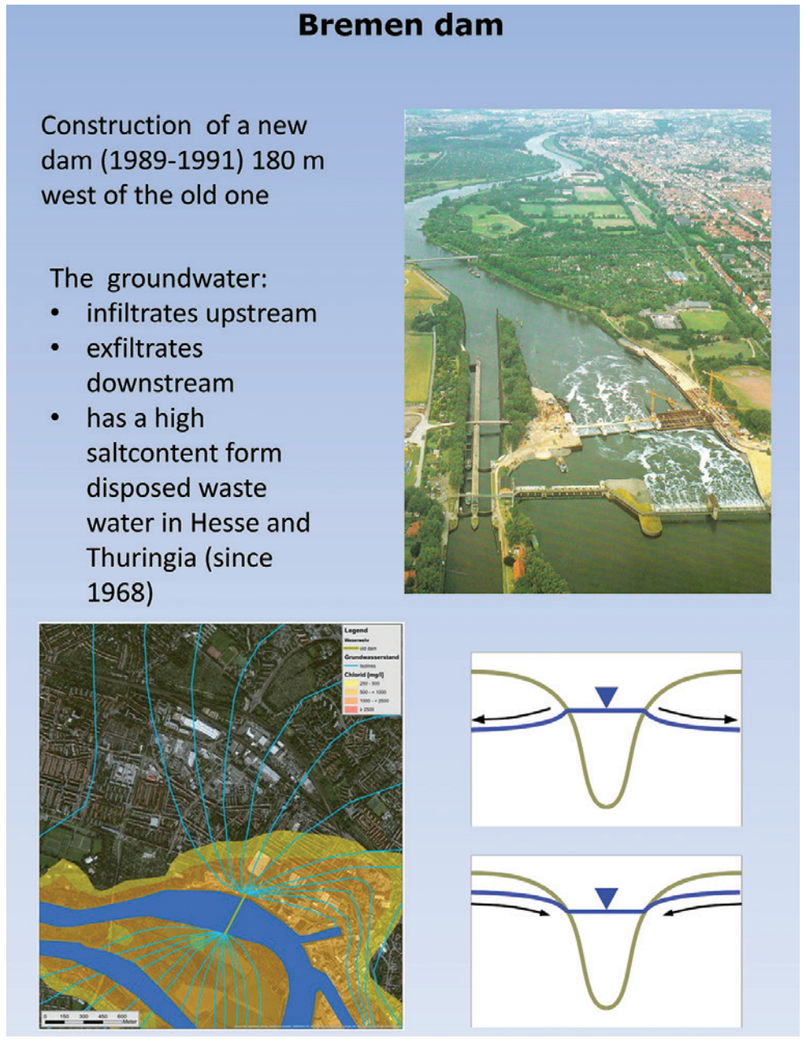
Surface water

- Real data
- Model calculations

Field scale

- Catchment scale

In Bremen the river Weser is backed-up in order to the production of electric power and to improve shipping traffic. In recent years, the dam has been shifted, which influences the flow of the connected groundwater. Saltwater bypasses the dam through the adjacent aquifer. Likewise, CHC from contaminated sites change flow direction and can be used as a tracer, representing the old and new flow regime, which has to be qualified. In recent years the salt concentration of the Weser has been significantly reduced. This measure will affect groundwater quality. The groundwater recharge and the water level of the Weser will also be affected by climate changes.



QUALITY INDICATOR: Under construction.

DELIVERABLES

Recommendation	A guideline for future large disruptions of the groundwater flow by construction projects e.g. dam site constructions.

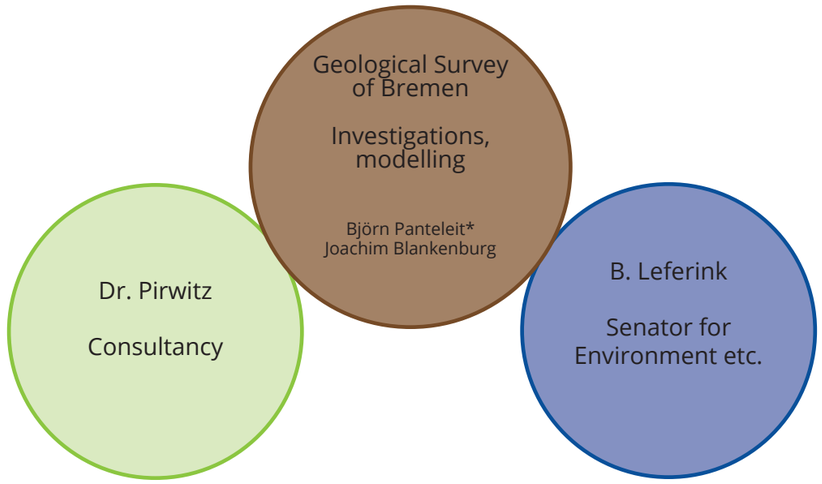
ACTIVITIES

Measurement of groundwater levels	Continuous.
Groundwater sampling and analysis	Continuous.
Drillings	2017.
3-D geological modeling with Gocad	To be finished 4. quarter 2018.
Groundwater modeling	To be finished 2. quarter 2019 .
Guideline	Developing a guideline to the effects of dams in tidal rivers. 4. Quarter 2019.

GE 3:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT GE 4

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GE 4: AquaModul

CHALLENGES

Flooding
Saltwater intrusion
- Groundwater buffer

Soil conditions
Break down capacity

- Groundwater

Surface water

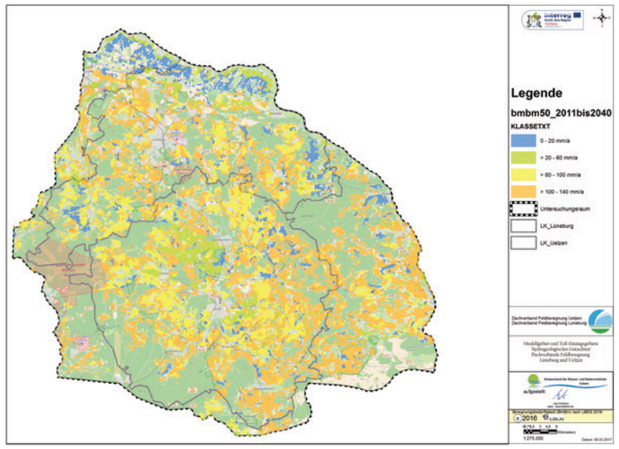
- Real data
- Model calculations

Field scale
- Catchment scale

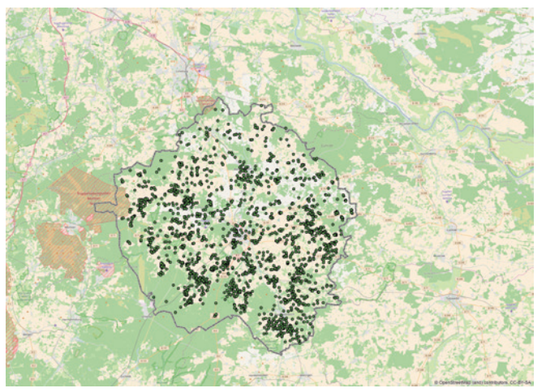
Due to sandy soils and a strong negative climatic waterbalance during the vegetation period the county of Uelzen has become the center of Germany's largest agricultural irrigation area. Mainly groundwater is used. The limiting factors to the necessary additional groundwater extraction due to climate change are the WFD requirements of preserving (and improving) protected groundwater dependant ecosystems.

During the last decade the hydrological effects of the summary of the wells have been investigated with the help of iterative modelling. Yet a practicable and significant monitoring system and interpretation methods are still lacking and shall be developed and tested now. Due to the enormous size and partial interdependance of the involved groundwaterbodies and furthermore due to the specific very discontinous groundwater exstractions only during drought situations of the vegetation period appropriate monitoring systems don't yet exist. It will become the basis for the future management of extractions or possibly artificial recharge.

Simplified illustration



Map of project area with forecasted irrigation (in Millimeter classes) necessity until 2040



1076 irrigation wells were surveyed according to location and height in Uelzen district.

QUANTITY INDICATOR: A quantitative indicator is not applicable.

