THE WATER FRAMEWORK DIRECTIVE EXPLORER:

AN INTERACTIVE TOOL FOR THE SELECTION OF MEASURES

Erwin Meijers, Joost van den Roovaart

Contact:
Erwin Meijers
Deltares

Princetonlaan 6,
3508 AL Utrecht, the Netherlands
erwin.meijers@deltares.nl

1 THE WFD EXPLORER

1.1 What is the WFD explorer?

The WFD explorer is an analysis tool to calculate the effect of restoration and mitigation measures on the ecological and chemical quality of surface waters. Users will gain insight in the effectiveness of programmes of measures in relation to WFD objectives. Measures can be defined both related to point sources such as wastewater treatment plants, and diffuse sources such as agriculture and traffic.. Likewise, it is possible to calculate the effectiveness of restoration measures such as stream re-meandering or the construction of near-natural riparian zones.

The WFD explorer is a flexible tool. Users can easily import or adjust e.g. their own schematisation of a river basin, emission data and area specific characteristics. The user-friendly user interface makes it easy to set up a model structure, perform an analysis and produce reports in an organized and systematic way.

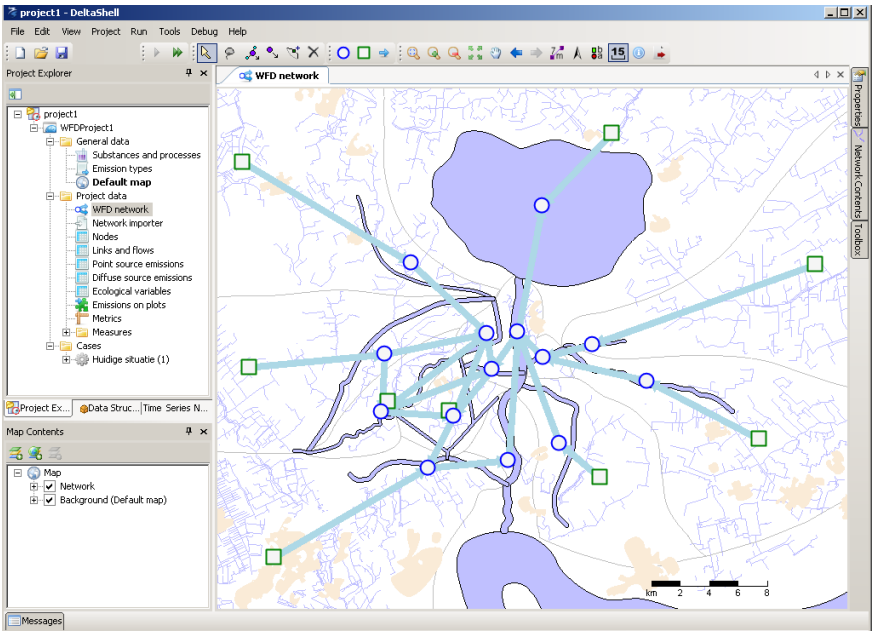

Figure 1 The User interface of the WFD Explorer

The WFD explorer can be used to:

- assess the current status of WFD water bodies;
- compare the effectiveness of measures in relation to WFD objectives;
- gain insight in the effectiveness of programmes of measures;
- gain insight in the differences between various water bodies within the river basin both regionally and internationally as well as between freshwater and marine water bodies;
- stimulate and structure the development of ecological knowledge;
- produce clear reports (maps and tables) to be used in policy briefings, for the communication with stakeholders and as background documentation for reports to the European Commission.

1.2 How does the WFD Explorer work?

The WFD explorer comprises of a water balance, a substance balance and an ecological module. They can be applied together or individually. To import data, the WFD explorer makes use of external databases describing the study areas in terms of as drainage systems, surface water systems, hydrology and nutrient emissions. Hydrological information can be specified by the user or can be imported or derived from 1-D hydrological models such as SOBEK. Emission data can be specified by the user or imported from databases such as the Emission Registration database in the Netherlands. A cost module is available to calculate and map the costs of measures.

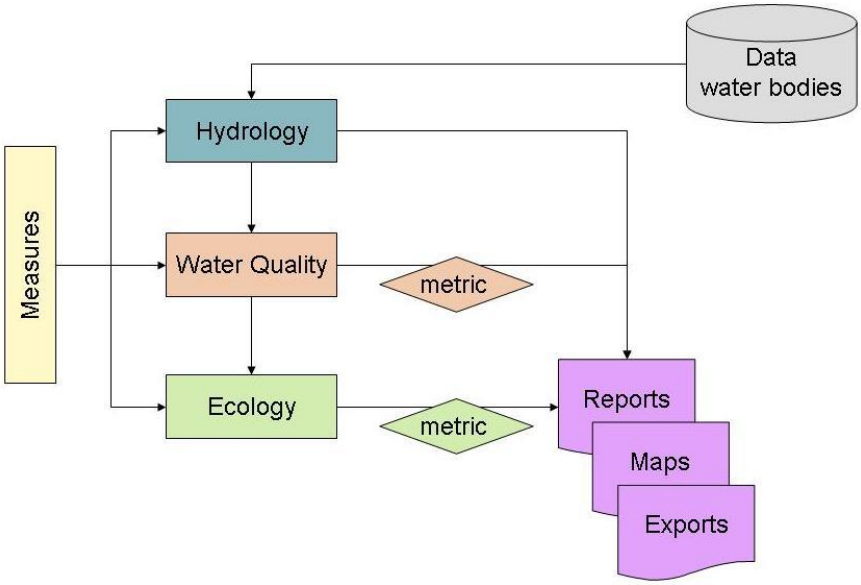

Figure 2 Scheme of processes and workflows in the WFD-Explorer.

1.3 Hydrology and water quality

The WFD explorer uses surface water units as representation of the main waterways and drainage units as a representation of the catchments. The WFD explorer can automatically create these calculation units based on available shape files from a geographical information system (GIS).

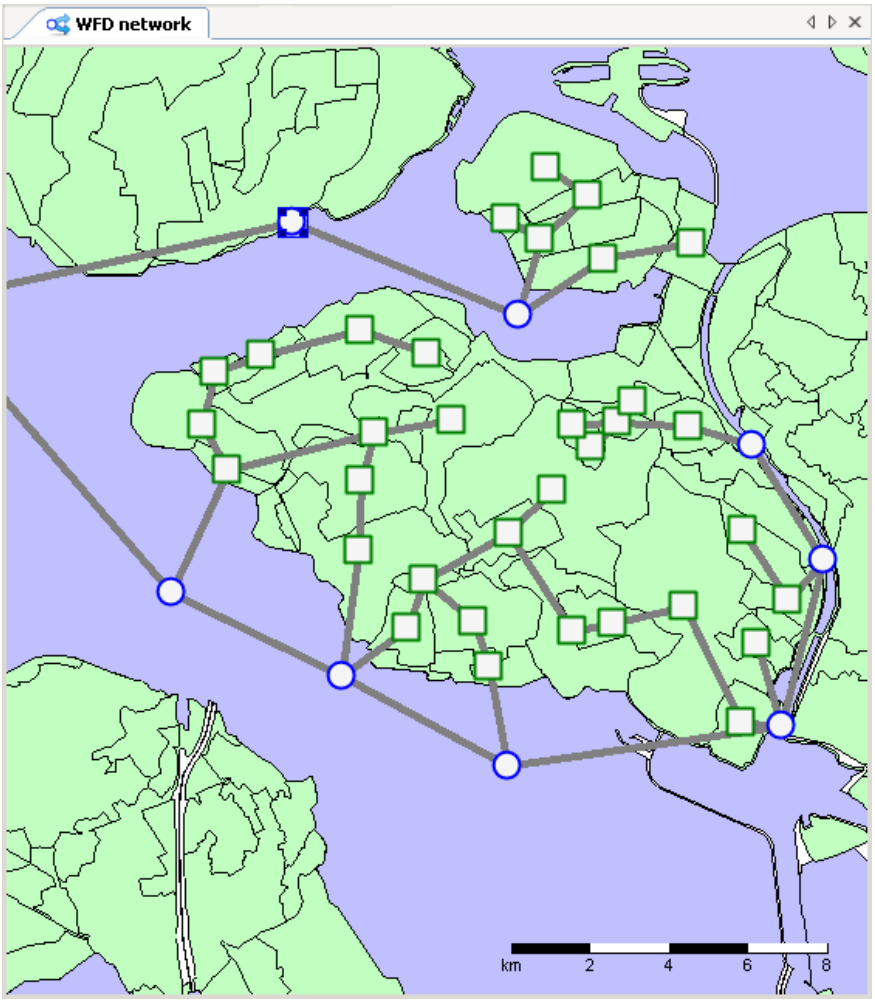

Figure 3 Example of the WFD-Explorer schematization. The surface water units are represented as circles and the drainage areas are squares. The gray connections between the circles and the squares represent the water and mass flows between these nodes.

