Hydrol. Earth Syst. Sci. Discuss., 4, S2348–S2353, 2008
www.hydrol-earth-syst-sci-discuss.net/4/S2348/2008/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Forecasting land-use change and its impact on the groundwater systemof the Kleine Nete catchment, Belgium" *by* J. Dams et al.

J. Dams et al.

Received and published: 3 June 2008

RESPONSE TO GENERAL COMMENTS of anonymous referee #2

Comment 5:

The state-of-the-art in this subject is still far from satisfactory, thus, publications of relevant research in this subject should be encouraged in HESSD. In the present paper, however, there are many shortcomings that have to be clarified before publication. Moreover, no novel concepts have been presented in this paper.

Authors response to comment 5:

The authors agree that research in this subject is still strongly developing and admit that there are still shortcomings in todays methodologies of assessing the future state of our groundwater system. However, the authors believe this paper makes a valuable contribution to the research on the impact of future land-use changes in the groundwater system. Linking interdisciplinary models helps to take into account more realistic conditions influencing the groundwater and can help to reduce the general uncertainty of the future groundwater state.

The authors disagree with that the fact that the performed research is not novel. The authors strongly believe that no results so far have been published were a coupling between a land-use change model and a groundwater flow model has been made. Hence, this paper gives a new and original contribution to the problem of assessing the future state of groundwater systems under changing land-use conditions.

RESPONSE TO SPECIFIC COMMENTS of anonymous referee #2

Comment 24:

It is not clear from the text how the IPCC scenarios were used to predict the LULC changes in the study area. It is also not clear why the Authors did not considered changes in the climatic forcings (e.g. precipitation and temperature), which are the main drivers of the water cycle. See p.4271 l. 7-8.

Authors response to comment 24:

Linking the SERS scenarios to LULC changes was not part of this research but was done in the EURURALIS project (Klijn et al., 2005). Klijn et al. (2005) used a coupling between the LEITAP model, an adapted version of the Global Trade Analysis Project (GTAP) and the Integrated Model to Assess the Global Environment (IMAGE). For the four SERS scenarios an economic growth, a population growth, the consumption pattern and the international cooperation was estimated. These estimations were used in the LEITAP model to estimate the demand on and trade in agricultural products. On its turn these demands and trade in agricultural products in combination with assumed sectoral and technical progress linked to each SERS scenario were used to estimate the land-use and environmental development via the IMAGE model. An iterative approach between the LEITAP and IMAGE model was followed to obtain the land-use change scenarios for each SERS scenario.

In this paper we have focused on the impact on land-use changes on the groundwater system. In our opinion this impact is not well documented and required the necessary attention. Following the approach from the EURURALIS project, using the SERS scenarios as a basis for our land-use change scenarios it is possible to also incorporating climate change scenarios. The resulting combined effect of land-use and climate change is described by Woldeamlak (2007), a paper is in preparation.

Comment 25:

The land cover model seems to have parameters obtained from empirical analysis. Please show them and give indication of the goodness of the fit of the model in the calibration and validation faces. This is not valid unless a serious cross-validation study shows that this is possible.

Authors response to comment 25:

The obtained Relative Operating Characteristics (ROC) were added in this revised manuscript. These ROC values assess the validity of the calculated logistic regression coefficients and as such give an indication about the accuracy of the used probability maps for each land-use type. ROC values range from 0 to 1, where 1 indicates a perfect fit and 0.5 indicates a random fit. The larger the ROC, the better the fit.

The ROC values show that the empirical relation describes relatively well the allocation of land-use types such as urban and industrial areas, coniferous and mixed forest, heather and wet meadow. The relationship for deciduous forest, agriculture and meadow is less strong.

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Interactive Comment

The ß-coefficients obtained from the logistic regression indicate that negative ß-coefficients show a negative correlation between that driving force and the land-use type, for example the higher the slope, the less likely it is that a pixel will be converted to urban or industrial land-use. Because of the different scales for the input parameters no direct link can be seen between the magnitude of the ß-coefficient and the impact of each driving force. No further statistical analysis has been performed.

Comment 26:

There is no reference in the text with regard to the calibration and validation of the hydrologic model employed. Please indicate the calibration and validation periods, and several measures of efficiency (Nash-Sutcliffe efficiency coefficient, bias, RMSE, etc.).

Authors response to comment 26:

The WetSpass model (Batelaan and De Smedt, 2007) is a spatially distributed water balance model developed to simulate the long-term average recharge. Because of the long-term average results no calibration of the model on time series is possible. The calibration is therefore integrated and coupled with the calibration of the groundwater flow model.

Comment 27:

A long term forecasting with no serious uncertainty analysis is very risky. Conclusions derived based on this footing might be misleading. Please carry out a serious analysis of the uncertainties involve in all models used in these paper.

Authors response to comment 27:

An additional section regarding uncertainty analysis has been added and is now much improved

Comment 28:

Please consider the following suggested literature.

Suggested References 1) Bronstert, A., Niehoff, D., Bürger, G., (2002). Effects of climate and land-use change on storm runoff generation: present knowledge and modelling capabilities. Hydrol. Process. 16 (2), 5098211;529. 2) Hundecha, Y, Bärdossy (2004). Modeling of the effect of land use changes on the runoff generation of a river basin through parameter regionalization of a watershed model. Journal of Hydrology 292 (2004) 2818211;295. 3) Samaniego L., Bärdossy A.(2006). Simulation of the Impacts of Land Use/Cover and Climatic Changes on the Runoff Characteristics at the Mesoscale. Ecological Modelling, Vol. 196, Issue 1-2, pp. 45-61. dx.doi.org/10.1016/j.ecolmodel.2006.01.005

Authors response to comment 28:

The above suggested papers have been incorporated in the introduction of the manuscript. In this paper we have tried to focus on the impact of land-use changes on the groundwater system. In our opinion current research, of which above mentioned papers are good examples, focuses on the impact of land-use change and climate change on surface runoff. So far, very little results have been published on the effect of land-use change on groundwater recharge and consequently groundwater levels. As the surface runoff is of course linked to the groundwater recharge, above mentioned papers contain interesting information.

TECHNICAL CORRECTIONS

Comment 29:

There are many sentences that are very vague and do not provide numerical evidence, i.e. p4280, l 18-21. Please improve them.

Authors response to comment 29:

The whole text was carefully checked on clarity and vagueness, numerous sentences were modified. However, in the conclusion section it was chosen not to include the numerical evidence which can be found in the results and discussion section.

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