DELIVERABLES

Integrated system of groundwater monitoring devices	A workable systematic gradational pilot monitoring in line with ecosystems' affectedness and sensitivities will be installed.
Method for data interpretation	Hydraulic assignment of observation points to protected areas; Determination of necessary observation periods and frequencies; Discussion of significance of to be collected data or of possible thresholds;

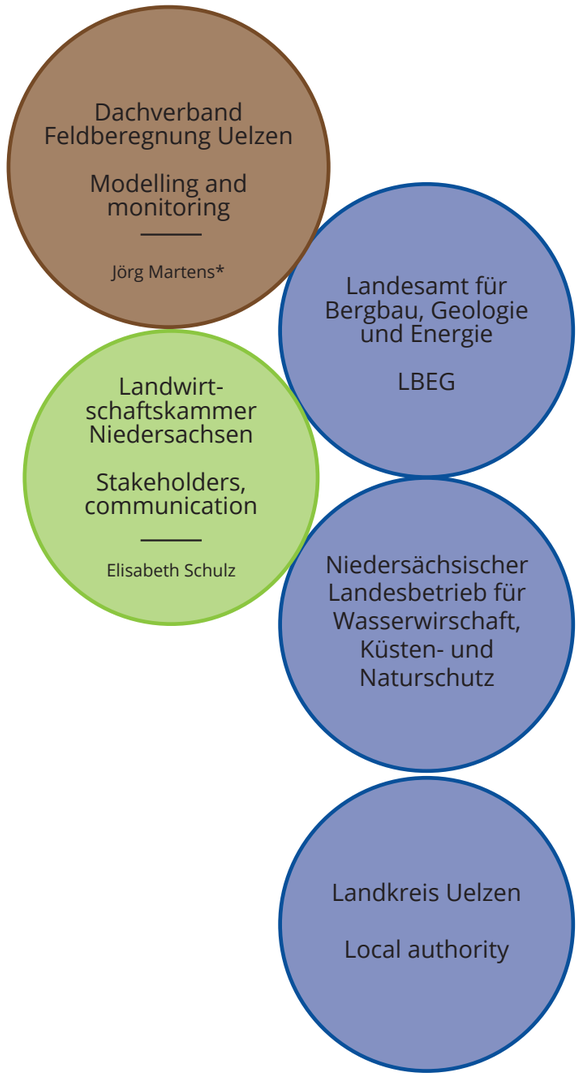
ACTIVITIES

1. Installation of stakeholder Round Table	Done
2. Identification of existance, type and qualilties of data to better discribe the geohydrologic system; definition of significant lacks and search for practical improvements	Mostly done.
3. Technical research and stakeholder involvement to improvement data collection	Modell is adapted and improved. First scenarios during second half of 2017; Design of monitoring in 2017-18.
4. Use of existing modells and improved data to design a pilot monitoring system and to run scenarios	2018
5. Pilot installation of monitoring technology including identification of innovative technology	To be finished 2. quarter 2019.
6. Investigation of interpretation methods and development of groundwater management tools	2018
7. Testing phase	2018-19

GE 4:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT GE 5

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GE 5:

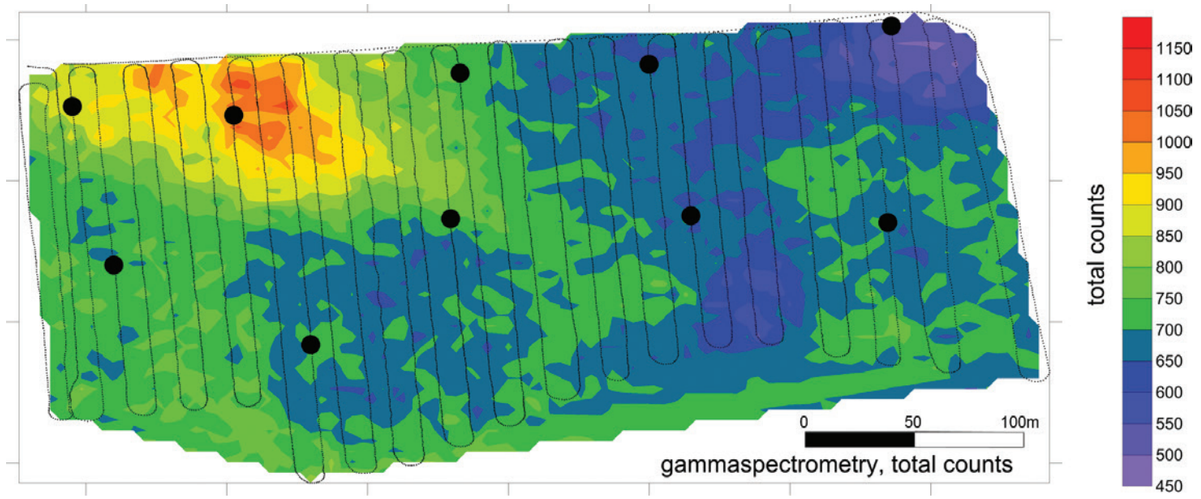
Enabling farmers to better protect the groundwater from nitrate and veterinary pharmaceuticals

CHALLENGES

Flooding
Saltwater intrusion
Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater
  Surface water
- Real data
- Model calculations
- Field scale
  Catchment scale

This pilot in the western part of Lower Saxony aims to strengthen the Precautionary Drinking Water Protection at farm level. Large parts of the provision area of OOWV are characterized by intensive agricultural land use combined with little buffering soil conditions, i.e. with vulnerable underlying groundwater bodies. This pressure feeds concerns that pollutants (e.g. nitrates) are on their way to groundwater layers and constantly threatening drinking water production: if they reach the water procurement areas (i.e. the deeper groundwater layers), it will be very difficult for water suppliers to remove them again. BGR and OOWV thus work on a tool which helps farmers to better assess the vulnerability of their soil, and set priorities for specific, groundwater protecting management.



second measurement campaign, 10.-13.10.2016,
incl. sites for soil sampling

QUALITY INDICATOR: Concentration of nitrate in seepage water indicating the effectiveness of agricultural measures on the farm plot.

QUANTITY INDICATOR: Concentration of selected veterinary pharmaceuticals in seepage water indicating agricultural pressure on the farm plot.

DELIVERABLES

Farm based soil map	OOWV plans to develop a farm based soil map in a participatory process for selected farms of different production types in the area of south of Oldenburg.
Analysis of seepage paths into groundwater	BGR will estimate here the input of selected veterinary pharmaceuticals based on application practices of farm fertilizers.
Recommendations for agricultural management practice	Recommendations for agricultural management practices improving groundwater protection.

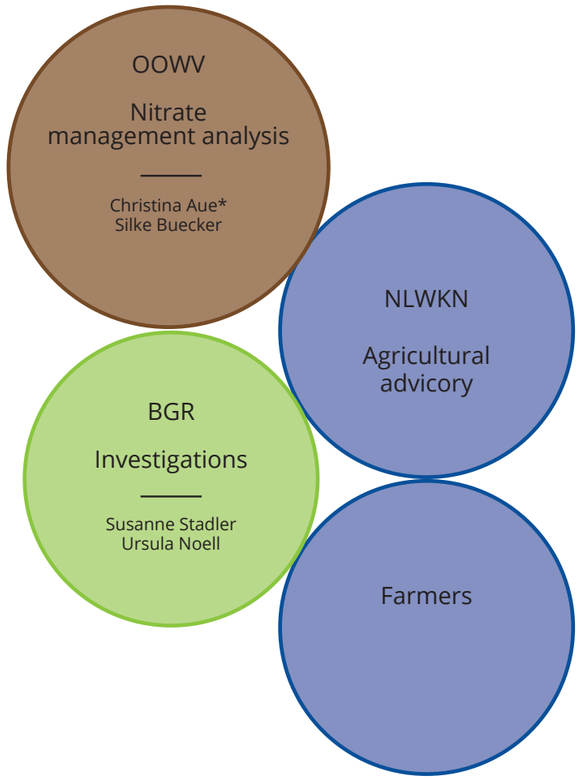
ACTIVITIES

Selection of further sample farms	Ongoing. Due to the just released review of the fertilizers' directive discussions are heated and take place in a challenging political atmosphere. Still, we hope that the benefits for farmers – i.e. that they gain detailed information on their fields which will also support other management objectives – will further help to lead to a fruitful cooperation with them.
Soil physical, chemical and geophysical analysis	Ongoing. Currently, BGR samples first fields on one farm for understanding the solute transport conditions due to preferential flow. More farmers are approached currently.
Cooperation with responsible water agency	BGR has established cooperation with the Agency for Water, Coastal and Nature Protection in Lower Saxony (NLWKN) as they had implemented a study on the immission of agricultural pharmaceuticals into groundwater.
Development of detailed soil maps	Currently, OOWV prepares the development of soil maps at field level for the later cooperating farmers.
Testing of different management practices to protect groundwater from nitrate	Planned for 2018/2019.

