The Daisy Model Newsletter
Department of Plant and Environmental Sciences
University of Copenhagen

Daisy Newsletter no. 38

1. Special

Associate Professor Carsten Tilbæk Petersen, leader of the Agrohydrology group, PLEN, Copenhagen University is retiring. We wish to thank Carsten for his contribution to the field of Agrohydrology and soil physics, especially regarding water flow and solute transport in macropores, soil drainage and the effect of biochar incorporation on soil physics and plant growth. Carstens many field experiments laid the foundation for several of the models found in Daisy.

2. Job opportunity

As part of a new 4-year EU project on the Physically-Based Integrated Soil Health Simulation Platform (PHISHES) the Agrohydrology group at KU is hiring 1-2 postdocs, with flexible start date(s). The project aims at investigating how different managements affects the soil ecosystem services with focus on the filter function for new groups of pollutants, main PFAS and nitrification Inhibitors. Check our homepage and linkedin where you will find the job advertisement soon and please reach out to us if interested in the position(s).

3. The Daisy code, v. 6.44/6.45

The latest available versions for Windows- and Mac-computer are 6.45 (termed 6.45b for Mac) as the earlier mentioned problems found in version 6.41 for Mac have been solved. For Linux the latest available version is 6.44.

In the next, upcoming release, the default values for linear ammonium sorption to clay and organic matter (K_clay and K_OC) will been changed as the earlier linear sorption parameters (the "NH4"-model) was based on a wrong parameterization of the vS_S-model. The changed sorption parameters will in general result in a higher NH_4^+-N crop uptake and a lower NO_3^-N crop uptake, due to lower sorption. Nitrification is reduced too. A complete description of the parameterization of ammonium sorption, together with some tests investigating the effect of the different parameterizations will soon be available in the Technical Documentation Chapter 7.

4. Courses

Please remember that this year's Daisy PhD-course will be carried out at University of Bayreuth in Germany, hosted by Prof. Efstathios Diamantopoulos. The course will be held 9_{th}-13_{th} September 2024. A flyer is available here.

5. Events

Laura Andersen and Sofie Bak Nielsen will defend their MSc-thesis called Effects of soil hydrology and within-field soil heterogeneity on N_2O-emission 14th June, 13.30 to 15.30 in room A2-70.03, Thorvaldsensvej 40, 1871 Frederiksberg.

6. Progress on AgroEco-HPM

Daisy have been moved to a new repository with a new structure and a set of new installers. The aim is to make it easier to navigate in the code and build Daisy yourself. The repository can be found here.

The technical documentation is progressing. Chapter 4 describing water flow in the soil is now available on Daisy homepage. Chapter 7 on mineral N and Chapter 9 on soil organic matter are well on the way.

As part of the new quality assurance, the established test framework and documentation we have decided to branch out Daisy in two versions. 1) A well-tested and documented Core Daisy version, including all the primary functionalities and quality controlled. 2) An

experimental version including Core Daisy, together with existing and new processes incorporated during different projects and to test alternative or new processes descriptions. Functionalities in the experimental version will, when tests and documentation are deemed adequate, be included in Core Daisy.

We have developed a python package for retrieving data from DMI, featuring a selection of tools used in GeoDaisy. The focus is currently on using satellite data to correct the raw weather data from the weather stations, bringing wind down to 2 meters and adjusting precipitation data. We have also integrated with field data from the Danish Agricultural Agency, giving us access to information regarding crops and area covered. We hope to use this information to derive a management scenario. Further, we are looking at the data compiled in the DIGIJORD project, which we hope to use in defining soil columns for Daisy.

Maja Holbak will take over as editor of the Daisy newsletter from next issue.

7. Recent articles where Daisy has been used

Holbak et al. (2024) investigated the possibility of reducing pesticide leaching by selecting to "the best application day", by analyzing six combinations of pesticide-crop-seasons, three synthetically generated climate series and 800 soil profiles. Leaching, calculated by Daisy and measured in maximum hourly toxic unit (mTU), was in a period of 300 days from application. Selecting the "best day" compared to a "random day" reduced the 90th percentile of mTU by 62%. If the application window was reduced to 5 days, a reduction of the 90th percentile of up to 21% could be obtained. Thus, there seems to be a mitigation potential for reducing pesticide leaching to drains by tailoring the timing of pesticide application to weather conditions.

Pohanková et al. (2024) investigated the effects of climate change on soil organic matter content, considering two different agricultural management practices. They used a model ensemble (APSIM, Daisy, DSSAT, HERMES, MONICA) to simulate the different conditions. The article contains a nice discussion of similarities and differences between the models.

The article by Pouryazdankhah et al. (2024) describes development and validation of a sunflower crop growth module for Daisy. It was mentioned in Daisy Newsletter no. 33 in a Farsi-version, but this time, it is in English. The crop model was developed on data collected in 2012 and 2013 and was validated on data from six treatments in 2015-16 with respect to LAI, height and dry matter production. Soil water content was considered in the validation too. The new parameterization is available as supplementary material, and we will add it to the contribution page on the Daisy homepage to make it available for other users.

Vuaille et al. (2024) developed a mulch module for Daisy (see also App. 3.1 in the documentation), to compare pesticide leaching in conservation agriculture (CA) with conventional tillage (CT). Due to a high density of continuous macropores in CA, there is a fear of high leaching risk. While the total pesticide loss was comparable in the simulations, the degradation and sorption patterns were different. In CA degradation took place in the mulch layer and uppermost soil (0-3.5 cm), while in CT, the whole topsoil (0-30 cm) contributed. It is the first time, the module is tested and described in an article.

