Soil Erosion Risk Modelling in the Alps – ERKBerg as a Prototype of ERK2 for mountain zones III, IV and summering grazing zones

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Soil Erosion on grassland is generally neglected due to the protective character of dense grass vegetation on soil loss. However, recent studies by MEUSBURGER ET AL. (2010), KONZET AL. (2012) and ALEWELL ET AL. (2013) show that large amounts of topsoil are mobilized also on grassland in the alpine areas (Fig. 1).


Figure 1a: Soil Erosion in the Swiss Alps
Figure 1b: Soil Erosion in the Swiss Alps

A soil erosion modeling approach for arable land (Erosionsrisikokarte ERK2; Prasuhn et al. 2013) was already realized by the *Centre for Development and EnvironmentUniversity Bern* and *Agroscope Reckenholz*. To complement the ERK2-results and to create a **nationwide soil erosion risk map**, a risk assessment for the (alpine) grassland will be realized by geospatial modeling.

According to a comprehensive approach, the model is based on the Revised Universal Soil Loss Equation (**RUSLE**) by WISCHMEIER & SMITH (1978). The general soil-loss-equation of RUSLE is a function of five factors:

$$A = R * K * LS * C * P$$

Where A is the mean long-time soil loss in t ha^{-1} yr^{-1}, R the rain erosivity factor, K the soil erodibility and the parameters L and S describe the length and slope of the relief. C is the cover and management factor, P is a factor for protection and soil conservation.

The main task of the ongoing project is the **adaptation of the model parameters**which aren't generally accepted for steep slopes and grassland in alpine areas. Furthermore, the project aims the investigation of **spatial AND temporal** soil erosion patterns by a dynamic soil erosion risk assessment.

The **monthly rainfall erosivity** of Switzerland, based on 87 automated gauging stations and a regression kriging approach, revealed spatial and temporal pattern with highest R-factors in summer (Fig.2; SCHMIDT ET AL. 2016). A proportion of 62% of the total annual sum of rainfall erosivity affects soils within a time period of 4 months (June, July, August, and September) (Fig. 3).

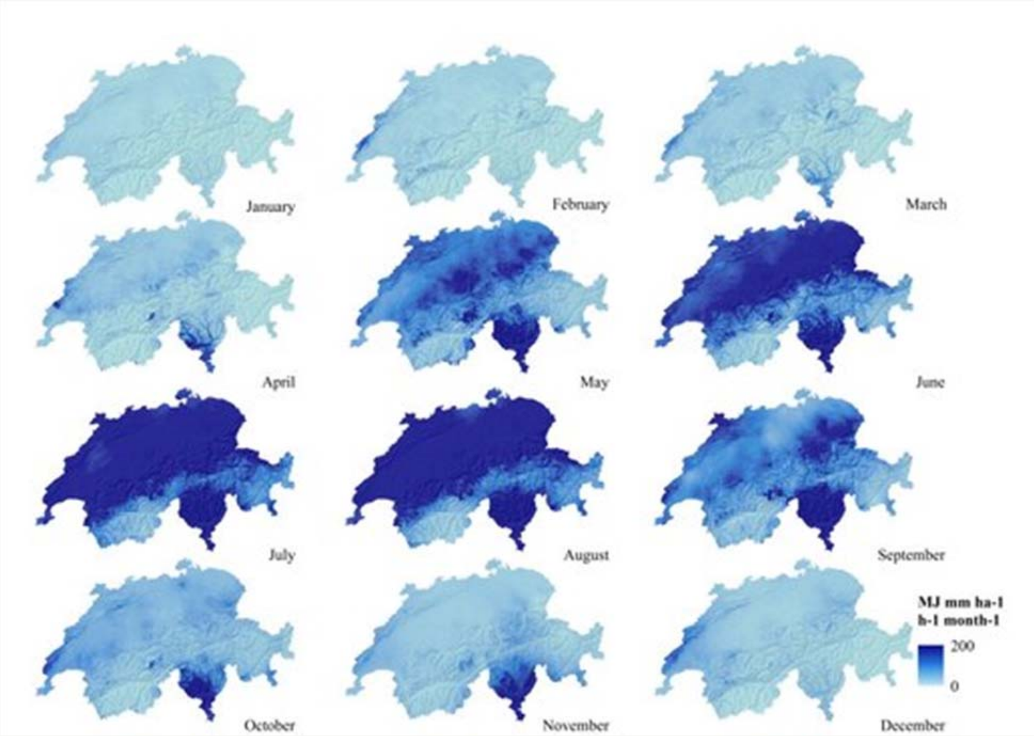

Figure 2: Monthly rainfall erosivity maps for Switzerland derived by regression-kriging (SCHMIDT et al. 2016)

The increase of spatial and temporal resolution of remote sensing datasets enabled the mapping of **C-factors** on a monthly scale. We used an orthophoto with a spatial resolution of 0.25m (Swissimage FCIR) and a time-series of the fraction of green vegetation cover with a temporal resolution of 10-days (FCover) to calculate the dynamics of the C-factor on Swiss grassland. The annual average C-factor of all Swiss grassland is 0.012 (Schmidt et al. in review a). A **national map of Swiss grassland**and Swiss permanent grassland was presented for the first time (SCHMIDT et al. in review b).

The national **soil erodibility** map of Switzerland is based on digital soil mapping with 199 Land Use/Cover Area frame Survey (**LUCAS**) topsoil samples. The mean national K-factor for Switzerland is 0.033 t ha h ha^{-1} MJ^{-1} mm^{-1} (SCHMIDT et al. in prep.).