GE 5:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



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NEXT NL1A

NL 1A: Freshwater - Drentse Aa

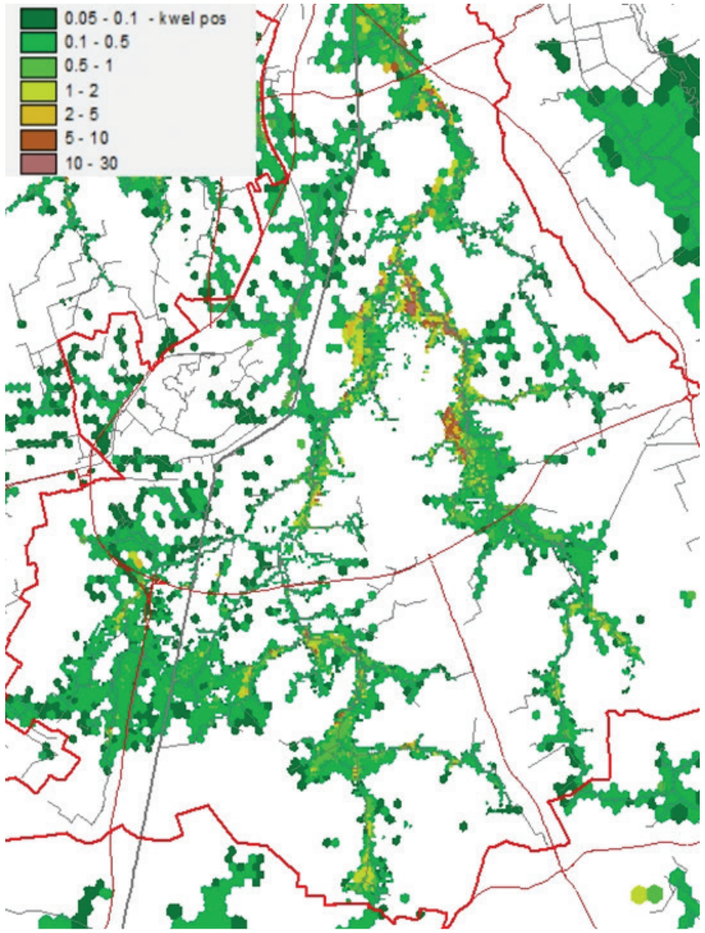
CHALLENGES

Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions

Break down capacity
- Groundwater
  Surface water
- Real data
- Model calculations
- Field scale
- Catchment scale

Climate change will effect Nature and agriculture. In the Drentse Aa region measures are implemented already to deal with the effects of increased flood risk due to climate change. In this pilot we will study measures to deal with increased water shortage due to climate change. An existing groundwater model will be actualized and used to study the problem and to develop measures to reduce the increasing drought risks for nature and agriculture.

Map with seepage zones in Drentse Aa; calculated with groundwater model (seepage in mm/day)



QUANTITY INDICATOR: Reduce 10% of the potential drought damage in 2050

DELIVERABLES

3D groundwater model	A hydrogeological model of the uppermost 50-100 m of the subsurface with a top-layer model. With the model the effects of climate change and measures on ground water levels , seepage, drainage& infiltration and groundwater buffering will be determined.
Adaptation strategy	Adaption strategies for farmers: - a map with zones where farmers are allowed to sprinkle from groundwater. - a list + map of measures farmers can take to mitigate the drought damage. Adaption strategies for nature: - list of measures and maps that nature organizations can take to mitigate the drought damage

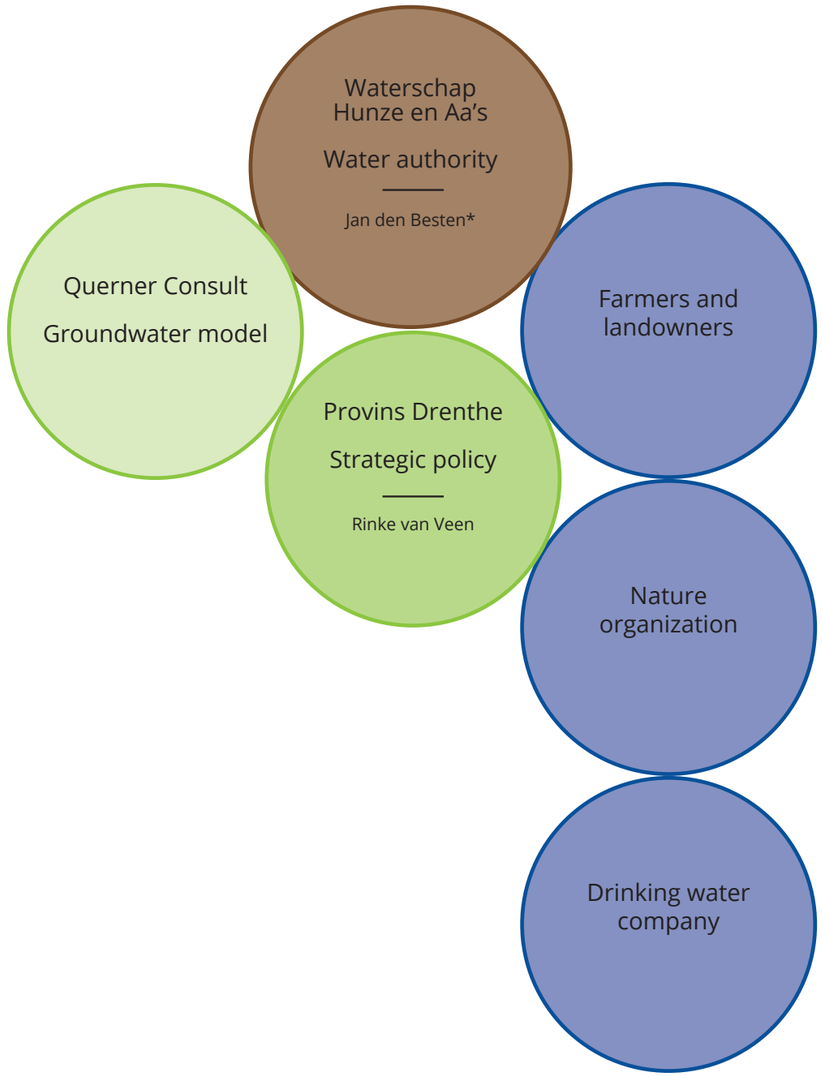
ACTIVITIES

Actualizing ground water model	Finished 3nd quarter of 2016.
Analyses with model	To be finished 1st quarter 2017.
List + maps measures	To be finished 3rd quarter 2017.
Plan to implement measures	To be finished 1 st quarter 2018.