Zong et al. (2024) investigated how diversification of maize rotations with other industrial crops influence biomass yield, nitrogen uptake and nitrogen leaching. Daisy was only used to calculate the downwards flow in the upper 1 m

soil required to transform suction cup measurements to N-leaching. Generally, biomass production, nitrogen uptake and C and N-stocks in the soil increased, but N-leaching did not decrease in all cases.

8. Recent preprints where Daisy has been used

Hao et al. (2024-preprint) have measured and simulated DON for a soil column. It seems that they have copied descriptions from Daisy into a COMSOL program. They found that DON accounted for a substantial portion of total dissolved nitrogen (33-68%). That is considerably more than the fraction of DON-N found in Danish measurements of soil water (3.5-15 %), according to the latest land monitoring report.

Rashid et al. (2024-preprint) evaluated the performance of biobased fertilizers (ammonium sulfate (AS), digestate from a biogas plant (DIG) and the liquid fraction of the digestate (LFDIG)) as a substitute of conventional fertilizers. Ten scenarios were considered, covering five climatic regions represented by two scenarios each. Three types of fertilization were considered i) full replacement (mineral and manure-N) with equivalent total N input as baseline, ii) full replacement with hither total N input due to lower (<100%) fertilizer replacement values, and iii) partial replacement (only manure-N) with equivalent total N-input as baseline.

In both partial and full replacement scenarios with equivalent total N input, AS, DIG, and LFDIG had a minimal impact (<5%) on N yield, NUE, and total N losses compared to the baseline. SON stocks either decreased or increased at a slower rate with AS and LFDIG. Conversely, in the full replacement scenario with relatively higher total N input, BBFs led to higher N yield and N losses but lower NUE relative to the baseline. SON stocks either accumulated or depleted at a slower rate with DIG. The effect of BBFs on N leaching varied among cropping systems. These findings suggest that for full replacement, BBFs should be improved to achieve a FRV close to 100%, or else higher N losses appear inevitable.

Rydgård et al. (2024-preprint) is a life cycle assessment of application of untreated versus pyrolyzed sewage sludge in agriculture. It mainly concerns phosphorus, but Daisy was used to estimate nitrate leaching and crop yields associated with sludge and biochar application in the field. Scenario runs were carried out to compare the sludge products with NPK fertilizer with respect to fertilizer consumption, yield and leaching.

9. References

Daisy

Hao, Y., Zheng, T., Zheng, X., Liu, L., Jiang, S., Cao, M., Luo, J., 2024. The Impact of Dissolved Organic Nitrogen (Don) Retention in the Vadose Zone on Nitrogen Leaching Losses. https://doi.org/10.2139/ssrn.4784799

Holbak, M., Vuaille, J., Diamantopoulos, E., Styczen, M.E., Petersen, C.T., Strobel, B.W., Abrahamsen, P., 2024. Application timing as a mitigation tool for pesticide leaching to drains in northwest Europe. J. Hydrol. Reg. Stud. 53, 101734. https://doi.org/10.1016/j.ejrh.2024.101734

Pohanková, E., Hlavinka, P., Kersebaum, K.C., Nendel, C., Rodríguez, A., Balek, J., Dubrovský, M., Gobin, A., Hoogenboom, G., Moriondo, M., Olesen, E.J., Rötter, R., Ruiz-Ramos, M., Shelia, V., Stella, T., Hoffmann, M.P., Takáč, J., Eitzinger, J., Dibari, C., Ferrise, R., Bohuslav, J., Bláhová, M., Trnka, M., 2024. Expected effects of climate change on the soil organic matter content related to contrasting agricultural management practices based on a crop model ensemble for locations in Czechia. Eur. J. Agron. 156, 127165. https://doi.org/10.1016/j.eja.2024.127165

Pouryazdankhah, H., Shahnazari, A., Ahmadi, M.Z., Khaledian, M., Andersen, M.N., 2024. Development and validation of a sunflower crop growth module for the Daisy model. Front. Sustain. Food Syst. 8. https://doi.org/10.3389/fsufs.2024.1370063

Rashid, M.A., Duan, Y.-F., Lesschen, J.P., Groenendijk, P., Bruun, S., Jensen, L.S.S., 2024. Evaluating the Performance of Biobased, Recovered Nitrogen

Fertilizers in European Cropping Systems Using Modelling. https://doi.org/10.2139/ssrn.4780883

Rydgård, M., Bairaktari, A., Thelin, G., Bruun, S., 2024. Application of untreated versus pyrolysed sewage sludge in agriculture: A life cycle assessment. J. Clean. Prod. 454, 142249. https://doi.org/10.1016/j.jclepro.2024.142249

Vuaille, J., Abrahamsen, P., Jensen, S.M., Diamantopoulos, E., Wacker, T.S., Petersen, C.T., 2024. Modelling pesticide degradation and leaching in conservation agriculture: Effect of no-till and mulching. Sci. Total Environ. 929, 172559. https://doi.org/10.1016/j.scitotenv.2024.172559

Zong, M., Manevski, K., Liang, Z., Abalos, D., Jabloun, M., Lærke, P.E., Jørgensen, U., 2024. Diversifying maize rotation with other industrial crops improves biomass yield and nitrogen uptake while showing variable effects on nitrate leaching. Agric. Ecosyst. Environ. 371, 109091. https://doi.org/10.1016/j.agee.2024.109091