Soil erosion policy in Switzerland

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Abstract

In Switzerland, the problem of soil erosion by water persists despite numerous studies and significant improvements. Erosion in the typical mixed crop-livestock farming systems in the hilly Midlands are causing on-site as well as off-site damages. The effect of these damages involves economic and ecological costs for society. Within the environmental policy the tolerable level of soil erosion is set to 2 or 4 t/ha and year, respectively, depending on soil depth (<70 or >70 cm); values that are often exceeded. The Swiss agricultural policy system is based on a system of direct payments (subsidies) to compensate farmers for the different types of services they deliver to society. This system supports prevention of soil erosion indirectly, e.g. by defining a minimal crop rotation or an optimal soil coverage. Furthermore, financial support is given to farmers applying conservation tillage. In the context of a new enforcement of erosion protection, payments are cut for farmers who experience recurrent soil erosion and do not cope by developing a site-specific action plan and taking adequate prevention measures. In Switzerland, agro-environmental policies are the result of negotiation and compromise rather than optimal expert determination. Despite their comprehensiveness, inconsistencies remain, leading to an ineffective implementation.

Keywords: Switzerland, on- and off-site erosion, long-term monitoring, enforcement of erosion protection, policy

Introduction

Soil erosion by water is one of the major soil threats in Switzerland (Stolte *et al.,* 2016; FOEN, 2017). Despite numerous studies and significant improvements, the problem persists, compromising the fertility of Swiss agricultural lands in the long term. Even more, beyond the provision of food, the multitude of services provided by soil is affected, leading to impacts for the society as a whole. As in many other countries, the quality and multi-functionality of soils is still insufficiently acknowledged among land users, planners and policy makers. Explicit evaluation of soil quality with respect to specific soil threats, soil functions and ecosystem services has rarely been implemented (Bünemann *et al.*, 2018). However, ecosystem services specifically related to soil have recently become increasingly important to justify and support sustainable soil management for the mitigation or prevention of soil threats (Schwilch *et al.*, 2018). This goes in line with the fact that in many countries including Switzerland, off-site effects of soil erosion – besides on-site effects – gain importance in research as well as in targeting mitigation measures.

In the typical mixed crop-livestock farming systems in the hilly Midlands of Switzerland, sheet, rill and ephemeral gully erosion, are causing on-site as well as off-site damages related to the deposition of eroded material downslope (e.g. water contamination and damages on public and private infrastructure). Long-term field studies of soil erosion on cropland in different parts of Switzerland have shown that off-site effects are considerable (Ledermann *et al.*, 2010).

Within the environmental policy, the Soil Pollution Ordinance (SoilPO) sets the tolerable level of soil erosion to 2 or 4 t/ha and year, respectively, depending on soil depth (<70 or >70 cm); values that are often exceeded (FOEN, 2017). An erosion risk map in a 2x2-metre grid (ERM2), covering the agricultural area of Switzerland (Prasuhn *et al.*, 2013), is used to support enforcement of the laws to prevent soil erosion (FOEN and FOAG, 2013). The Swiss agricultural policy system is based on a complex system of direct payments (subsidies) to compensate farmers for the different types of services they deliver to the society (e.g. food security, landscape protection, etc.). This system of direct payments supports prevention of soil erosion indirectly, e.g. by defining a minimal crop rotation or an optimal soil coverage. Furthermore, financial support is given to farmers applying conservation tillage. Despite this comprehensive legal framework, after 20 years of implementation, observers conclude that the results of these efforts to reduce soil degradation remain disappointing (Derungs, 2018). In the context of a new enforcement of erosion protection (started in 2017), payments are cut for farmers who experience recurrent soil erosion and do not cope by developing a site-specific action plan and taking adequate prevention measures.

Methodology

This work is compiled from several studies as well as experiences from the national and cantonal administration. The methodology of these studies include long-term field monitoring of soil erosion conducted on arable land in the Swiss midlands as well as an ethnographic survey.