NL 1A:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT NL1B

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NL 1B: Drentsche Aa and Hunze waterquality

CHALLENGES

Flooding
Saltwater intrusion
Groundwater buffer
- Soil conditions
- Break down capacity

Groundwater
- Surface water

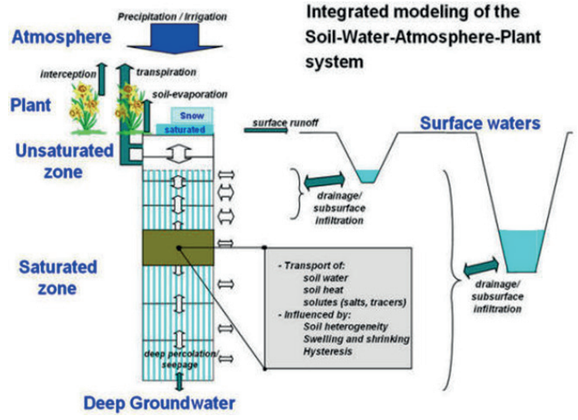
- Real data
- Model calculations

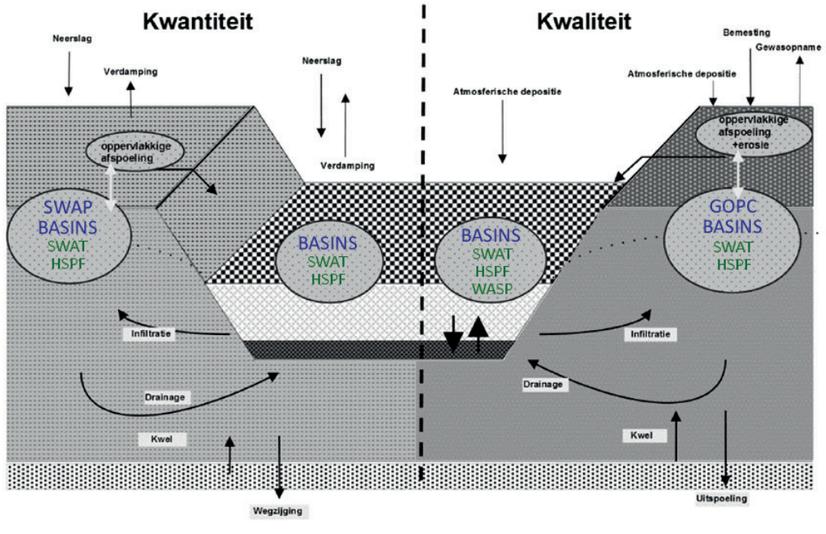
- Field scale
- Catchment scale

The aim of the project is to get a better grip on the increased leaching of nutrients and pesticides due to climate change and to determine measures together with the farmers in the area. The project contains two pilot areas:
- Drentsche Aa catchment with combination of agricultural use and nature
- Hunze with mostly agricultural use

Impact of pesticides will be investigated in the Drentsche Aa (from which also drinking water is extracted), nutrients will be investigated in both pilot areas.

Due to phosphate saturation in the soil P- leaching increases; due to climate changes and decreasing good soil conditions pesticide leaching to surface water takes place and leaching of nutrients increases.
Measures to be taken by farmers on fields scale will be investigated by modelling as well as through realty check on their effect on “good farming management” as well as improving waterquality to reach the goals of the water authority and the drinking water company (pesticides).





QUALITY INDICATOR:

Increase the water quality. The percentage of improvement is uncertain while the effect of the measures is a long term trend. Awareness/ behavioral change by the stakeholders.

DELIVERABLES

Recommendation/ report	Modelling to find the most risky places for leaching and run of of nutrients and pesticides. Maps with areas where run off of nutrients and pesticides are most likely to occur. Model to quantify the effects of measures on diminishing run off and leaching. Determine the effect of measures based on sustainable farming in pilot areas.
Information Database	Database used for modelling; deliver models that we can use after Top Soil is finished in other pliot areas/ catchments.
Models (both current and scenario’s)	The current situation and effect of measures on parcel level is modelled with SWAP both on nutrients and pesticides. Reality check with stakeholders to make sure risk maps are real-time.

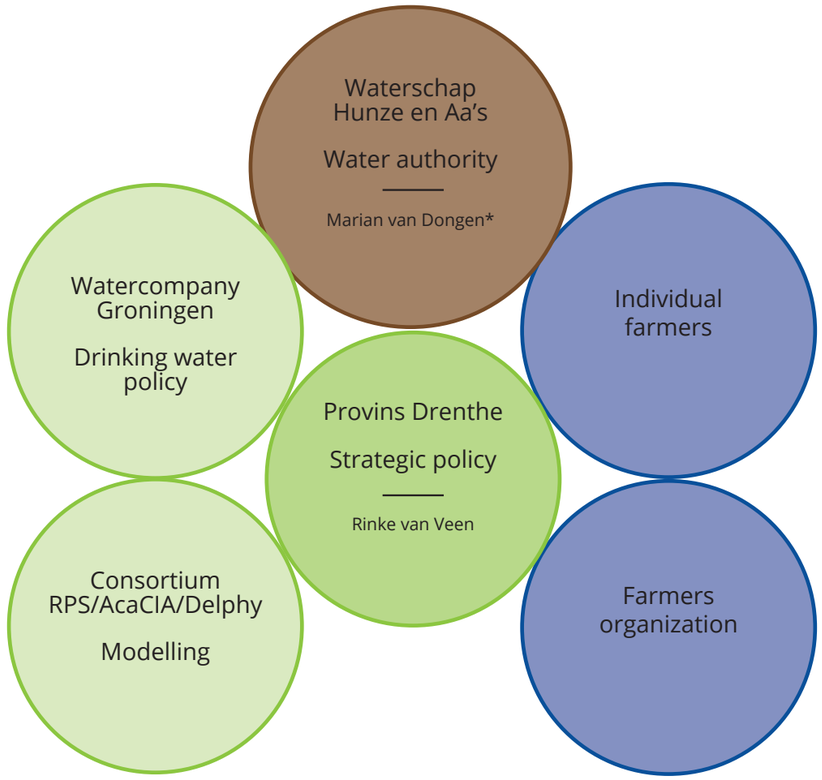
ACTIVITIES

Data collecting and set up for models	Is finished 2017 Q1.
First risk maps	2017 Q2.
Running model SWAT and SWAP and fine-tuning risk maps Drentsche Aa	Q2-Q4 2017.
Modelling quantifying effect of measures Drentsche Aa	2018 Q1 - Q4.
Running model SWAT and SWAP Hunze and fine-tuning risk maps	2017 Q2- 2018 Q4.
Determine extra Measuring Hunze needed and carry out measuring	2017 Q2- 2018 Q4.
Determine most efficient measures by modelling and reality check	2018 Q4.

NL 1B:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT NL2

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NL 2: Sustainable Dwarsdiep catchment