1.4 The Water Framework Directive

The Water Framework Directive is a European directive which aims to achieve a good ecological and chemical status of all designated water bodies by 2027. Water bodies are assessed on their basis to their chemical and ecological condition. To meet the required chemical condition, the concentration of WFD priority substances and blacklist substances must be below legal standards. The ecological condition is primarily assessed on the basis of biology, by means of the occurrence of aquatic flora, phytoplankton, benthic invertebrates and fish. In addition, physiochemical parameters, such as temperature, chloride and nutrient concentrations, hydro-morphological parameters and concentrations of specific pollutant substances are taken into account.

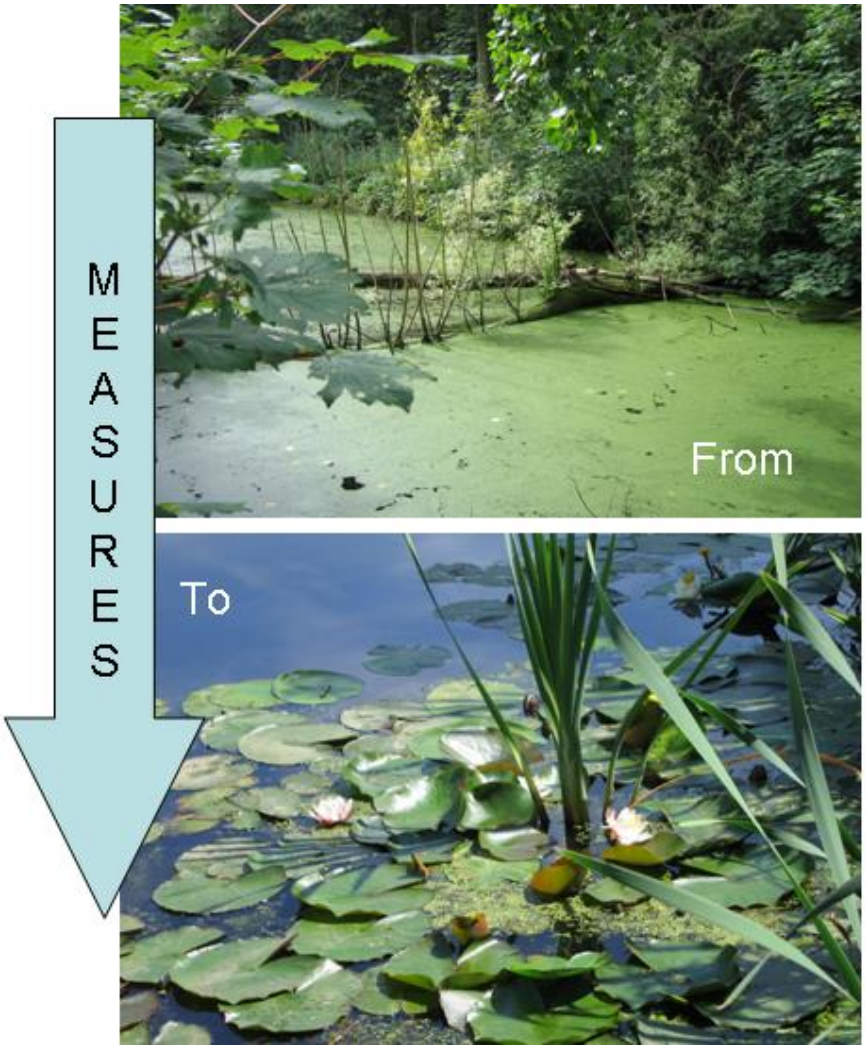

Figure 4 The Water Framework Directive (WFD) aims to achieve good ecological and chemical status in all WFD water bodies

1.5 Calculations

The WFD explorer calculates both the exchange of water and substances (sediment, nutrients) between these units and between water bodies within a catchment.

The WFD explorer performs static calculations based on four periods per year (winter, spring, summer and autumn), but future versions will also include dynamic calculations. The user can add, modify or delete surface water units or drainage water units. Measures to reduce emissions can be simulated in various ways, for instance by entering a higher purification performance for a sewage treatment plant or by simulating a filter system in wetlands or agricultural drains. Available emission information can be easily translated by the WFD explorer to meaningful boundary conditions for the calculation.

1.6 The Ecological module

The ecological module focuses on biology, using 4 biological quality elements (macrophytes, benthic invertebrates, fish and phytoplankton) that together determine the ecological status. In the WFD directive this ecological status is quantified by the EQR-score or ecological quality

ratio. This ecological quality ratio is determined by comparing a current or predicted condition of a water system with the natural or reference condition. The score is given on a scale from 0 to 1, where the reference condition equals 1. Various methods are available in the WFD explorer to calculate the EQR-score for each water unit, including a method based on ecotopes comprising species and abundances. The users can simulate various types of measures by specifying specific surface water characteristics or water quality conditions.

1.7 Results

Various tools are available in the WFD explorer to produce graphical and tabular output regarding water quantity, water quality and ecology, including tabels and charts to show the status of each substance and biological quality element through the five coloured WFD classes. Users can adjust the graphical user interface of the WFD explorer to their own preferences, for instance to compare various measurement programmes.

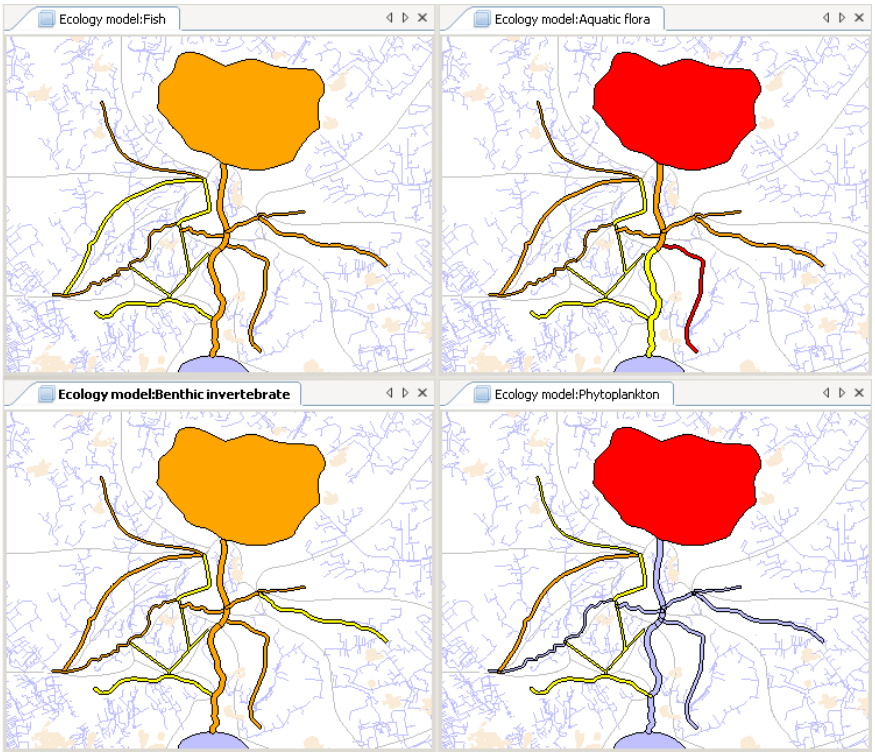

Figure 5 Calculation results are presented in maps or tables. The colour pattern corresponds with the WFD metrics

2 MORE INFORMATION

The new WFD explorer is available free of charge. The WFD explorer is developed by Deltares, PBL and Alterra by order of The Ministry of Infrastructure and Environment, The Ministry of Transport, Public Works and Water Management, the Foundation for Applied Water Research (STOWA) and “Het Waterschapshuis” (the executive agency on Information and Communication Technology for the 26 regional water authorities in The Netherlands).