Since late 1997, the national agricultural research institution Agroscope conducts a long term monitoring in the region of Frienisberg in the canton of Bern. Family farms, which predominate in the area, apply mixed farming methods of growing crops and keeping livestock. Winter intercrops are widespread and crop rotations mostly include a high proportion of temporary grass-clover mixtures. Prasuhn (2011) investigated 203 arable fields in the region with a total area of 265 ha, reporting a mean slope gradient of 6.5% (range 1–25%) and a mean slope length of 68m (range 15–210 m). All visible erosion features were continuously mapped and quantified over 20 years. The eroded soil volume associated with linear erosion features was calculated by measuring the length and cross-sectional area in rills at representative positions and the extent of interrill erosion was estimated.

An interdisciplinary study by Derungs (2018) combining natural, political and social sciences focused on the sustainable management of agricultural soils. It tackled Swiss environmental and agricultural policies for qualitative soil protection and the accompanying measures to limit water erosion. The study conducted ethnographic fieldwork and interviews with farmers, agricultural advisers, public servants in cantonal and federal administrations and scientists, and analysed existing national and international reports. In the end, 67 interviews and 15 field observations were carried out, and hundreds of articles and reports were consulted.

Results

The assessed soil loss values are highly variable, especially from year to year, as they strongly depend on the weather and the land management. Averaged across the first 10 study years, one-third (32.2 %) of the fields exhibited erosion. With 0.75 t ha^{-1} yr^{-1} (mean) and 0.56 t ha^{-1} yr^{-1} (median), the average annual soil loss of the region was relatively small. The year-to-year variation in soil loss of the region was great and ranged from 0.16 to 1.83 t ha^{-1} yr^{-1}. The maximum annual soil erosion in a single field was 58 t ha^{-1} yr^{-1}, thus demonstrating that only a few erosion events on a few fields may decisively contribute to the total extent of soil erosion in a region. The value for long-term tolerable soil erosion according to SoilPO was exceeded in 14 fields. 88 % of soil erosion took place on plough tilled land (PT), 9 % on non-ploughed land with less than 30 % surface residue cover (RT), 1 % on mulch-tilled land with more than 30 % surface residue cover (MT), and 2 % in non-tilled or strip-tilled land with >30 % soil cover (NT). At 0.07 and 0.12 t ha^{-1} $year^{-1}$, respectively, the mean soil loss in MT and NT fields was more than an order of magnitude lower than that under PT (1.24 t ha^{-1} $year^{-1}$) (Prasuhn, 2012). Wheel tracks, furrows, headlands, and slope depressions were important on-site accelerators of erosion. Run-on from adjacent upslope areas was an important trigger of erosion. Of the soil moved by erosion, 52 % was deposited within the field of origin. A high proportion (72 %) of the linear erosion features caused off-site damage. Part of the total eroded soil (20 %) was transported into surface water.

The largest soil losses in the hilly case study area are found on potato fields (Prasuhn *et al.*, 2017). Over 10 years, a total of 521 t of soil was eroded from these potato fields at an average of 2.87 t ha^{-1} $year^{-1}$. This corresponds to 26 % of total soil erosion in the region, despite potato fields only covering 7 % of the total agricultural area. Promising measures such as a device digging holes into the bottom of the furrows between the potato ridges showed how soil surface structure can be changed and infiltration increased, thereby reducing soil erosion and preventing waterlogging (Lemann *et al.,* 2018).

Comparing the first 10 years with the second decade of observation showed that the overall soil loss reduced from 200 t/y to 59 t/y (Fig 1). Also the number of high erosion loss features has been reduced.