CHALLENGES

Flooding
Saltwater intrusion
Groundwater buffer

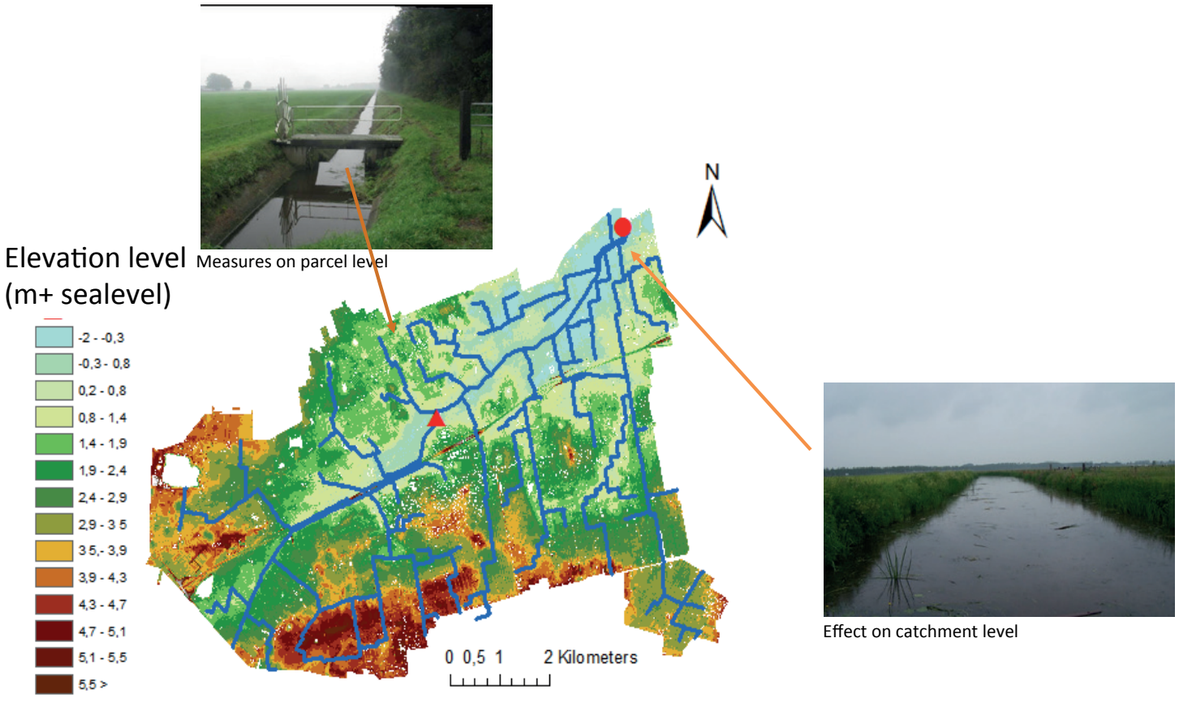
- Soil conditions
- Break down capacity

- Groundwater
- Surface water

- Real data
- Model calculations

- Field scale
- Catchment scale

A lot of activities will take place in the Dwarsdiep catchment the coming years. The activities are in terms of creating water storage, crook restauration and creating nature. Additional to these measures the TOPSOIl project Dwarsdiep focuses on the farmer parcels on the flanks of the catchment. The goal of the project is to find a set of measures on parcel level which improves agriculture circumstances but meets the goals of the regional water authority for quantity and quality as well, now and in future. The strategy is to emphasize the mutual benefit and the relationship between parcel and catchment level.



QUALITY INDICATOR:

Increase the quality. The percentage of improvement is uncertain while the effect of the measures is a long term trend.

QUANTITY INDICATOR:

Increase the buffer capacity of the soil with 10%.

DELIVERABLES

Recommendation/ report	Advice on a set of measures.
Information Database	Database accessible for farmers with information about the selected measures.
Models (both current and scenario's)	The current situation and effect of measures on parcel level is modelled with SWAP. The current situation and the effect of measures and climate change on Catchment level is modelled with WALRUS.

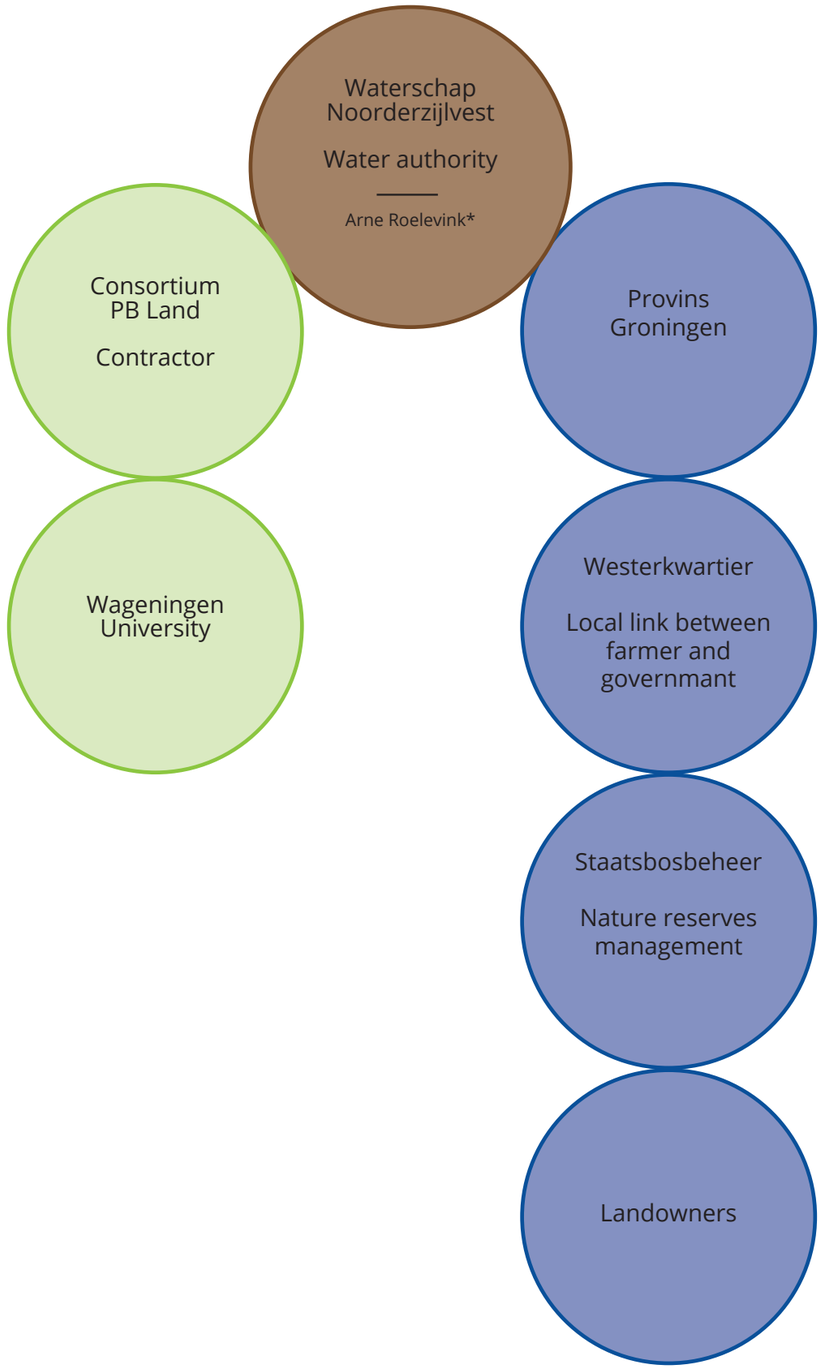
ACTIVITIES

Define current situation - Data collecting and analyzing - Field inventory - Modelling current situation (SWAP and WALRUS) - Stakeholders analysis	2017 Q1 – 2017 Q2.
Define measures - Compile a list of potential measure - Calculate effect of potential measure (SWAP and WALRUS) - Develop Information Database - Judge the effect of the measure together with the users (farmers)	2017 Q3 – 2018 Q3.
Define final set of measures - Define a set of cost – effective measures - Plenary sessions stakeholders - Reporting including method and results	2018 Q4 – 2019 Q3 Q2-Q4 2017.

NL 2:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT NL 3

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NL 3: GeoTOP

CHALLENGES

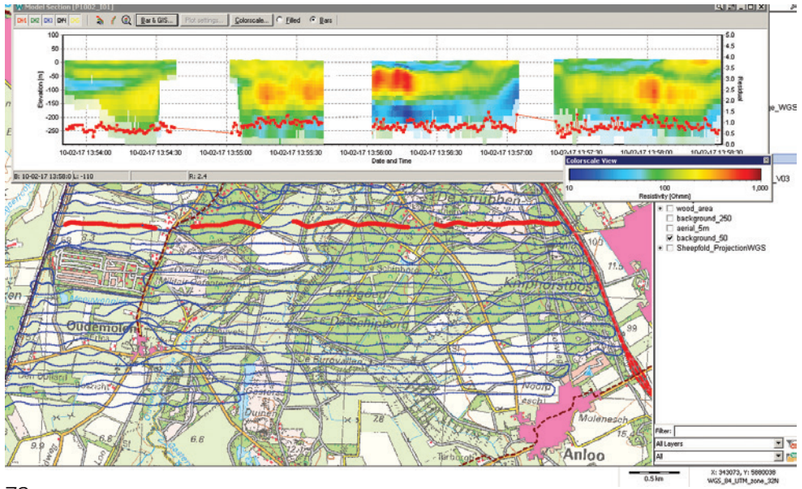
- Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions
  Break down capacity

- Groundwater
  Surface water
- Real data
  Model calculations

  Field scale
- Catchment scale

The objective of the project is to gain experience using more detailed soil information and models to solve water problems on a regional and local scale. The way soil information is detailed using existing boreholes and knowledge of the origin of the soils will be compared to the principle of electromagnetic induction.

The aim of the project is to get a better understanding of the effect of climate change to groundwater on a local scale. Because of the heterogeneous soil in Drenthe with less permeable layers just below the surface the impact of drought and heavy rain can differ from area to area. This will have an impact on both water quantity as on water quality.