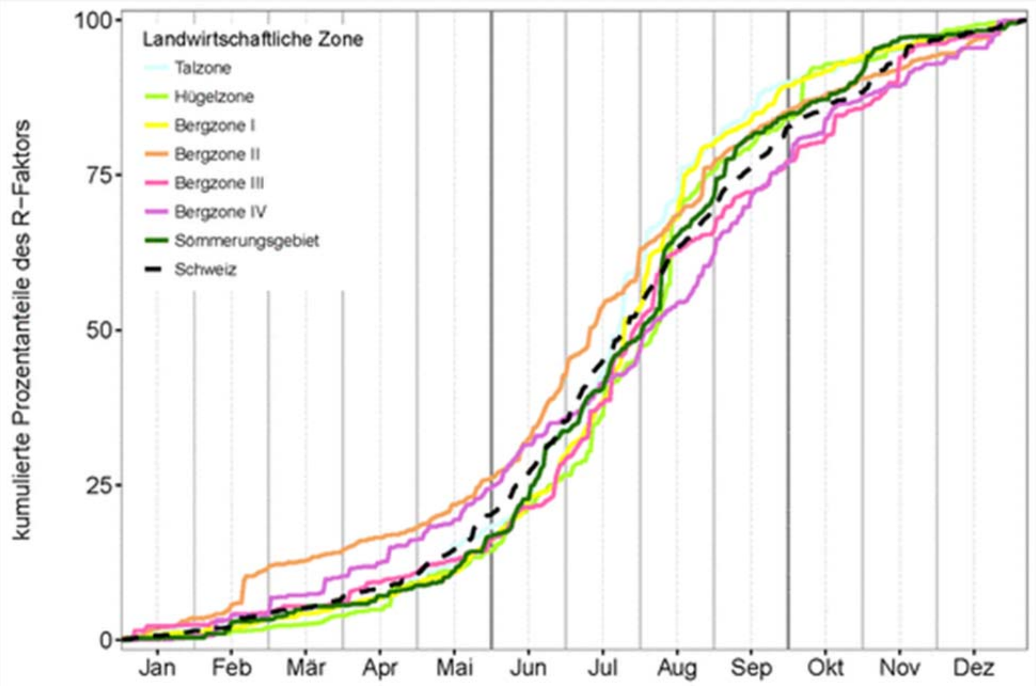

Figure 3: Cumulative daily rainfall erosivity proportion for Swiss biogeographic units, Switzerland and monthly erosivity for Europe (linear smoothed) (SCHMIDT et al. 2018)

Slope length and steepness for Switzerland is based on the Multiple Triangular Flow Direction (MTFD) approach (SEIBERT & MCGLYNN 2007) and was extensively tested on plot scale (BIRCHER et al. in prep.).

Due to the **excellent database of Switzerland**, the model could be used as a **prototype** for risk assessment in the European alpine regions. It is envisaged to present the soil erosion risk map for grassland by the end of the year 2018.

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Literature

ALEWELL, C.; MEUSBURGER, K.; JURETZKO, G.; MABIT, L.; and KETTERER, M. (2013): Suitability of $^{239+240}$Pu as a tracer for soil erosion in alpine grasslands, Chemosphere, doi: 10.1016/j.chemosphere.2013. 12.016.
BIRCHER, P., PRASUHN, V., LINIGER, H.-P. (in prep.): Comparison of different multiple flow algorithms for RUSLE slope-length factor (L) and slope steepness factor (S) calculation in Switzerland.
KONZ, N.; PRASUHN, V.; and ALEWELL, C. (2012): On the measurement of alpine soil erosion, CATENA, 91, 63-71, 10.1016/j.catena.2011.09.010.
MEUSBURGER, K.; KONZ, N.; SCHAUB, M.; and ALEWELL, C. (2010): Soil erosion modelledwith USLE and PESERA using QuickBird derived vegetation parameters in an alpine catchment, International Journal of Applied Earth Observation and Geoinformation, 12, 208-215, 10.1016/j.jag.2010.02.004.
PRASUHN, V., LINIGER, H., GISLER, S., HERWEG, K., CANDINAS, A.,CLÉMENT, J.-P. (2013): A high-resolution soil erosion risk map of Switzerland as strategic policy support system, Land Use Policy 32, 281–291. 10.1016/j.landusepol.2012. 11.006.

SEIBERT, J., MCGLYNN, B.L. (2007): A New Triangular Multiple Flow Direction Algorithm for Computing Upslope Areas from Gridded Digital Elevation Models, Water Resources Research 43, 10.1029/2006WR005128.
SCHMIDT, S., ALEWELL, C.,MEUSBURGER, K. (in review a): Mapping Spatio-Temporal Dynamics of the Cover and Management Factor (C-Factor) for Grasslands in Switzerland.
SCHMIDT, S., ALEWELL, C., MEUSBURGER, K. (in review b): Swiss National Grassland Map and Change (1996-2015) of Permanent Grasslands Extent in Switzerland.
SCHMIDT, S., ALEWELL, C., PANAGOS, P., MEUSBURGER, K. (2016):Regionalization of monthly rainfall erosivity patterns in Switzerland, Hydrol. Earth Syst. Sci. 20, 4359–4373.10.5194/hess-20-4359-2016.
SCHMIDT, S., ALEWELL, C., PANAGOS, P., MEUSBURGER, K. (2018): Saisonale und räumliche Variabilität der Niederschlagserosivität in der Schweiz, BGS Bulletin 38.
SCHMIDT, S., BALLABIO, C., ALEWELL, C., PANAGOS, P., MEUSBURGER, K. (in prep.): Mapping soil erodibility (K-factor) and ist seasonal variability in Switzerland.
WISCHMEIER, W. H.; and SMITH, D. D. (1978): Predicting Rainfall Erosion Losses – A Guide to Conservation Planning, U.S. Dep. Of. Agriculture, Handbook No. 537.