Website: www.krwverkenner.nl

Contact: joost.vandenroovaart@deltares.nl or erwin.meijers@deltares.nl

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Enabling Delta Life

WFD - Explorer 2.0

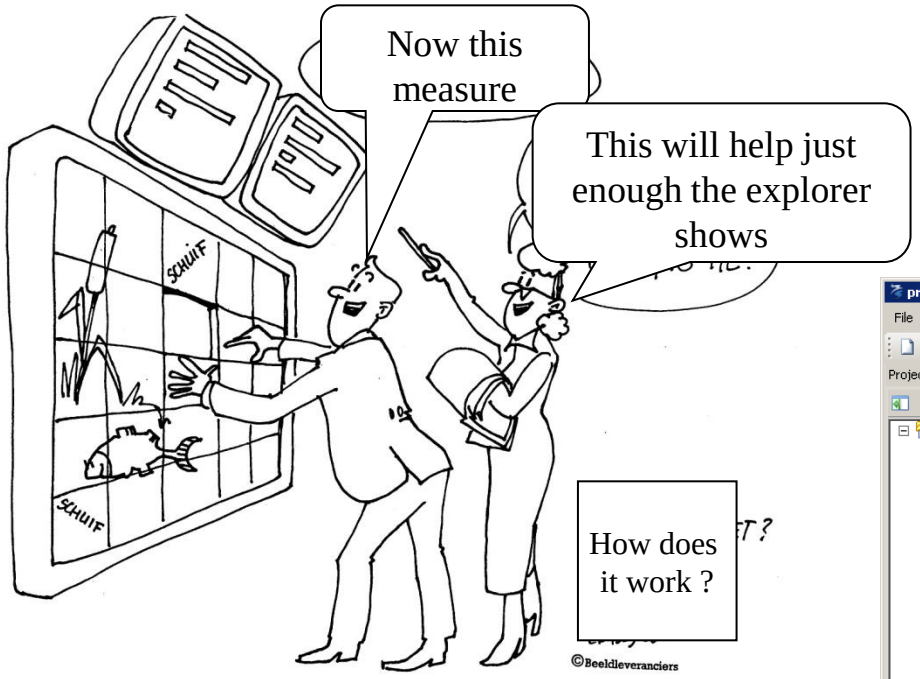
Karlsruher Flussgebietstage

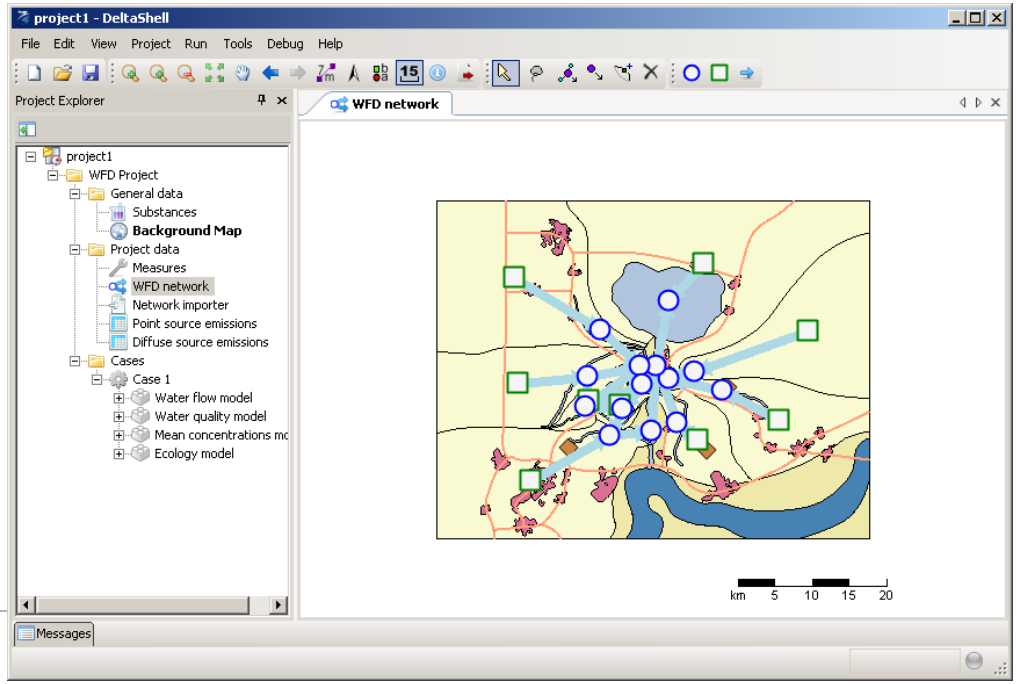
Erwin Meijers, Joost van den Roovaart

June 21th 2013

WFD-Explorer

An interactive tool for the selection of measures





It sounds simple …

today

research

measures

2015 - 2027

“Green soup”

“Good ecological potential”

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The Water Framework Directive (Europe)

- Target is to reach Good Ecological Status (GES) in EU in 2015 - 2027
- Targets are defined for various quality elements :
  - > Phytoplankton (algae)
  - > Aquatic flora
  - > Benthic invertebrates
  - > Fish
- The target is linked to the reference situation for natural waters
- Derived targets for non-natural (artificial, heavily modified) waters: Good Ecological Potential (GEP)
- Scores per quality element: Ecological Quality Ratio (EQR)

Bad	Insufficient	Fair	Good	Very good
EQR < 0,2	EQR 0,2-0,4	EQR 0,4-0,6	EQR 0,6-0,8	EQR > 0,8

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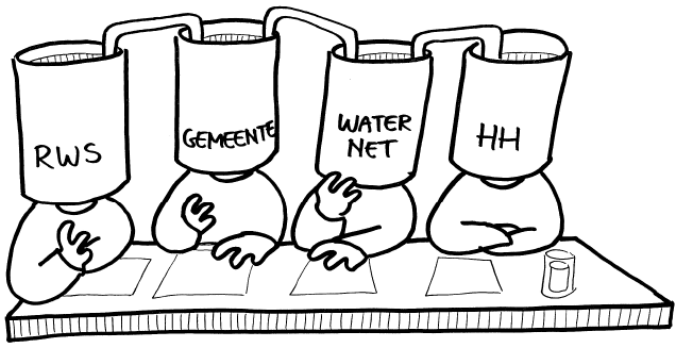
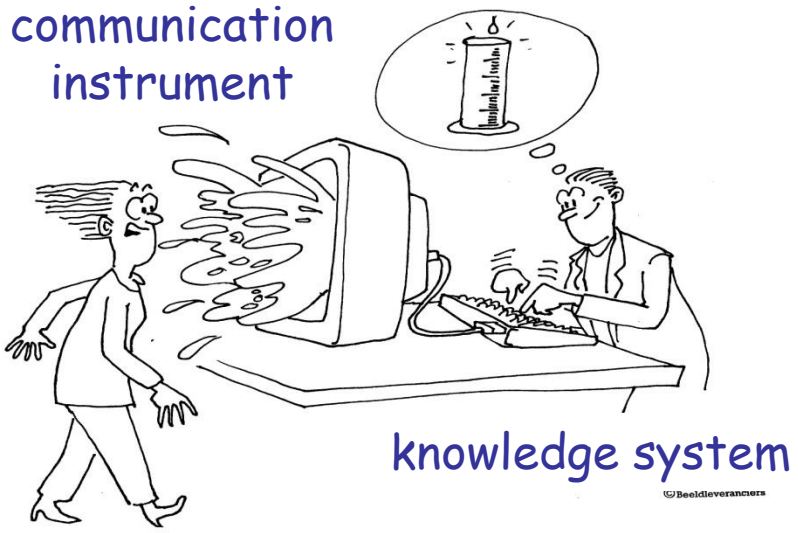
Objectives of the WFD-Explorer

- Support the drafting of a River Basin Management Plan (RBMP)
- Select the (most cost effective) measures for the RBMP
- Determination of the good chemical and ecological status / potential of the water bodies
- Stimulate the communication with stakeholders
- Encourage uniformity in the knowledge that is being used





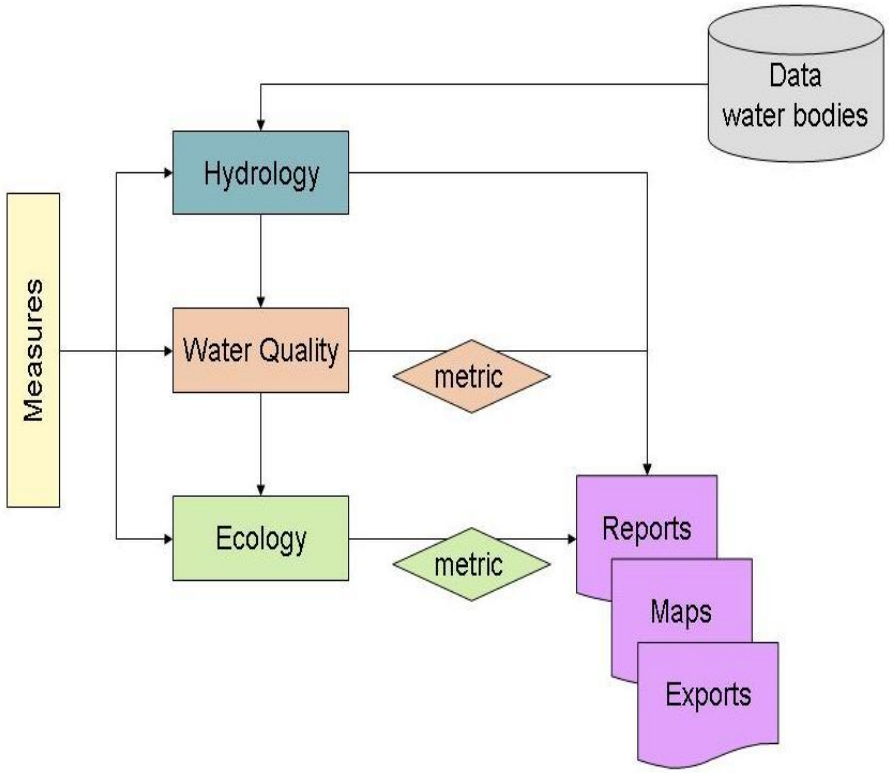
Role at implementation WFD

- Analyse effects of generic and regional package of measures
  - effect on ecology
  - effect on water quality
  - costs

