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Application of SWAT for modeling nitrogen and phosphorous cycles at the Damma glacier CZO

Juna Shrestha, Maria Andrianaki, Stefano Bernasconi, and BigLink Consortium
Geological Institute, ETH Zurich, Sonneggstrasse 5, 8092 Zurich, Switzerland

The Damma Glacier, the CZO of the BigLink and SoilTrec projects, is located in the Central Alps of Switzerland. It encompasses 10 km^2 area and ranges between 1792 to 3630 m a.s.l of altitude. The CZO represents a pristine alpine observatory for initial stage of soil formation from the underlying bedrock exposed after glacier retreat. In the first phase of the BigLink project, the research consortium successfully investigated a wide range of processes during early ecosystem development and soil formation at the Damma Glacier forefield. In addition, the SoilTrec project has successfully modeled the water budget for the catchment using the SWAT model. In this study, we further apply SWAT for nitrogen and phosphorus modeling. The main objective is to quantitatively model important processes at catchment scale towards a better understanding of the interactions between physico-chemical processes of weathering and the biological build-up of soil nitrogen and phosphorus in soils.

Atmospheric input (wet and dry deposition) is the main source of nitrogen in the Damma catchment. The model show that more than half of the nitrogen input leaves the system as surface runoff through the Damma Reuss river and the remaining are mostly retained as soil organic nitrogen or as above- and below- ground biomass while gaseous loss through denitrification and ammonium volatilization are negligible. Modeled values of nitrogen load in the river Damma Reuss were comparable to measured values.

Weathering is the main source of soil phosphrous and most of the phosphorous is internally recycled and retained within the catchment i.e. phosphorous made available through biological or chemical weathering are cycled between soil, microbes and plants and very little amount is leached out of the system.

Although the nutrient cycle routines in SWAT are optimized for agriculture or urban landuse types, the application of SWAT at the Damma CZO has shown that it can be also be used with some limitations to model alpine landscapes. However, further development of SWAT will be required for extensive and intricate modeling of pristine and dynamic ecosystem like Damma CZO where nutrient cycle is characterized primarily by weathering and ecological succession stage.