QUALITY/QUANTITY INDICATOR: 20% increase of accuracy of mapping the melt water till.

DELIVERABLES

3D modelling of the upper 30 meters	Geological characteristics to get more detail into the geological model GEOTOP.
Mapping vulnerability	Make a map of conductance of different soil layers to calculate infiltration/run off.
Modelling	Local model calculations on the effects of drainage.
Update hydrological model	Increase of detail and accuracy of regional hydrological model Mipwa.
Gain knowlegde to improve water management	Because of the heterogeneous soil in Drenthe with less permeable layers just below the surface the impact of drought and heavy rain can differ from area to area. This will have an impact on both water quantity as on water quality.
WP 7 new management regime	Synthesize the roadmaps (WP6) and their impact on policy challenges per catchment area.

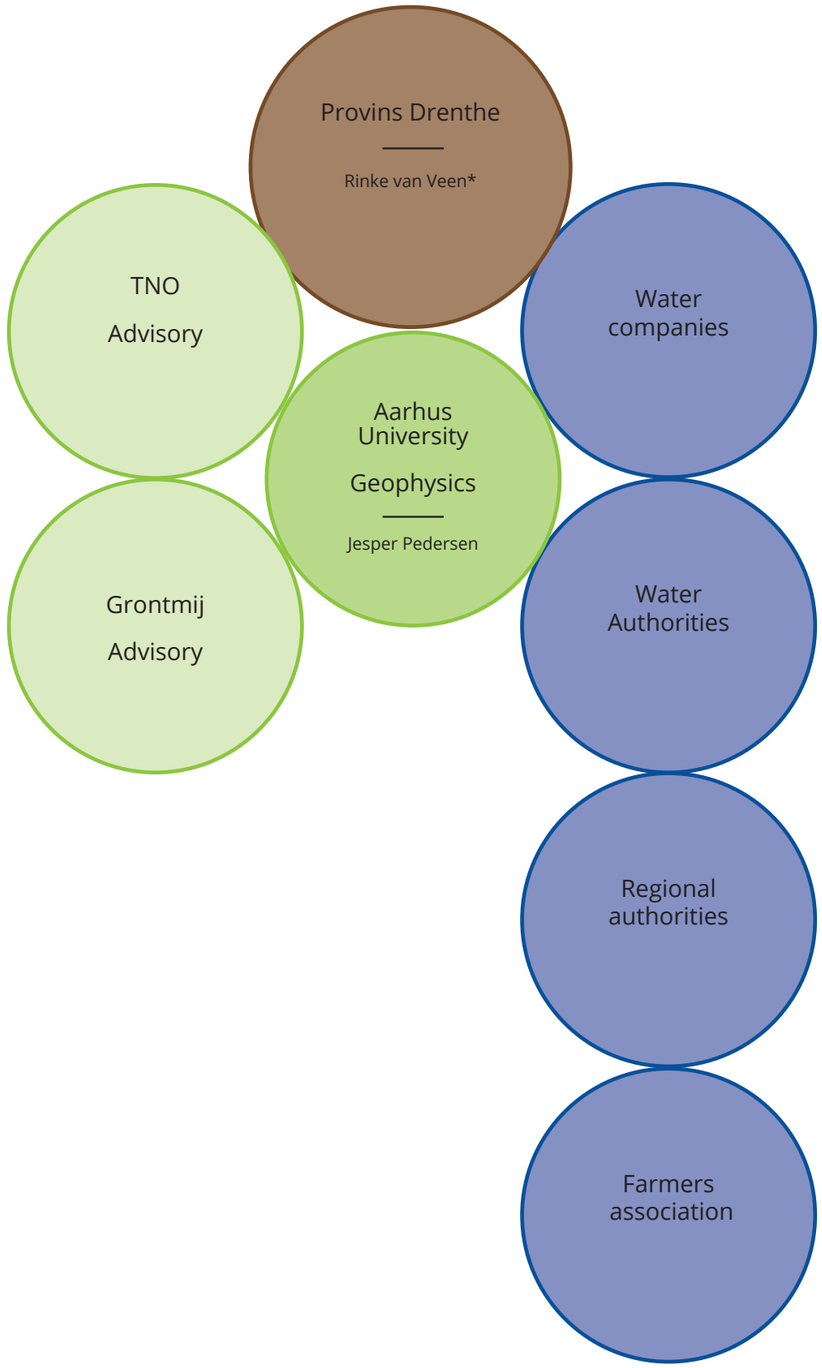
ACTIVITIES

Projectdescrition and tender SkyTEM	2017 Q1 – 2017 Q2.
SkyTEM flights	2017 Q3 – 2018 Q3.
Data management and quality control	2018 Q4 – 2019 Q3 Q2-Q4 2017.
Interpreting results	To be finished 2. Quarter 2017.
Updating Geological model GeoTop	To be finished 4 quarter 2017.
Developing maps	To be finished in 2018.
Updating hydrological model	Expected in 2020.

NL 3:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



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NEXT UK 1

UK 1: Surface and groundwater connectivity and implication for water resource protection and management

CHALLENGES

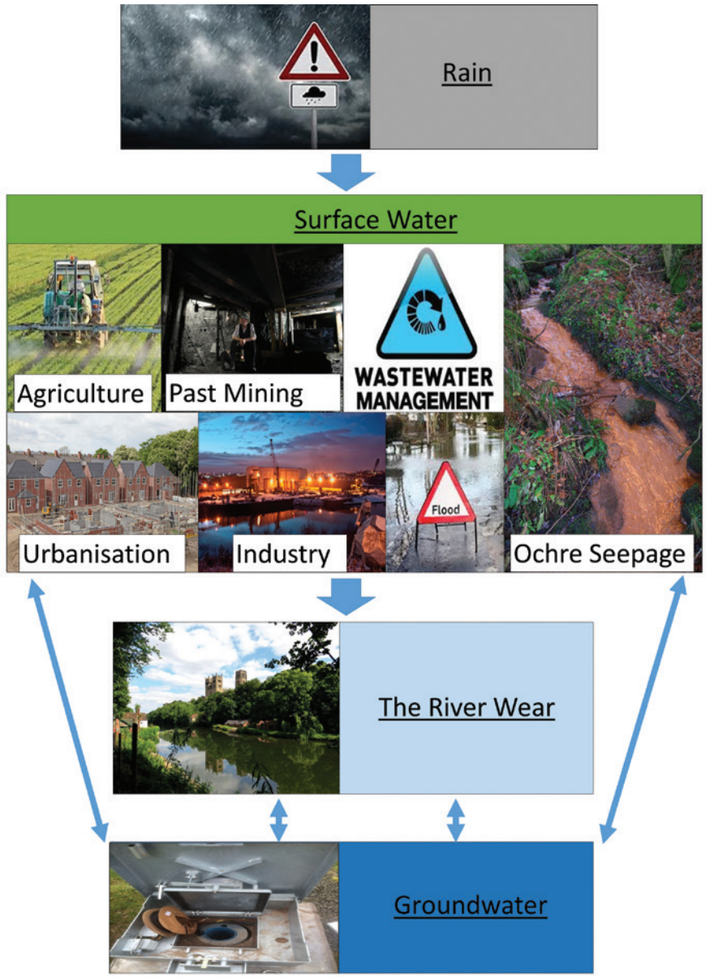
- Flooding
  Saltwater intrusion
  Groundwater buffer
- Soil conditions
  Break down capacity

- Groundwater
- Surface water

- Real data
  Model calculations

  Field scale
- Catchment scale

To gain a greater understanding of surface-groundwater interactions within the Wear catchment. Drinking water is abstracted from the Magnesian Limestone (ML) aquifer. Abstracted water quality is generally good, with one exception exhibiting rising trend in nitrate from an unconfirmed source. The ML groundwater (GW) body is currently at Poor status. The influence of the surrounding Coal Measures GW body (Poor status: due to chemical impacts from mining) on the ML aquifer is not fully understood. Urbanisation, waste water management, abstraction, surface water flood risk, climate change, agriculture and historical industrial contamination occurring within these GW bodies potentially put the ML aquifer at risk. Surface-groundwater connectivity maps, identifying possible GW and surface water (SW) interaction have been produced for ML. Fracture flow within the ML aquifer is the dominant flow mechanism and travel times are thought to be fast and afford little attenuation of recharge or pollution. Integrated Catchment Situation Reports for selected catchments will be communicated to stakeholders through the Wear Catchment Partnership.