  } do you reach the WFD-target?
- Information system for “measure – effect relation” (setup of documentation for EU)
- Next phase: develop basin management plans

Schematic overview WFD Explorer

- Hydrology and Water Quality
  - steady state
    - $\Sigma Q_{in} = \Sigma Q_{out}$
    - $\Sigma M_{in} = \Sigma M_{out} + M_{retention}$
  - seasonal forcing (4 periods/y)
  - simplified first order decay processes
  - dynamic calculations planned
- Ecology
  - several methods available
  - based on statistical relations
  - easy to expand with new data



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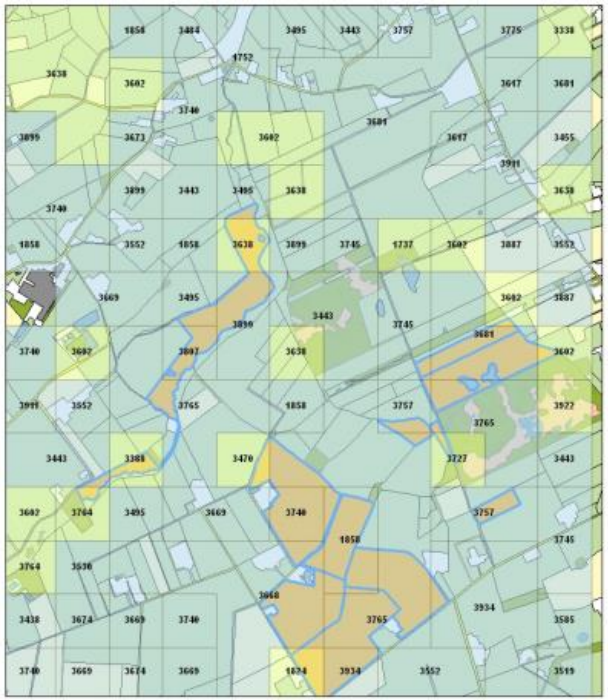
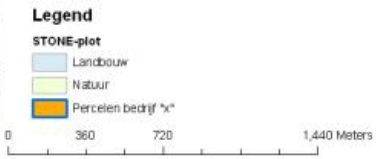
Emissions in the WFD-Explorer

1. Point Sources
   - Name
   - Id
   - Emission Type
   - Location

2. Diffuse Sources
   - Emission Type
   - Location (lumped)

3. Emissions on Area's
   - Emission Type
   - Location (lumped)
   - (Measure)





2009 Van der Salm et. al.

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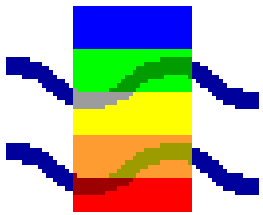
Ecology (Dutch data sets)

National

Regional data

Ecotopes
Species
Abundancy

Key factors
Layout
Substances
Maintenance



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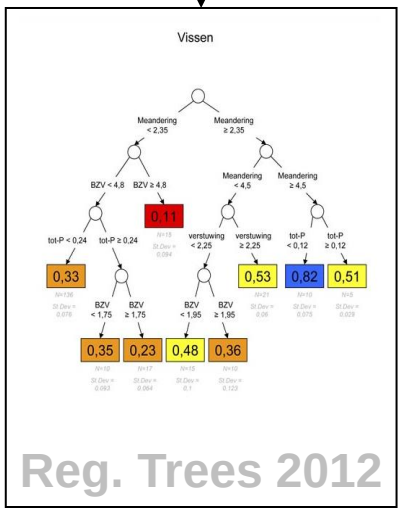
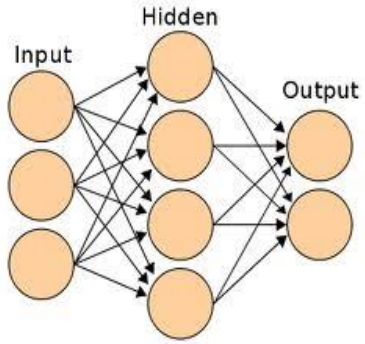
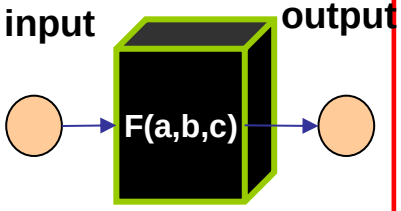


Reg. Trees 2012



Neural Network



PUNN

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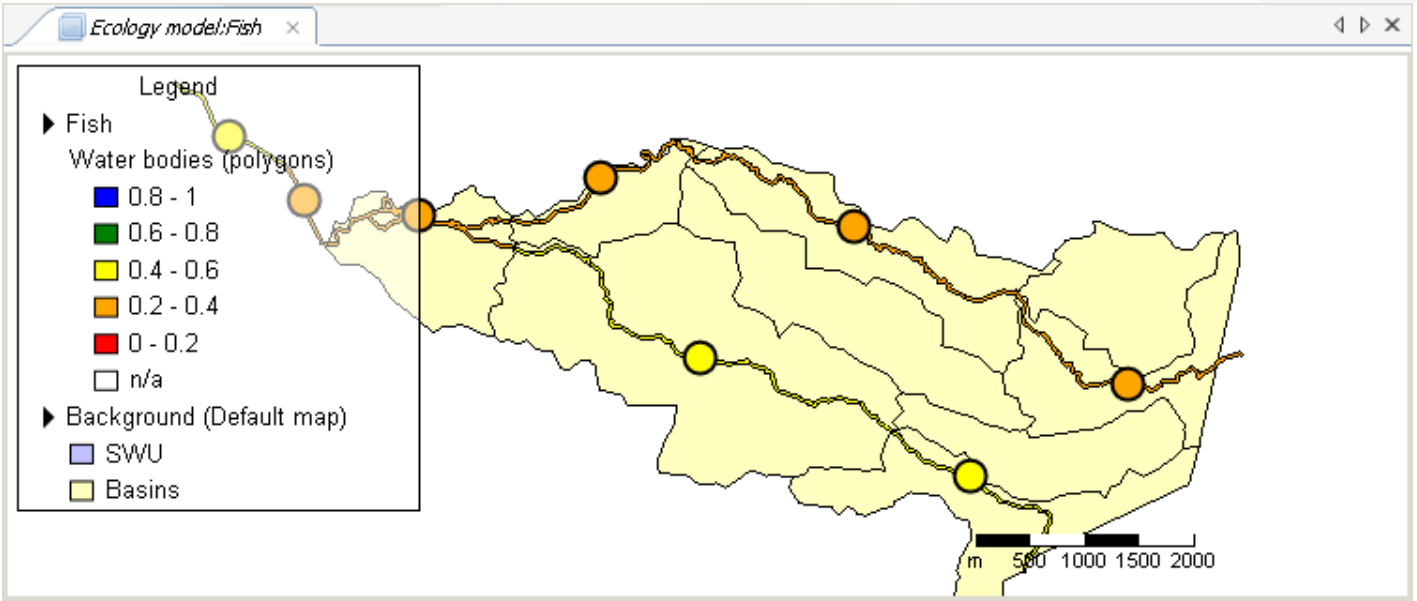
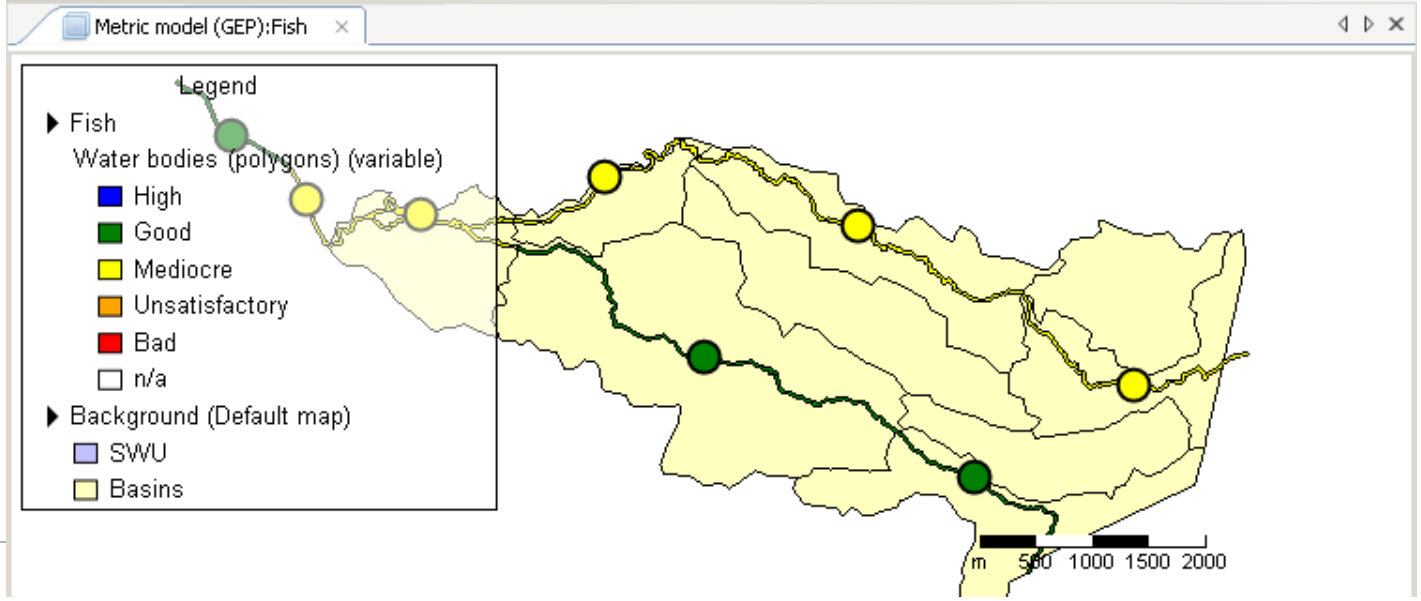
Metrics

