**Project no. 505428 (GOCE)**

# AquaTerra

**Integrated Modelling of the river-sediment-soil-groundwater system; advanced tools for the management of catchment areas and river basins in the context of global change**

**Integrated Project**

**Thematic Priority: Sustainable development, global change and ecosystems**

***Deliverable No.:*** **BASIN R3.17**
***Title:*** **Chapter in Basin report for Meuse case on updated research questions and detailed research plan for month 25-42, including a new work package description**

**Due date of deliverable: March 2006**
**Actual submission date: March 2006**

**Start date of project: 01 June 2004** **Duration: 60 months**

**Organisation name *and contact* of lead contractor *and other contributing partners* for this deliverable:**
**TNO, P.O. Box 342, 7300 AH Apeldoorn, The Netherlands**
**Jan Joziasse** jan.joziasse@tno.nl
**Jos Vink (RIZA), Eric Kessels (AbdK), Serge Brouyère (HGULg), Claire van der Wielen (ISSeP)**

**Revision: H. Rijnaarts / J. Barth**

| **Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)** | | |
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| **Dissemination Level** | | |
| **PU** | Public | **X** |
| **PP** | Restricted to other programme participants (including the Commission Services) | |
| **RE** | Restricted to a group specified by the consortium (including the Commission Services) | |
| **CO** | Confidential, only for members of the consortium (including the Commission Services) | |

## SUMMARY

The work plan for the period Month 25 – 42 is presented in this deliverable. The activities foreseen are a logical follow-up of the past activities, so no major updates compared to the previous description of work (covering months 13 – 24) was needed.

**MILESTONES REACHED**

- R3.6: Steps for realization of GIS-DSS for the Meuse have been defined (Month 18)
- R3.7: Data analysis for Dommel samples performed, plan for application of GIS-DSS system in the Dommel sub-catchment ready (Month 18)
- R3.8: Piezometric surveys, groundwater sampling and monitoring for the Flémalle former cokery site performed (Month 18)

Besides the milestones listed above (taken from the DoW for months 13-24), also contacts have been made and intensified with stakeholders in the Meuse basin, including the International Meuse Commission (IMC). A workshop was organised in Liège together with the Integrator I2 work package and AquaTerra contributions will be presented in a meeting of the IMC in 2006.
For the Dommel sub-catchment a meeting was organised in Eindhoven (Janurary 31$^{st}$, 2006) with AquaTerra participants from Trend (T1), Biogeochem (BGC2) and Flux (F3) work packages. Also possible interaction with the Interreg Benekempen project was discussed. A next meeting is planned in the autumn of 2006. These meetings serve to exchange views, communicate mutual results and increase coherence between the partners active in the Dommel region.
For the activities in the Walloon part of the Meuse, conducted by HGULg, co-operation is foreseen with Biogeochem partners (for the Flémalle site) and with Hydro (H1) and Integrator (I2) work packages for the Geer basin.

| WP | T | Description | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R3 | | **BASIN Meuse** | | | | | | | | | | | | | | | | | | |
| | 1 | Perform field experiments and facilitate sampling for scientific sub-projects | | | | | | | | | | | | | | | | | | |
| | 2 | Perform site-specific activities like stakeholder contacts | | | | | | | | | | | | | | | | | | |
| | 3 | Interpretation of field experiments and results | | | | | | | | | | | | | | | | | | |
| | 4 | Reporting, plan next DoW | | | | | | | | | | | | | | | | | | |

## BASIN 3 MEUSE

| **Work package number** | R3 | **Start date or starting event** | | | Month 25 |
|---|---|---|---|---|---|
| **Activity Type** | RTD/Innovation | | | | |
| **Participant id** | TNO | RIZA | ABdK | HGULg | ISSeP |
| **Person-months per participant** | 7.7 | 4 | 4 | 11 | 8 |

**Objectives**

- Development of a spatial, interactive decision support system (DSS) to calculate the chemical speciation of heavy metals in floodplain sediments under various environmental conditions. Effects of redevelopment measures, such as river widening, storage, and nature restoration, are assessed by scenario comparisons.
- Improve the soil, sediment, groundwater and river quality in the Dommel (a tributary to the river Meuse)
- Quantification of groundwater quality effects by river - groundwater interaction in the Belgian part of the Meuse system.
- Quantification of coupled ecotoxicological effects of contaminants from sediment, suspended solids and freshwater on aquatic organisms in the river Meuse