QUALITY INDICATOR: Prevention and reduction of pollutants in both surface and ground waters.

DELIVERABLES

Report	Collating the joint understanding of partners' technical understanding of surface water- groundwater interactions.
Recommendations	Communicate practical mitigation measures for surface - groundwater management to stakeholders through the Wear Catchment Partnership to prevent deterioration.

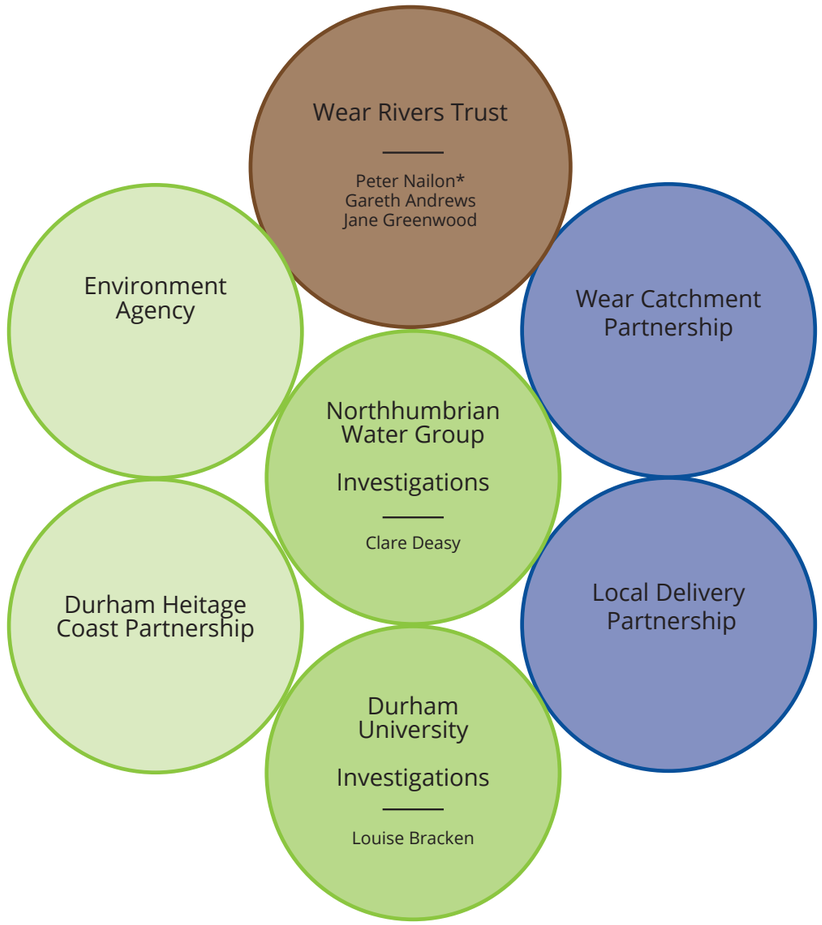
ACTIVITIES

Collate mitigation priorities from catchment reports	2019.
Integrated Catchment Situation Reports	2019.
Consider major fracture faults: possible pollutant pathways	2018.
Coastal Streams data collection and investigations	Initial phase: completion 1st quarter 2018.
Twizell Burn data collection and investigations	Initial phase: completion 1st quarter 2018.
Lumley Park Burn data collection and investigations	Initial phase: completion 4th quarter 2017.
Surface ground connectivity included in Local Authority strategic development planning	4th quarter 2017.
Surface ground connectivity included in Local Authority flood risk management strategy	4th quarter 2017.
Surface ground connectivity included in Wear Catchment Partnership Business Plan to 2030	1st quarter 2017. Reviewed annually.
Open access to Data and common understanding	Initially 1st quarter 2017. Continuous.

UK 1:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER



NEXT UK 2

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UK 2: Holistic water and soil management in East Anglia

CHALLENGES

- Flooding
- Saltwater intrusion
- Groundwater buffer
- Soil conditions
- Break down capacity

- Groundwater
- Surface water

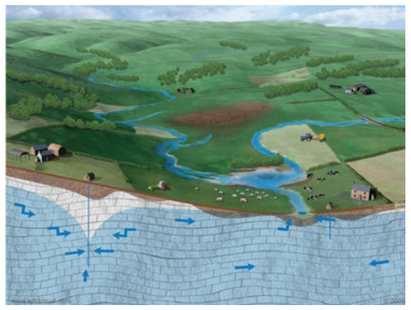
- Real data
- Model calculations

- Field scale
- Catchment scale

East Anglia is one of the driest regions in Europe but heavily reliant on water to support agriculture, nature and an increasing population. Much of the region is artificially drained and at risk from tidal & surface water flooding. The aim of the pilot is to deliver a series of sub-projects that demonstrate the benefits of a more holistic approach to the management of soil and water in the context of climate change and catchment management.

Principal sub-projects:

1) Reducing sediment input into important (N2k site & drinking water) reservoir
2) Managed Aquifer Recharge (MAR) – Storage of excess winter surface water in the aquifer for crop irrigation in the summer
3) Ground water catchment plans – working with stakeholders to develop common understanding of GW systems and produce bespoke water management plans for public supply boreholes
4) Water Sensitive Farming– improving soil health, reducing soil and nutrient loss and increasing water infiltration.



QUALITY INDICATOR:

Reduced contaminants (e.g. sediment, nutrients and pesticides) entering aquatic receptors (surface and groundwater).

QUANTITY INDICATOR:

Increased water infiltration/aquifer recharge.

DELIVERABLES

Recommendations	Recommendations and guidance for better management practices.
Management strategies	Bespoke management strategies for specific sites within the region and templates for wider adoption.