GES

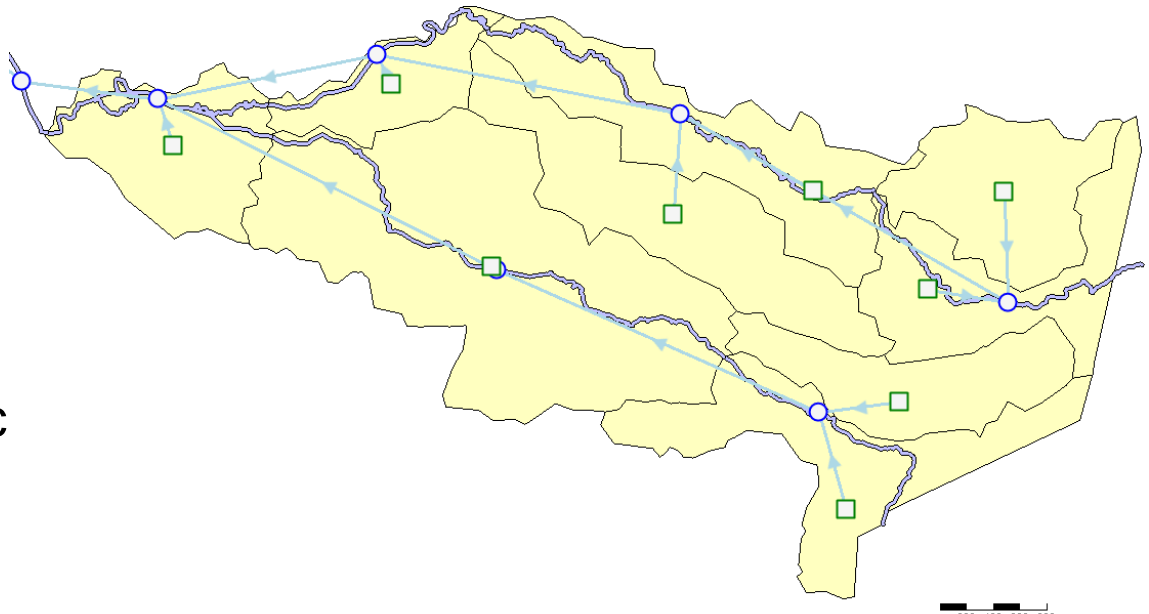
GEP





River Basin data

- Water network
  - Surface Water (Waterlichamen);
  - Catchments; and
  - routing
- Emissions
  - water; and
  - Substances
- Ecological parameters
  - Layout; and
  - Maintenance
- GIS material, maps, etc



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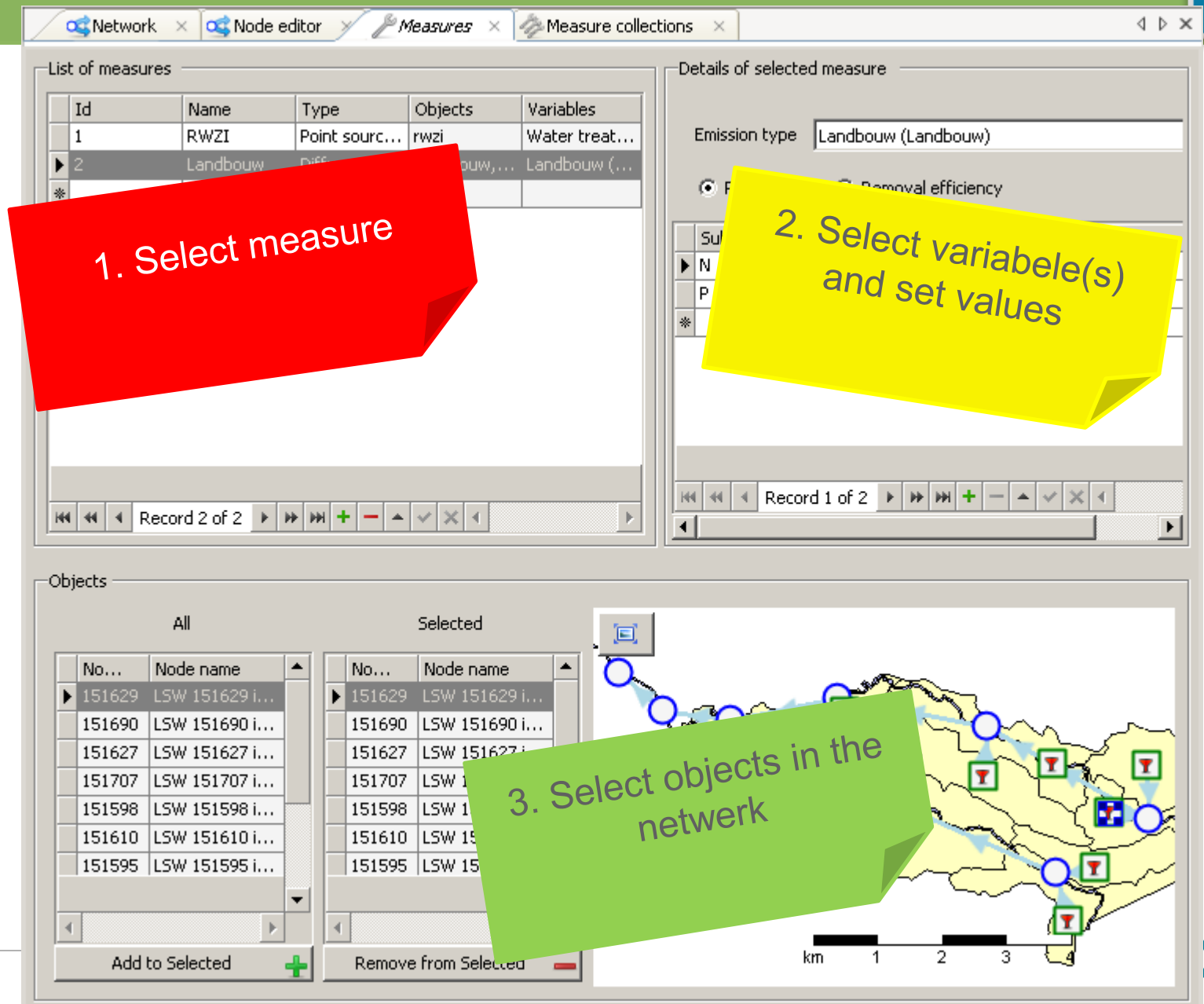
Measures


Network
Node editor
Measures
Measure collections
List of measures
Id
Name
Type
Objects
Variables
1
RWZI
Point sourc...
rwzi
Water treat...
2
Landbouw
Landbouw (...
Record 2 of 2
1. Select measure
Details of selected measure
Emission type
Landbouw (Landbouw)
Removal efficiency
Record 1 of 2
2. Select variabele(s) and set values
Objects
All
Selected
No...
Node name
151629
LSW 151629 i...
151690
LSW 151690 i...
151627
LSW 151627 i...
151707
LSW 151707 i...
151598
LSW 151598 i...
151610
LSW 151610 i...
151595
LSW 151595 i...
Add to Selected
Remove from Selected
3. Select objects in the netwerk
km
1
2
3