**Description of work**

**Floodplain sediments.** In the Netherlands a number of river basin management actions are being executed and/or planned, aimed at increasing the discharge capacity of the Meuse and at nature development. The guidelines followed with these management actions are known as ‘Active Soil Management’. In an earlier research program the fate and behaviour of heavy metals in sediment was studied including redox conditions, and accumulation by sediment dwelling organisms (flora and fauna). For the construction of a decision support system (DSS) – as described in deliverables R3.8 and R3.9 - separate chemical and toxicological modules are developed, enabling the time-spatial dynamic analysis of both "bioavailability" in soils and ecotoxicological risks to organisms. An existing data-set for the MEUSE will be used to validate the chemical speciation modules. This data-set will also aid in the construction of a soil-plant uptake module for 16 site-specific plant species.

A state of the art chemical speciation module is operational and is adapted to river flood plain systems carrying redox-dependent speciation scenarios for the flood plains in the Meuse and other similar river systems. For a representative selection of Meuse locations, the effects of speciation changes, as a result of changing environmental conditions, is analysed by using time dynamic exposure functions for biota (flora and fauna). The environmental conditions are specified by so-called scenarios. These will be worked out in the DOW III period, although some scenarios are already formulated (e.g., the effect of larger river discharges, resulting in more and longer flooding, on metal mobility its ecotoxicological consequence). The scenarios will be individually documented. The conclusions will primarily be site-specific, but we will give a first instance of a generic analysis for selected environmental pressure points, or patterns for the Meuse river system

Links with the active soil management actions mentioned above are obvious:
*Soil – groundwater – river interactions:* On the one hand the storage of contaminated soil or

sediment in clay screens, sand and gravel pits, etc. has favourable effects by reducing the contact area between the contaminated material and water. On the other hand it may induce increased spreading of contaminants in the groundwater in the vicinity of the storage facility (and eventually into the river). It is not likely that the magnitude of this effect can be measured in a time period of a few years. Therefore use has to be made of models to get insight in the spreading processes for a number of locations alongside the river and in the factors by which these processes are determined, e.g. river water height, soil composition, groundwater flow, etc. This research subject is related to FLUX (Inter-compartment fluxes soil –groundwater - surface water).
*Flood plain sediments – river interactions:* When a floodplain is lowered a new surface is created. This surface largely has a better environmental quality than the original top soil (provided that it is not covered with a top layer of the original material). The lowering of the floodplains therefore gives a unique opportunity to monitor the loading of relatively clean soil with deposits of contaminated material brought down by the river. The monitoring results can serve to calibrate models developed to predict effects of contamination carried down and deposited by the river on soil quality in the floodplains and in the estuary. Soil quality development is the result of sedimentation and resuspension of particles, vertical mixing of soil by the action of biota and of migration, redistribution, immobilisation and biodegradation of contaminants. Factors to be accounted for are changes in land-use (for instance from agriculture to river-associated nature), emission reductions, etc. This research subject is related to TREND and BIOGEOCHEM.
**Catchment the Dommel.** The Dommel is a tributary to the river Meuse flowing through an ore melting industrial area for the production of zinc. These activities took place since one century at both sides the Dutch-Belgian border, leading to atmospheric deposition of zinc and cadmium on agricultural land and in nature reserve soils. The ore slacks were used as road construction materials and as yard elevation materials in the whole region. The consequence is that top soils, groundwater, river sediments and surface water are extensively contaminated with zinc and cadmium. Together with Belgian and Dutch authorities, the soil and water management organisation "Actief Bodembeheer de Kempen" follows an integrated system approach to improve the soil, sediment, groundwater and river quality in the Dommel. This system approach is hindered by a number of knowledge gaps, that are related to the research programmes as performed in the project. The research activities done within this work package interact with the research blocks BIOGEOCHEM, FLUX, COMPUTE and TREND.
**Belgian (Walloon) catchments of the Meuse system*; river-groundwater interaction***

In the period of Month 25-42, the objectives of HGULg will be:

- To finalize field investigations and surveys on the Flémalle cokery site (milestone: M28)
- To model groundwater flow and contaminant transport in the Flémalle site and between the site and the Meuse river (milestone M30)
- To model the impact of climate changes on groundwater resources of the Geer sub-catchment using climate scenarios prepared by HYDRO H1
- To contribute to the evaluation of global change scenarios together with INTEGRATOR I2 on the Geer basin (to be confirmed by BRGM C.Hérivaux)

