

Opponent's review of the Doctoral Thesis

Candidate Nina Elizabeth Noreika

Title of the doctoral thesis Modeling hydrological impacts of management practices in rural catchments using SWAT

Study Programme Civil Engineering

Tutor _____

Opponent ao.Univ.Prof. DI Dr. Andreas Klik

e-mail andreas.klik@boku.ac.at

Topicality of the doctoral thesis theme

Commentary:

Soil erosion is a naturally occurring phenomenon, accelerated due to human activities and inappropriate soil management practices to a degree that causes a severe soil degradation. In the recent decade, soils erosion process has been highlighted as one of eight major soil threats within European Union, with major implications for food security, drinking water quality, ecosystem services, flooding, eutrophication, biodiversity as well as carbon stock shrinkage. Nina Noreika applied and adopted a hydrological simulation model (SWAT) to assess the impacts of specific soil conservation measures, field sizes, land uses and their spatial distribution on the water cycle in a Czech agricultural watersheds. She uses new and innovative approaches to determine input parameters for the used SWAT model.

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Fulfilment of the doctoral thesis objectives

Commentary:

Nina NOREIKA elaborated a doctoral thesis entitled with „Modeling hydrological impacts of management practices in rural catchments using SWAT“. The background of this research is that in the Czech Republic land use and land management changed throughout the last 200 years leading to increasing soil degradation and significant changes in the hydrology of agricultural used watersheds. The objectives of this thesis are to assess the impacts of changes in land use, crop rotation and field sizes on water balance compartments like evapotranspiration, surface runoff and soil water content using the hydrologic simulation model Soil Water Assessment Tool (SWAT).

The dissertation is designed as a cumulative thesis, based on three SCI publications which are listed in respective chapters. The following publications are included, where the candidate serves as the main author:

(1) Noreika, N.; Li, T.; Zumr, D.; Krasa, J.; Dostal, T.; Srinivasan, R., 2020. Farm-Scale Biofuel Crop Adoption and Its Effects on In-Basin Water Balance. Sustainability. DOI: <https://doi.org/10.3390/su122410596>

(2) Noreika, N.; Winterová, J.; Li, T.; Krása, J.; Dostál, T., 2021. The Small Water Cycle in the Czech Landscape: How Has It Been Affected by Land Management Changes Over Time? Sustainability. DOI: <https://doi.org/10.3390/su132413757>

(3) Noreika, N.; Li, T.; Winterova, J.; Krasa, J.; Dostal, T., 2022. The Effects of Agricultural Conservation Practices on the Small Water Cycle: from the farm- to the management-scale. Land. DOI: <https://doi.org/10.3390/land11050683>

Besides these original paper contributions a frame section is written including an extensive introduction and general conclusions.

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Research methods and procedures

Commentary:

The introductory frame presents the overall objectives, the methodological frame and the role of the original research contributions to the overall aims. An outlook and the proposal for future demands and needs is included.

The first paper (chapter 2) investigates how crop changes and shifts in the sizes of the planted field affect the water balance in a small (0.52 km²) agricultural watershed. For this purpose Nina Noreika used observed daily discharges, climatic, soil and crop data to first calibrate and then to validate the SWAT model. The results showed a good model fit for the calibration and a satisfactory model fit for the validation period. Fig. 2.4. shows an underestimation of surface runoff for the validation period. It would have been good to include the equations of the trend lines. Simulated scenarios include partly or completely changes from winter wheat to rapeseed planting. In the discussion part the candidate discusses in detail the weaknesses of SWAT and how it could be improved to deliver more accurate results.

The second paper (chapter 3) describes how changes in land management in the Czech Republic throughout the last two centuries have changed the water cycle in agricultural used areas. In the Materials and Methods part the investigated watershed could have been better described including existing soils and topography maybe showing maps. The duration of time series and time intervals of runoff and sediment loads are not mentioned and if these observations were done at the watershed outlet. The results are described in detail and discussion extensively.

The third paper (chapter 4) shows the outscaling of SWAT applications from the farm to the management scale applied again at two Czech agricultural watersheds. The innovative part of this study is the investigation of the effects of the spatial distribution of conservation measures. Nina could show the positive impact of specific soil conservation measures. At the management-scale, she found that the widespread incorporation of agricultural conservation practices significantly reinforced the water cycle, but the relative scale and spatial distribution of their incorporation were not reflected in the SWAT scenario analysis. This can be attributed to the model structure. The paper contains a very nice literature review about how to incorporate conservation measures with respect to surface runoff parameters in SWAT.

The overall final conclusions (chapter 5) of the thesis again summarize the general findings of the papers. Nina mentions her challenges to obtain high quality input data like soil, land management and reservoir data which improve the accuracy of SWAT results. She gives an outlook and recommendations how to improve the water cycle in agricultural watersheds but what is necessary to increase the accuracy of hydrological modeling.

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Results of the doctoral thesis – dissertant's concrete achievements

Commentary:

The main achievements of the results are 1) the successful application of the SWAT model to Czech conditions, which has not yet been done often, 2) the useful information for farmers but also for policy makers about specific soil conservation methods, 3) the assessment of impacts of specific soil conservation measures on water cycle components.

SWAT has not been applied often under Czech soil, management and climate conditions. Nina Noreika used detailed spatial distributed input data to calibrate and validate the SWAT model which showed a good performance. The results show the ability of the model to assess the efficiency of several soil protection methods but show also the model limitations with respect to spatial distribution estimations. Nevertheless, the obtained results can be used by farmers and policy makers to improve soil management to maintain or improve soil quality. The assessment of impacts of soil conservation on the various components of the water cycle within agricultural used watersheds is a great achievement. The results are necessary to design land management/use systems which guarantee sustainable agriculture also under changed climatic conditions.

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Importance for practice and for development within a branch of science

Commentary:

The results showed how a hydrological model can be used for sustainable land use and land management evaluation. It was one of the first applications of the SWAT model in the Czech Republic.

The obtained results are very helpful and important and greatly aid farmers and landowners in making informed decisions regarding landscape management. The study also shows the ability of models to evaluate the efficiency of specific soil conservation measures. Governmental decisions about incentives could be based on such results.

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Formal layout of the doctoral thesis and the level of language used

Commentary:

Overall, Nina NOREIKA wrote a very good, solid and well structured doctoral thesis. All tables and figures are necessary and of good quality. An extensive reference list is included. The thesis is very well written.

excellent above average average below average poor

Statement on compliance with citation ethics

All citations in the thesis are listed in the reference list.

Remarks

no remarks

Final assessment of the doctoral thesis

Nina NOREIKA elaborated a doctoral thesis entitled with "Modeling hydrological impacts of management practices in rural catchments using SWAT" where she was able to show she could handle complex topics with sophisticated, scientific methods in the field of hydrological modeling, statistics and spatial analysis.

Overall it is a very good, solid and well-structured doctoral thesis. The thesis is well written, includes state-of-the-art knowledge and is well integrated into existing findings. With this study Nina NOREIKA brought the genuine proof about her ability of genuine self-reliant scientific work.

In summary, I rate the doctoral thesis as excellent.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree

yes

no

Date: June 8, 2022

Opponent's signature:.....