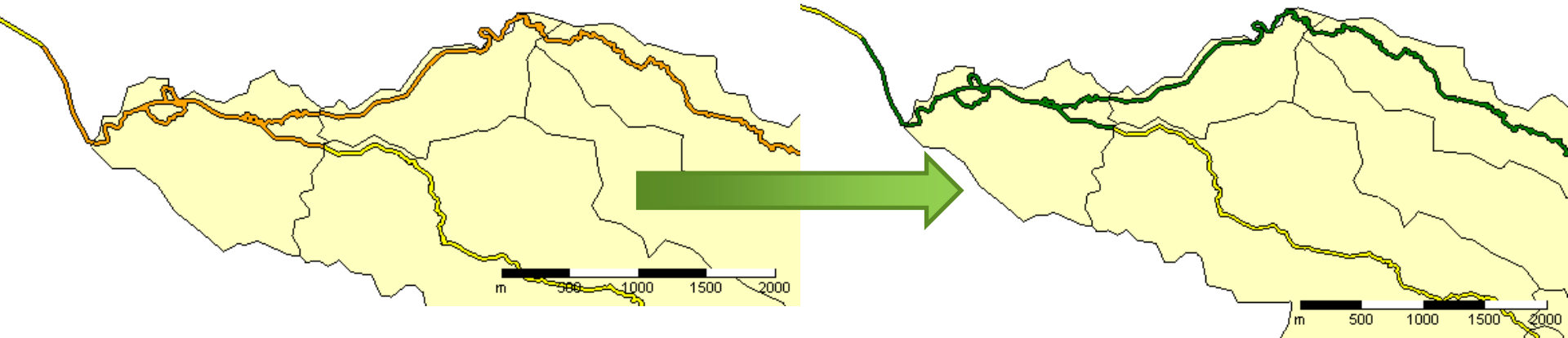
Types of measures

Emission reduction:

- Increased treatment of waste water (Household and Industries)
- (international) policy on fertilizer use

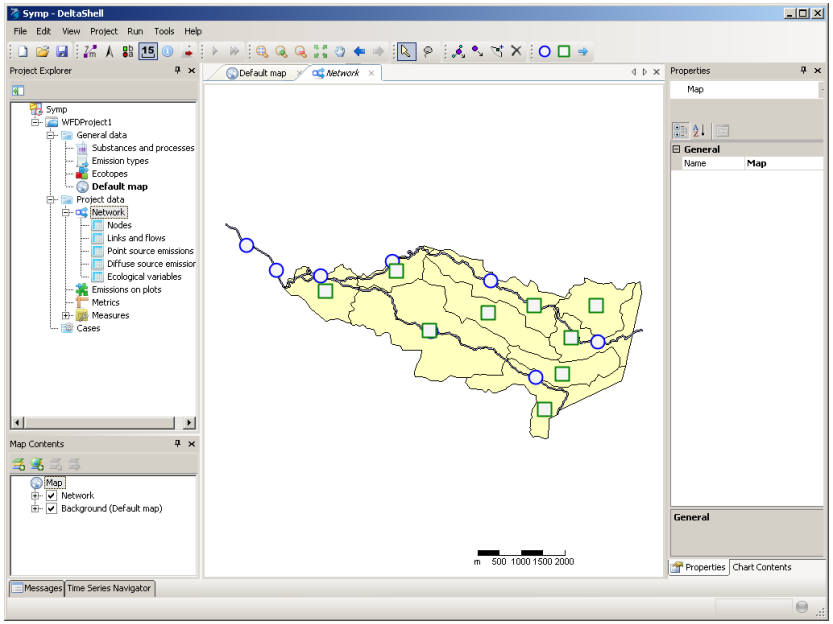
Ecological measures:

- Introduction of helophytes and wetlands (filters)
- nature friendly river banks
- restore meandering in small streams



How to set up a schematisation

- By scratch, manual by GUI
- Generate by GIS information and data
- Retrieve information from hydrodynamic models (i.e. SOBEK)



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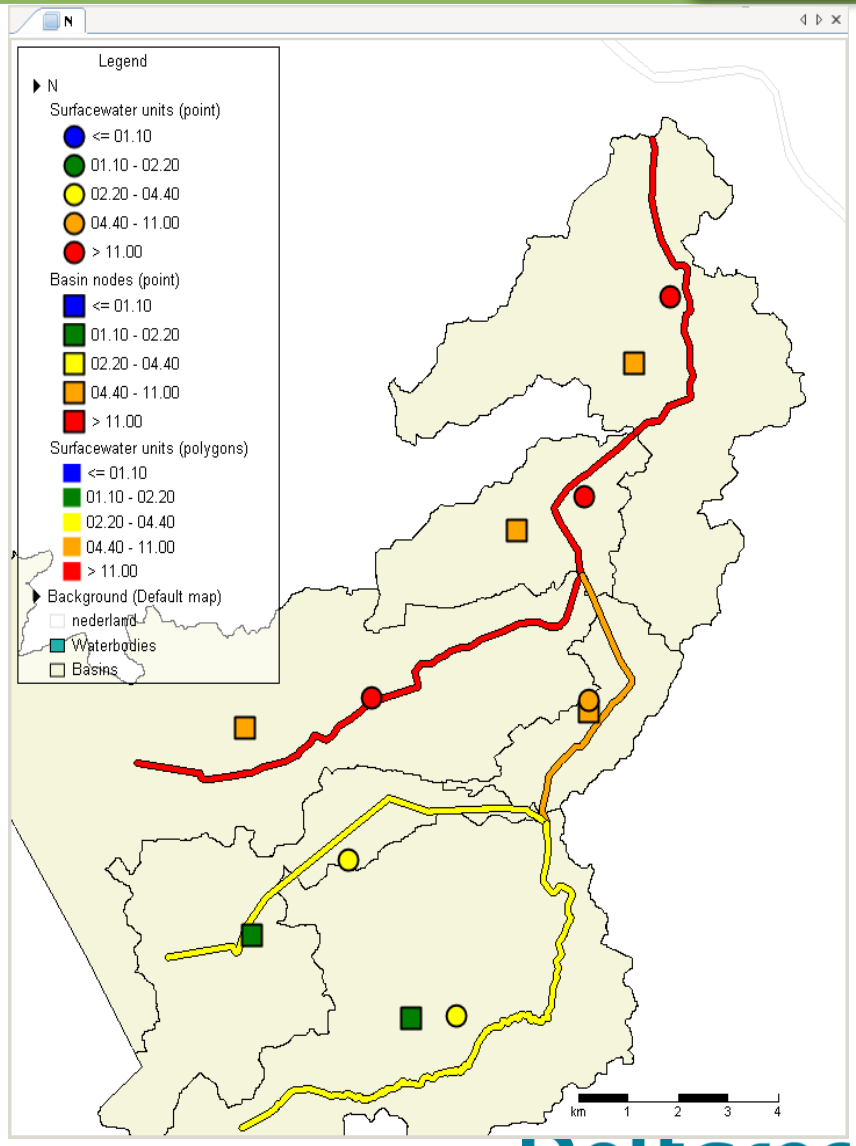
Results of computations

Result split into layers:

- “Real world” layer:
  - Polygons, i.e. Waterbodies
- Schematic network
  - Basin Nodes
  - Surface Water Units



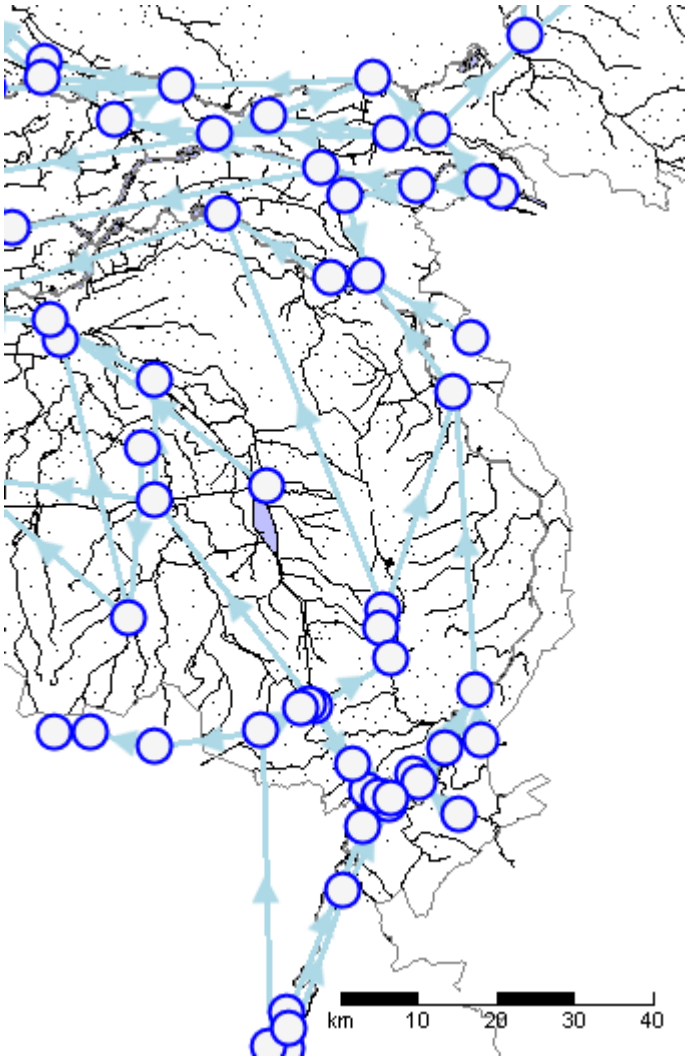
Application: an example

National schematisation of the Netherlands:

- Based on National Hydrological Instrument (NHI)
  - Ground water (250 m*250 m)
  - Surface water (± 8800 units)

- WFD- explorer schematisation
  - WFD water bodies
  - 18000 nodes
  - Emissions from (PRTR, STONE)

- Cases:
  - Nutrients (Ntot, Ptot)
  - Priority substances (30+)



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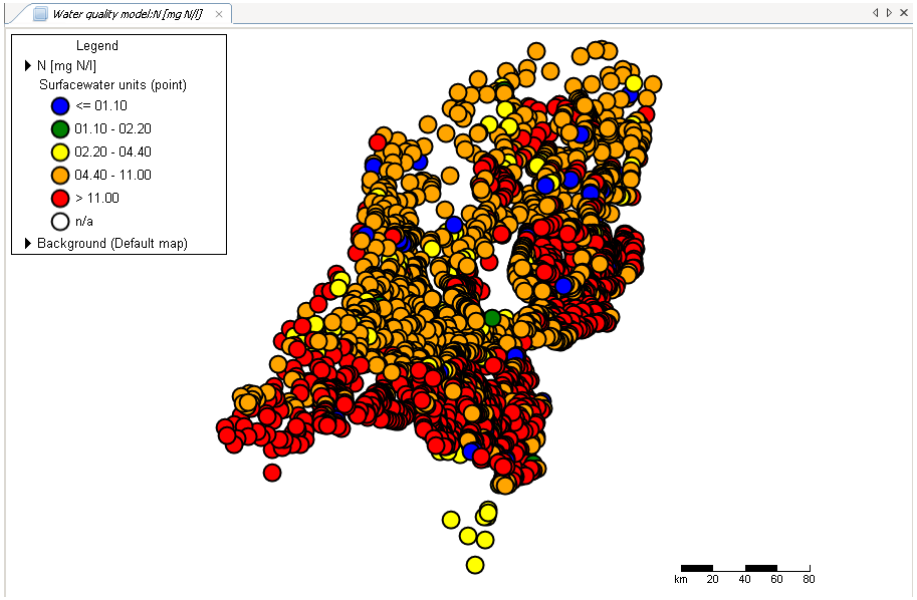
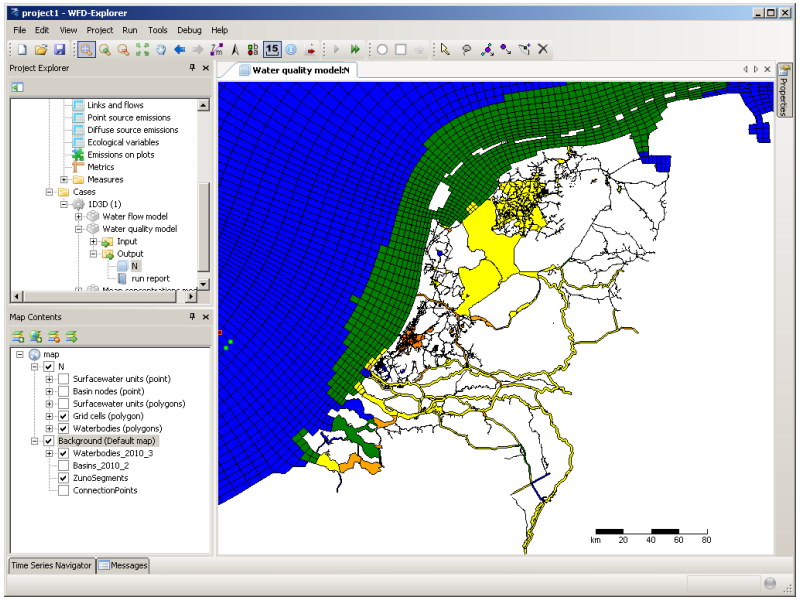
Nutrient case (pilot)

Objectives:

- Evaluate River Basin Management Plans, emission reductions
- Gain insight in nutrient flows in the Netherlands
- Present results to WFD Water bodies
- Present the effect of the measures on the North sea coast





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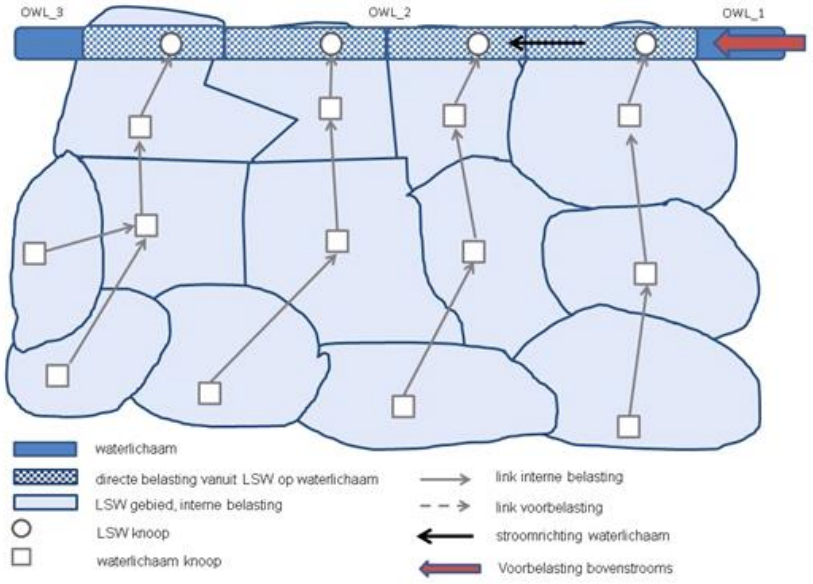
Priority substances

Objective:

- What is the contribution of different sources on the loading of priority substances on a water body level
  - 1. Direct loading on water body
  - 2. Loading on catchment of a water body
  - 3. Inflowing loads

Method:

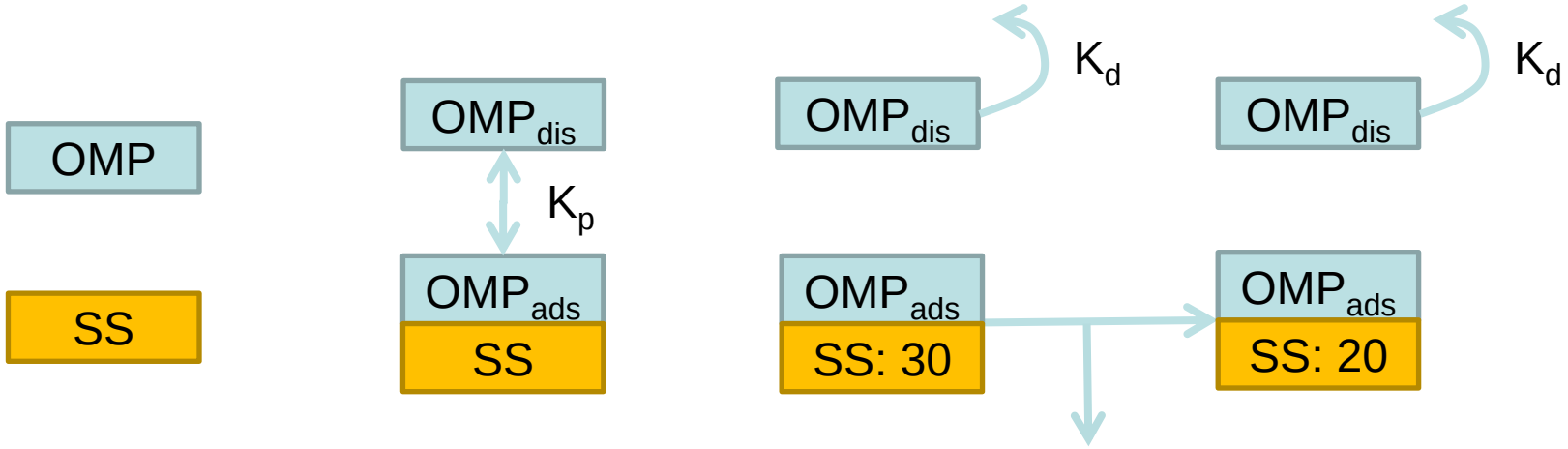
- National schematisation
- 30 substances
- Emissions from PRTR
- Extra processes added