In the period of month 25-28, HGULg will finalize the field investigations in the Flémalle cokery site: piezometric surveys, groundwater sampling and monitoring, ultimate tracer experiments (single well and multi well). In the period of month 25-30, the groundwater flow and contaminant transport model developed to quantify groundwater flow rates and contaminant mass fluxes in the site and to the river will be finalized and available for evaluating specific contaminants' behaviour (heavy metals, organic pollutants) using results coming from BIOGEOCHEM (to be confirmed by BIOGEOCHEM partners involved in Flémalle). A groundwater flow and transport model will be developed for the Geer sub-catchment (tributary of the Meuse), used for assessing the impact of climate changes on groundwater resources in that catchment (in collaboration with HYDRO H1).

**Belgian (Walloon) catchments of the Meuse system; *ecotoxicological effects of contaminants*.**

In the end, the study of the interactions (transfer rate, flux,…) between contaminants and different compartments is to be expressed in a "comprehensive effect on the environment". The study of biological effects on the organisms leads to a direct evaluation or answer to the models and may

be considered as a validation tool. The models indeed are mainly based on a substance approach rather than on a biological effect approach. Moreover, organisms are part of the functioning of the ecosystem and therefore functioning of the basin.

The battery of bioassays will be defined and applied on (additional) samples from the locations selected before, and on selected media, in order to enhance the robustness of the results and to refine the outcomes. Results will be compared with biological index, chemical data and model results in order to achieve the goal of quantifying coupled toxicological effects and modelling the functioning aspects of the river Meuse.

**Table of Deliverables**

| Name | Deliverable content | WP | Contractor | Month | Date due |
|---|---|---|---|---|---|
| R3.19 | Update on field experiments and description of the groundwater flow and transport model for the Flémalle cokery site | R3 | HGULg | 30 | Nov. 15, '06 |
| R3.20 | Application of DSS system in the Dommel sub-catchment; evaluation of results | R3 | RIZA / TNO | 36 | May 15, '07 |
| R3.21 | Intermediate report on the development of the Geer hydrological model (surface and subsurface water) for climatic change scenario on that sub-catchment | R3 | HGULg | 36 | May 15, '07 |
| R3.22 | Compilation of data from additional sampling & testing (bioassays) in the Walloon Catchment Region | R3 | ISSeP | 36 | May 15, '07 |
| R3.23 | Interpretation of results obtained from the eco-toxicological effects study (including chemical data, biological data & others). Text. Comments | R3 | ISSeP | 42 | Nov. 15, '07 |
| R3.24 | DSS system for the Dutch Meuse basin | R3 | RIZA / TNO | 42 | Nov. 15, '07 |

**Milestones and expected results (months 25 to 42)**

| Name | Expected result and achievement | WP | Contractor | Month | Date due |
|---|---|---|---|---|---|
| R3.9 | Field experiments finished in Flémalle | R3 | HGULg | 28 | Sept 15, '06 |
| R3.10 | Groundwater flow and contaminant transport model for quantification of groundwater flow rates and contaminant mass fluxes in the Flémalle test site developed | R3 | HGULg | 30 | Nov. 15, '06 |
| R3.11 | Transfer functions for DSS system tuned with TREND 1 participants and ISSeP | R3 | RIZA/TNO | 30 | Nov. 15, '06 |
| R3.12 | Sampling and testing (bioassays) in the Walloon Meuse catchment region performed | R3 | ISSeP | 32 | Jan. 15, '07 |
| R3.13 | DSS system applied in the Dommel sub-catchment and results evaluated | R3 | RIZA/TNO | 36 | May 15, '07 |
| R3.14 | All data necessary for the analysis of the bioassays results in the Walloon Meuse catchment collected | R3 | ISSeP | 38 | Jul. 15, '07 |
| R3.15 | DSS system for the Dutch Meuse basin set up | R3 | RIZA/TNO | 42 | Nov. 15, '07 |

**Milestones and expected results (> month 42)**

| Name | Expected result and achievement | WP | Contractor | Month | Date due |
|---|---|---|---|---|---|
| R3.16 | DSS system applied in the Dutch Meuse catchment and results evaluated | R3 | RIZA/TNO | 54 | Nov. 15, '08 |