Appendix 2

Project 4 (with work package 3)
full title project: Scenario development for water using hydrologic and land use models
project leader: Prof dr Piet Rietveld (VU/FEWEB) and Dr. Neno Kukuric (Deltares)
type of research: PhD (0.5, together with WP 3.1) + support
duration: 2010-2013

Description project (max. 1500 words – A through E)

A. Problem definition, aim and central research questions

Climate change will most likely lead to changes in the hydrological system in the Netherlands and the Rhine-Meuse basin due to changes in precipitation and evaporation. In addition socio-economic developments will lead to changes in land use and thus in the local amount of sealed surface and the location of, for example, agricultural and natural areas. These land-use related changes will in turn affect the hydrological system by a.o. changes in groundwater recharge and use and runoff to rivers. Alternatively, changes in the availability and quality of groundwater influence the local potential for spatial development. Also spatial development in flood hazard areas will affect the flood risk in future. A coupling of hydrologic and land use models would allow a more integrated assessment of the feedbacks between climatic and socio-economic changes and could thus assist in a better informed spatial planning.

This project aims to establish a coupling between hydrologic and land-use models to allow a better functioning of the models individually and provide the potential to simulate feedbacks between hydrologic and societal processes. That would us to answer questions such as: will an increase in sealed surface under future climatic conditions lead to a further lowering of the groundwater table of the higher sandy soils in our country (hotspot dry rural areas) and thus worse conditions for nature or agriculture. The coupling will make use of three modelling systems that are standards in their field in the Rhine basin and Netherlands and that are applied extensively in spatial planning issues: The FEWS-GRADE; the NHI hydrologic model and the Land Use Scanner model.

- The FEWS-GRADE system is a modelling system that simulates runoff and river discharge in the Rhine basin. It comprises a hydrological modelling system based on HBV (Bergström, 1976; Lindström et al., 1997, Eberle et al., 2005) and a hydraulic modelling system based on SOBEK (van der Veen, 2007)
- NHI is an integrated hydrological model that uses data on soil conditions and land use to simulate the future state of the water system. Such model simulations take account of anticipated climatic changes, but not future changes in land use. Initial attempts to link future land use patterns with hydrologic models were performed for the Dutch drought study, but experienced a lack of adequate spatial resolution in the land-use data (Dekkers and Koomen, 2007).
- The revised Land Use Scanner model that is applied extensively in the Netherlands (Koomen et al., 2008; Loonen and Koomen, 2009; Van der Hoeven et al., 2008) has a finer 100 metre resolution that comes closer to the preferred resolution of hydrologic models.

How the NHI system and Land use scanner model can be coupled is one of the results that will be produced in the Knowledge for Climate modelling platform project. In this project WP 3.4 the research questions to be answered are :

1. How can the FEWS-GRADE system and land-use models be coupled such that both the effects of land use changes are taken into account in the runoff production as well as the changes in land use are taken into account in flood safety. ?
2. To which extent does the propagation of errors and uncertainty influence the validity of the simulation outcomes?
3. To what extent is it important for long term decision making in the water sector to incorporate land use change scenarios
4. What are consistent water and land use change scenarios for the Netherlands.

B. Approach and methodology

The project is organised in three main tasks, out of which the actual Model coupling (Task 1); Error propagation and uncertainty (Task 2) and Scenario development (Task 3)

1. Task 1 Model coupling land use and hydrological modellling systems.
   a. Specification of input and output characteristics (e.g. spatial, temporal and thematic resolution) of the FEWS-GRADE both models.
   b. Treatment of land-use data to allow incorporation in the land-use model by. This step will involve an analysis of the degree of soil sealing associated with the individual land use types that can be based on the soil sealing data base recently developed by EEA-FTSP.
   c. Technically couple the land use development model to the hydrological modelling systems. .

2. Task 2 Error propagation and uncertainty analysis
   a. Qualitative description of the major sources of errors and uncertainties in each model..
   b. Qualitative assessment of the potential feedbacks between the majors sources of errors and uncertainties in each model.
   c. Assessment of the sensitivity of the model to changes in the input data (i.e. climate and land use).
   d. Formulate different formats to prepare scenarios including measures of uncertainties and errors from different sources based on the findings in WP 3.1.

3. Task 3 Scenario development and analysis
   a. Run the coupled system for the current conditons and for different combinations of land use projections and climatic changes
   b. Prepare scenarios in different formats (from task 2d) which includes preparation of inflormation for WP 3.2 and 3.4.
   c. Analyse the scenarios on their applicability for adaptation decision making (together with WP3.6).
   d.

Note: This project uses an approach from large scale (global) towards small scale (Regions within The Netherlands. As such this is complematary to the approach followed in Theme 2, WP 2. that aims at an assessment from the very small scale (ditch) to the larger scale (regions within the Netherlands)

C. Scientific deliverables and results

1. A PhD study that comprises a series of papers on the issues: comparison of hydrological response on land use and climate change, a comparison between the sources of uncertainty in hydrological response for water management purposes, a comparison of effectivity of different formats to show hydrological projections for water management purposes.

D. Integration of general research questions with hotspot-specific questions

This project aims to assess the future hydrologic conditions in the dry rural areas of the Netherlands. It also will provide boundary conditions for the Hot Spots: Rivers, Dry rural areas, Central Holland peat meadow area as well as for the sectors water safety, and water supply. Information on a further lowering of the groundwater table is crucial to the evaluation of natural and agricultural conditions in this hotspot area. When succesful it will be incorporated into the next generation of the climate change scenarios for the Netherlands. It further contributes to the questions from the Hot Spots, as it aims to find a format of information presentation that is better suits the development of adaptation strategies.

E. Societal deliverables and results

A concise report on scenario development for effects of climate change on water of the with special emphasis on Rhine –Meuse delta. The proposed work is of great interest to those working on an integrate assessment of socio-economic and climate-induced hydrologic changes. This makes water managers and, to a lesser extent, spatial planners an obvious target group. The EC-Joint Research Centre (JRC) and Dutch Environmental Assessment Agency (PBL) are very interested in the proposed model coupling as part of their ongoing land-use model development projects. Carlo Lavalle (JRC) and Arno Bouwman (PBL) will therefore act as an advisory group that will be informed about project progress and consulted about potential applications. In addition representatives of the Hotspot case study areas may take part in this advisory group.

F. Most important references (max. 15)

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