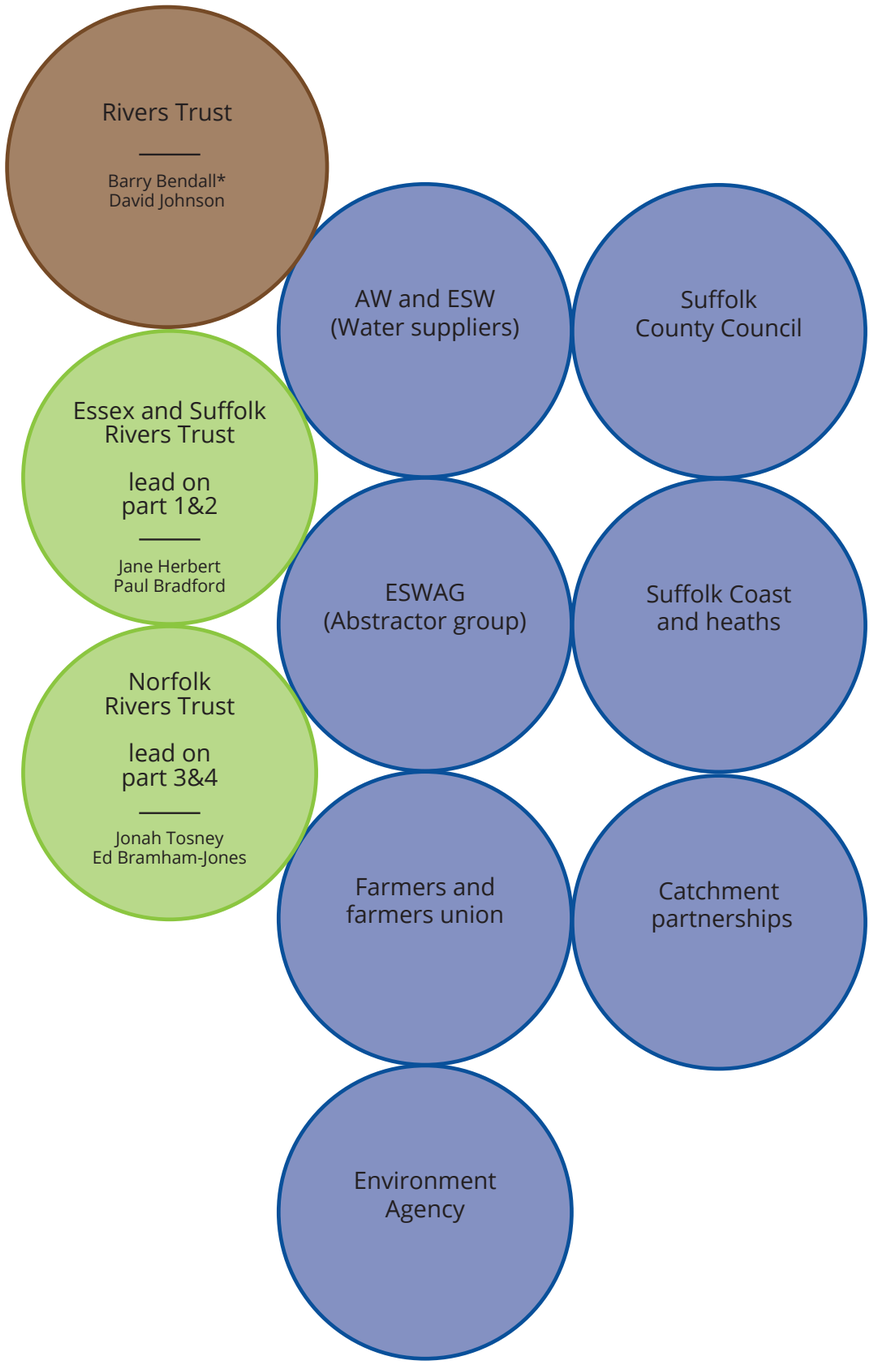
ACTIVITIES

Modeling	Ongoing – Source - pathway – receptor modeling & risk mapping and groundwater model validation.
Farm data	Ongoing – support modeling work, target interventions.
Field Investigations	Ongoing – determine MAR trial sites, sediment inputs, test ground water models, monitor benefits of project measures.
Possible geophysics survey	In development – subject to modeling and field investigation outputs.

UK 2:

ORGANISATION

- LEAD
- PARTNER
- EXTERNAL PARTNER
- STAKEHOLDER

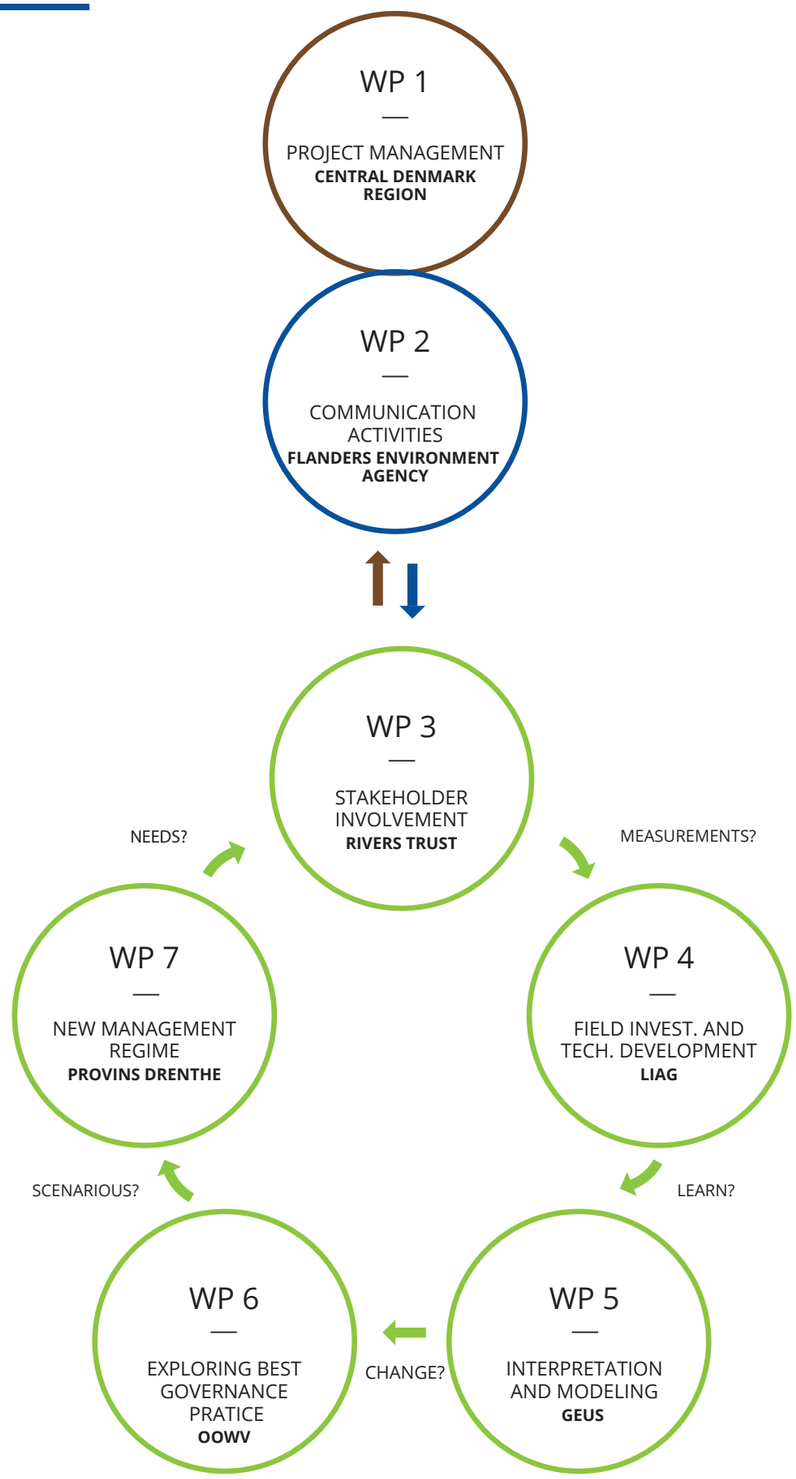


* barry@theriverstrust.org · 07551364639

WORK PACKAGES

AND LIST OF PARTNERS

WORK PACKAGES



PARTNERS

Belgium:
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Denmark:
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Horsens Municipality
Aarhus University
Geological survey of Denmark and Greenland (GEUS)
Central Denmark Region
Region of Southern Denmark

Germany:
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Dachverband Feldberegnung Uelzen (DFU)
Landesamt für Bergbau, Energie und Geologie (LBEG)
Landesamt für Landwirtschaft, Umwelt und ländliche Räume Schleswig-Holstein (LLUR)
Landwirtschaftskammer Niedersachsen (LWK)
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Geologischer Dienst für Bremen (GDfB)

The Netherlands:
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Waterschap Hunze en Aa's
Waterschap Noorderzijlvest

United Kingdom:
Durham University
Northumbrian Water Limited
Essex & Suffolk Rivers Trust
Wear Rivers Trust
Norfolk Rivers Trust
The Rivers Trust

Partner meeting, Hannover, Germany, September 2016

midt
Central Denmark Region

Landesamt für Landwirtschaft, Umwelt und ländliche Räume Schleswig-Holstein

HORSENS KOMMUNE

Universität Bremen GDfB

provincie Drenthe

NORFOLK RIVERS TRUST

AARHUS UNIVERSITY

Herning Kommune

Geologischer Dienst für Bremen GDfB

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

LBEG Landesamt für Bergbau, Energie und Geologie

GEUS

IfAG Leibniz Institute for Applied Geophysics

NORTHUMBRIAN WATER

WATERSCHAP Hunze en Aa's

oowv

Landwirtschaftskammer Niedersachsen

THE RIVERS TRUST the umbrella body of the rivers trust movement where there's water there's life

Essex and Suffolk Rivers Trust

FLANDERS ENVIRONMENT AGENCY

Flanders State of the Art

WEAR Rivers Trust

Waterschap Noorderzijlvest

Region of Southern Denmark

Dachverband Feldberegnung Uelzen

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