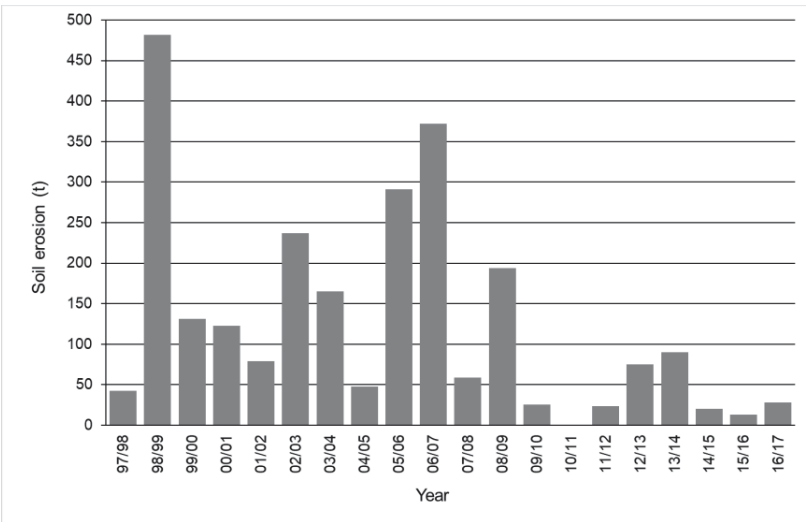

Figure 1: Development of annual soil erosion in a 265-hectare study area northwest of Bern (OFEV, 2017; data by Prasuhn)

The new enforcement of erosion protection within the Direct Payment Directive started in 2017. This implies that the cantonal administration has to take risk-based erosion controls on farmers' fields. The renewed erosion risk map is supporting the identification of high-risk areas, and combined with the intensity of rainfall events, provides an opportunity to concentrate on problem areas. If there is an erosion event taking place, the farmer has to design a site-specific action plan, either on his own or with support from the agricultural advisors. The action plan includes adequate prevention measures of his/her own choice, adapted to the local environmental but also socio-economic circumstances, providing more room for own solutions rather than prescribed measures. The action plan is elaborated for 6 years and includes concrete measures for each field. Only if the same farmer experiences recurrent soil erosion, he/she is punished by cutting direct payments.

The central role of technical experts at national and cantonal level and from research institutes such as Agroscope who function as spokespersons and moral entrepreneur for soil policy, has been a constant throughout the history of combatting soil erosion. This leading role can be seen as a strength and weakness. These experts succeeded in creating the first legal framework around qualitative soil protection in Europe. However, by confining the problem of soil erosion to an agronomic on-site problem and leaving it to technical expert circles, it became a top-down expert-based approach. In addition, the process of defining agro-environmental policies led to significant inconsistencies, such as the disconnection between quantitative (surface) and qualitative (fertility) soil protection measures, the lack of a coherent policy for the management of organic matter, the lack of guidelines around off-site erosion, etc. Furthermore, due to lack of human, financial, political and cognitive resources in environmental administration and to resistance with respect to sustainable management measures, the implementation of the SoilPO was incomplete. The analysis presented here demonstrates how points of consensus reached after long negotiations are constantly being called into question, sending confusing signals to all actors involved.

Discussion

The success of the soil erosion reduction in the Frienisberg area is probably mainly due to the financial support for conservation agriculture measures. The share of conservation agriculture practices increased from an average of 6 % in the first 10 years to 60% in the following 10 years as a result of participation in cantonal (2010-2015) and state subsidy programmes (2014-2017), and was 75 % of the arable land in the study area in 2017. The sensitisation of farmers by agricultural advisors as well as the scientific activities likely had a significant influence. In overall Switzerland, the proportion of conservation tillage methods in 2017 was only 23 %. This study thus shows that erosion control is possible and successful under real-life conditions. With its policy change after 2017, subsidy for the reduction of plant protection products became higher than for conservation agriculture, which lead to a re-increase of ploughed fields. Whether more erosion will take place due to this has to be seen in the coming years.

The environmental problem of soil degradation is not so much a technical as an expert, social, political and democratic problem. First, scientific research around soil erosion has mainly focused on a risk-based approach aiming at developing technical innovations. From this point of view, the efficiency of agri-environmental schemes depends on the participation of farmers. The lack of sociological expertise made soil degradation a depoliticized issue hardly understandable for lay people. Second, the unequal budgets and legitimacy as between environmental and agricultural administrations, as well as the influence of lobbies and the food industry, weigh heavily during the development, the implementation and the evaluation of agri-environmental policies. Trying to make soil degradation a social concern may improve balancing these power relationships.

Conclusions

Long-term monitoring in the field made it possible to draw conclusions with regard to extent, causes, spatial distribution, and off-site damage of soil erosion as well as the efficiency of mitigation measures. The approach taken in Switzerland may serve as input for similar considerations in other countries. However, experiences from the new enforcement are still lacking and although technical and agronomic innovations are essential, experts must bear in mind that soil erosion is a complex socio-environmental problem.

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