Adsorbed substances

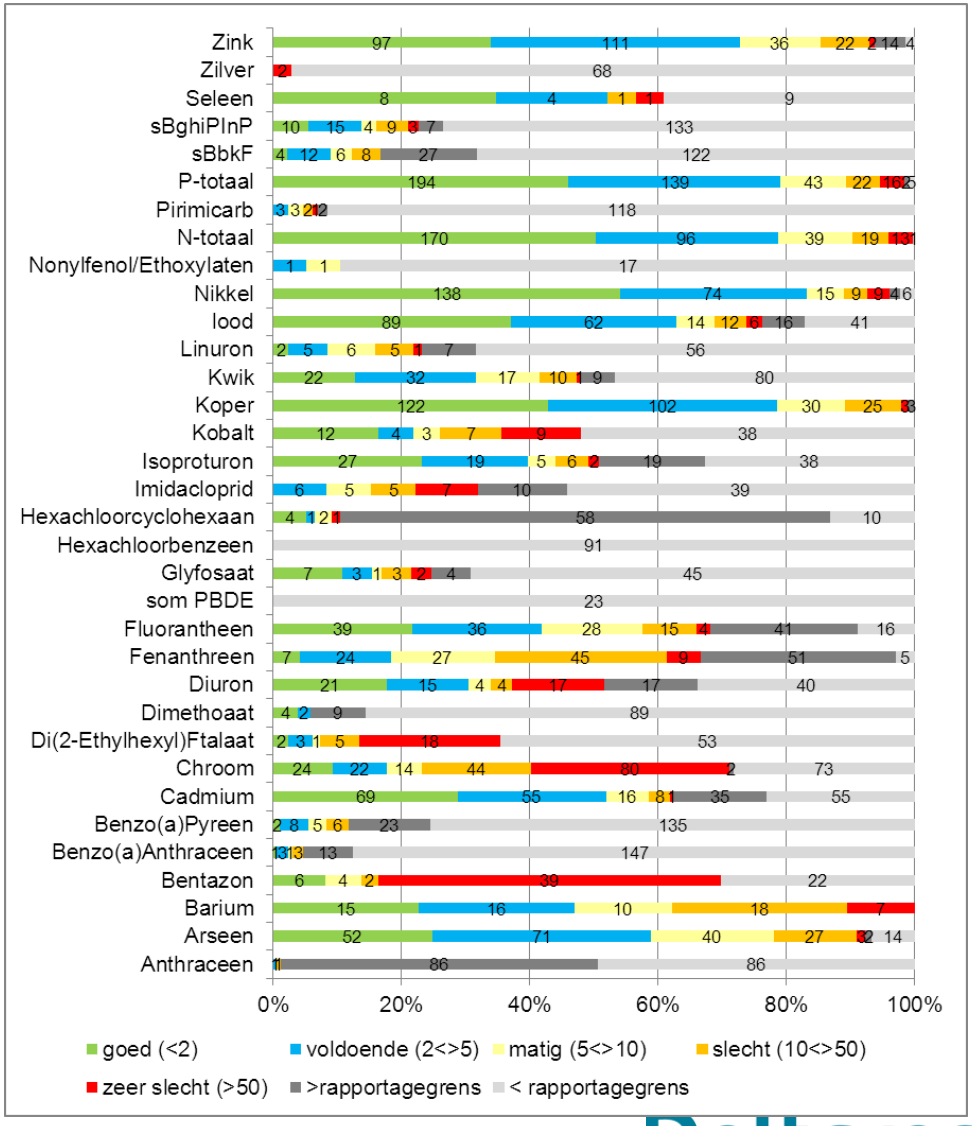
Process formulations (added to standard WFD-Explorer):

1. adsorption to SS by partition coefficient K_p
2. sedimentation of adsorbed fraction by difference in Suspended Solids concentrations (when concentration drops)
3. Decay of the dissolved fraction (biodegradation, photolysis, volatilization)



Substances taken into account (30+)

- Priority substances
  - N, P
  - Cd, Zn, Pb, Cr
  - Imidacloprid
  - ..
- Rhine Substances List
  - Bentazone
  - Phenanthrene
  - ..



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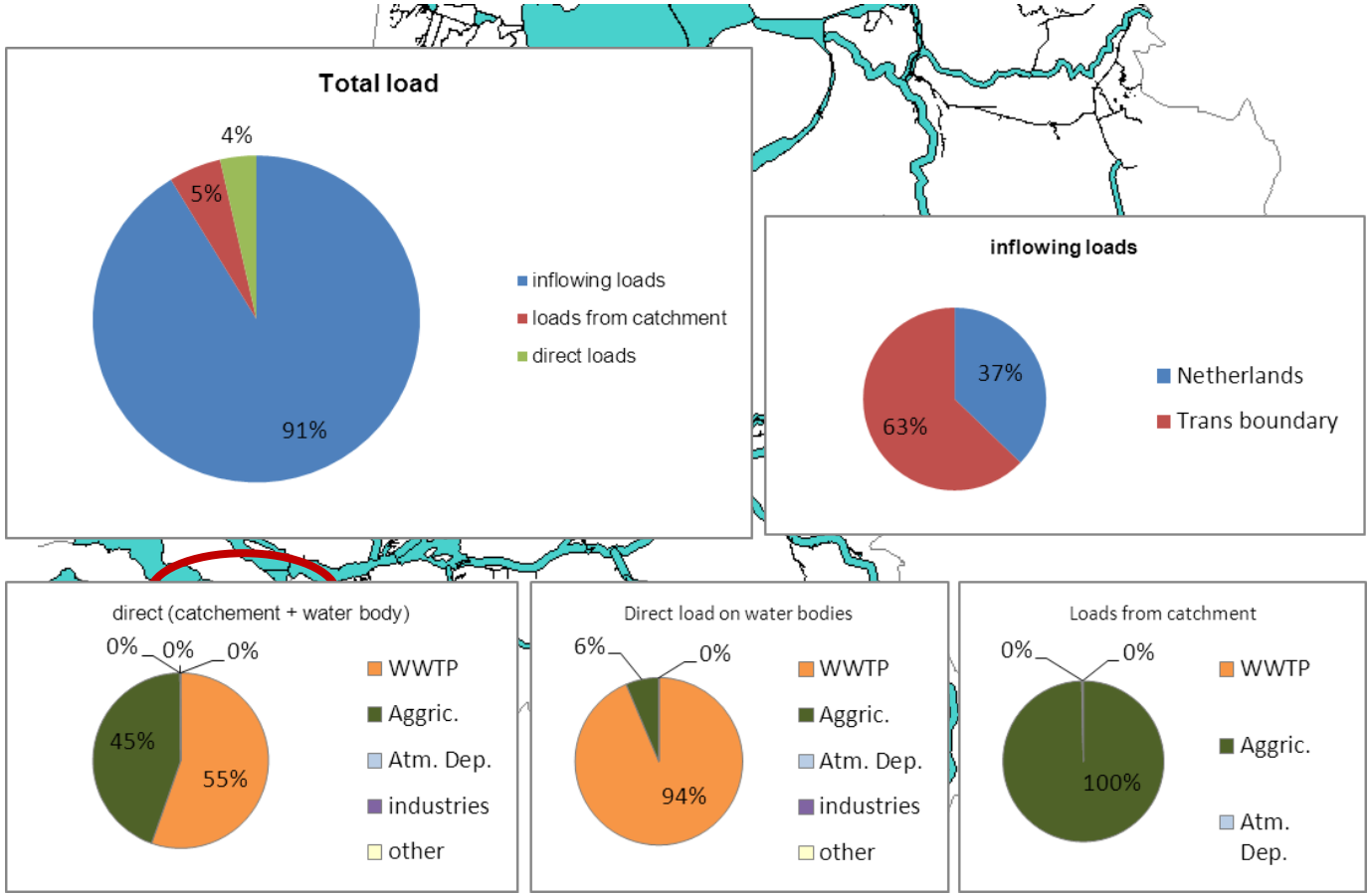
Results: Pie charts of contributions

Ntot on water body **“Volkerak”**



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Future developments

- Dynamic computations (hydrology, water quality)
- Access to detailed water quality processes library (DELWAQ)
  - Nutrients
    - fractions: NH4, NO3, orgN, etc.
    - processes: (de)nitrification, uptake by algae, etc.
  - HM, OMP: Sedimentation and resuspention, detailed decay
- International knowledge rules for Ecology

WFD – Explorer: Information

Development:

Website (Dutch):

- http://public.deltares.nl/display/KRWV/KRW-Verkenner

Contact:

- Joost van den Roovaart (joost.vandenroovaart@deltares.nl)
- Erwin Meijers (erwin.meijers@deltares.nl)

Thanks for your attention!